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ECOSYSTEM IN HIGHER EDUCATION INSTITUTIONS IN
ISRAEL**

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FIELD OF ACTIVITY**

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**EVALUAREA ȘI MANAGEMENTUL ECOSISTEMULUI DE
INOVARE ÎN INSTITUȚIILE DE ÎNVĂȚĂMÂNT SUPERIOR
DIN ISRAEL**

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DOMENIUL DE ACTIVITATE**

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ANNOTATION
to the doctoral thesis in economics by Israeli Milana
“Evaluation and management of innovation ecosystem in higher education institutions in Israel”,
Free International University of Moldova, Chisinau, 2023

The structure of the thesis: introduction, four chapters, conclusions and recommendations, bibliography from 276 sources, 168 pages of main text, 34 figures and 26 tables, 62 appendices.

The purpose of research is to scientifically substantiate the methodological provisions of the management mechanism and develop scientific and practical recommendations for assessing the development of the innovation ecosystem of higher educational institutions in Israel to improve their competitiveness.

Objectives: to reveal the conceptual aspects of the innovation ecosystem; to study the approaches to the formation and development of the university innovation ecosystem ; describe approaches to assessing the innovation ecosystem of higher education institutions; to analyze the national innovation system of Israel; to diagnose the innovation ecosystem of higher education institutions in Israel; analyze the factors of the external and internal environment of the innovation ecosystem of higher education institutions in Israel; to develop a mechanism for managing the innovation ecosystem of higher education institutions; to form an approach to the development of a strategy for the formation and development of the university innovation ecosystem ; to develop a methodology for assessing the development of the university's innovation ecosystem.

The scientific novelty: lies on the definition of the innovation ecosystem in the university that has been clarified and its features have been revealed. They are expressed in the intermediary role of the ecosystem between the university and the external market environment. In the process of this mediation, scientific and educational institutions, business partners and government organizations are united. a model of the university's innovation ecosystem has been developed. It considers the interrelationships of educational, research and entrepreneurial activities. a scheme of the mechanism for managing the university innovation ecosystem has been developed. This scheme of the mechanism is a set of processes, principles and methods that ensure the achievement of goals for the creation and promotion of innovations. This process involves the implementation of comprehensive activities through coordinated center. An approach to the development of a strategy for the formation and development of the innovative ecosystem in the university has been formed. This approach includes stages, goals, objectives, and activities adapted for implementation at the institutional level in Israel's higher education system. A methodology for assessing the development of the innovative ecosystem in higher education institutions was developed and proposed for implementation. It includes the calculation of the integral index and consists of four stages. Each stage is based on the development of a strategic map and the interaction of strategic aspects that are a functional component of the university's innovation ecosystem.

The scientific problem is the study of theoretical and practical aspects of the innovation ecosystem in Israeli higher educational institutions, the creation of a mechanism for its management and a development assessment methodology.

The theoretical significance lies in the fact that the application of the conceptual foundations for the formation of the university innovation ecosystem develops the scientific and methodological apparatus for the organization of scientific and innovative activities and contributes to the purposefulness of the processes of managing the results of intellectual activity.

The practical significance is determined by the high degree of possibility of applying the results of the study relating to the solution of the scientific and practical problem of assessing and managing the innovation ecosystem in the field of higher education. The scheme of the mechanism for managing the university innovation ecosystem and the set of measures for its coordination center, the approach to the development of a strategy for the formation and development of the university's innovation ecosystem, the methodology for assessing the development of the innovation ecosystem are practically applicable to improving the innovation management system in higher educational institutions of Israel.

Implementation of scientific results. Scientific research in the form of conclusions and recommendations were presented at scientific conferences and in journals: 4 articles (3.3 a.l.) published in scientific journals of category “B”, 3 articles (2.0 a.l.) published in scientific journals of other databases, 4 reports (1.9 a.l.) presented at foreign conferences and 1 report (0.45 a.l.) at conferences held in the Republic of Moldova.

ADNOTARE
la teza de doctor în științe economice Israeli Milana cu tema
„Evaluarea și managementul ecosistemului de inovare în instituțiile de învățământ
superior din Israel”,
Universitatea Liberă Internațională din Moldova, Chișinău, 2023

Structura tezei: introducere, patru capitole, concluzii și recomandări, bibliografie din 276 de surse, 168 pagini de text principal, 34 figuri și 26 tabele, 62 anexe.

Scopul tezei este de a fundamenta științific prevederile metodologice ale mecanismului de management și elaborarea de recomandări științifice și practice pentru evaluarea dezvoltării unui ecosistem inovator al instituțiilor de învățământ superior din Israel pentru a-și îmbunătăți competitivitatea.

Sarcinile tezei: dezvoltarea aspectelor conceptuale ale ecosistemului inovației; explorarea abordărilor de formare și dezvoltare a unui ecosistem inovator al unei universități; descrierea abordărilor de evaluare a ecosistemului de inovare al instituțiilor de învățământ superior; efectuarea unei analize a ecosistemului național de inovare al Israelului; diagnosticarea ecosistemului inovator al instituțiilor de învățământ superior din Israel; analizarea factorilor mediului extern și intern al ecosistemului de inovare al instituțiilor de învățământ superior din Israel; dezvoltarea unui mecanism de gestionare a ecosistemului de inovare al instituțiilor de învățământ superior; să formeze o abordare a dezvoltării unei strategii pentru formarea și dezvoltarea ecosistemului de inovare al universității; dezvoltarea unei metodologii de evaluare a dezvoltării ecosistemului de inovare al universității.

The scientific novelty: constă în definirea ecosistemului de inovare al universității și dezvoltarea trăsăturilor sale. Ele se exprimă prin rolul de intermediar al ecosistemului dintre universitate și mediul de piață externă. În procesul acestei medieri, instituțiile științifice și educaționale, partenerii de afaceri și organizațiile guvernamentale sunt unite. A fost dezvoltat un model al ecosistemului de inovare al universității. Acesta ia în considerare interrelațiile dintre activitățile educaționale, de cercetare și antreprenoriale. A fost elaborată o schemă a mecanismului de gestionare a ecosistemului de inovare al universității. Această schemă a mecanismului este un set de procese, principii și metode care asigură atingerea obiectivelor de creare și promovare a inovațiilor. Acest proces presupune implementarea unor activități cuprinzătoare prin intermediul centrului coordonat. S-a format o abordare a dezvoltării unei strategii pentru formarea și dezvoltarea ecosistemului de inovare al universității. Această abordare include etape, scopuri, obiective și activități adaptate pentru implementare la nivel instituțional în sistemul de învățământ superior din Israel. A fost elaborată și propusă pentru implementare o metodologie de evaluare a dezvoltării ecosistemului de inovare în instituțiile de învățământ superior. Aceasta include calculul indicelui integral și constă din patru etape. Fiecare etapă se bazează pe elaborarea unei hărți strategice și pe interacțiunea aspectelor strategice care sunt o componentă funcțională a ecosistemului de inovare al universității.

Problema științifică soluționată: studiul aspectelor teoretice și practice ale ecosistemului de inovare în instituțiile de învățământ superior israeliene, crearea unui mecanism de management al acestuia și a unei metodologii de evaluare a dezvoltării.

Importanța teoretică constă în faptul că aplicarea fundamentelor conceptuale pentru formarea unui ecosistem inovator al universității dezvoltă aparatul științific și metodologic de organizare a activităților științifice și inovatoare și contribuie la obiectivitatea proceselor de gestionare a rezultatelor activității intelectuale.

Semnificația practică este determinată de gradul înalt de posibilitate de aplicare a rezultatelor studiului privind soluționarea problemei științifice și practice de evaluare și gestionare a ecosistemului inovației în domeniul învățământului superior. Schema mecanismului de gestionare a ecosistemului de inovare al universității și un set de măsuri pentru centrul său coordonator, abordarea a dezvoltării unei strategii de formare și dezvoltare a ecosistemului de inovare al universității, metodologia de evaluare a dezvoltării ecosistemului inovației, dezvoltat de autor, sunt aplicabile pentru a îmbunătăți sistemul de management al inovației în instituțiile de învățământ superior din Israel.

Implementarea rezultatelor științifice. Cercetările științifice sub formă de concluzii și recomandări au fost prezentate la conferințe științifice și în reviste: 4 articole (3,3 c.a.) publicate în reviste științifice de categoria „B”, 3 articole (2,0 c.a.) publicate în reviste științifice din alte baze de date, 4 rapoarte (1,9 c.a.) prezentate la conferințe externe și 1 raport (0,45 c.a.) la conferințe desfășurate în Republica Moldova.

АННОТАЦИЯ

к диссертации на соискание ученой степени доктора экономических наук
Исраели Миланы, “Оценка и управление инновационной экосистемой в высших
учебных заведениях Израиля”,

Международный Независимый Университет Молдовы, Кишинэу, 2023

Структура диссертации: введение, четыре главы, выводы и рекомендации, библиография из 276 источников, 168 страниц основного текста, 34 рисунков и 26 таблиц, 62 приложений.

Цель диссертации заключается в научном обосновании методологических положений механизма управления и разработки научно-практических рекомендаций оценки развития инновационной экосистемы высших учебных заведений Израиля для повышения их конкурентоспособности.

Задачи диссертации: раскрыть концептуальные аспекты инновационной экосистемы; исследовать подходы формирования и развития инновационной экосистемы ВУЗа; описать подходы к оценке инновационной экосистемы высших учебных заведений; провести анализ национальной инновационной экосистемы Израиля; провести диагностику инновационной экосистемы высших учебных заведений Израиля; провести анализ факторов внешней и внутренней среды инновационной экосистемы высших учебных заведений Израиля; разработать механизм управления инновационной экосистемой высших учебных заведений; сформировать подход к разработке стратегии формирования и развития инновационной экосистемы университета; разработать методику оценки развития инновационной экосистемы университета.

Научная новизна: уточнено определение инновационной экосистемы университета и выявлены ее особенности: посредническая роль экосистемы между университетом и внешней рыночной средой при объединении научно-образовательных учреждений, бизнес-партнеров и государственных организаций; разработана модель инновационной экосистемы университета с учетом взаимосвязи образовательной, исследовательской и предпринимательской деятельности; разработана схема механизма управления инновационной экосистемой университета как совокупность процессов, принципов и методов, обеспечивающих достижение целей по созданию и продвижению инноваций, что подразумевает реализацию координационным центром комплексных мероприятий; сформирован подход к разработке стратегии формирования и развития инновационной экосистемы университета, включающий этапы цели, задачи и мероприятия, адаптированные для реализации на институциональном уровне в системе высшего образования Израиля; разработана и предложена к внедрению методика оценки развития инновационной экосистемы высших учебных заведений на основе расчета интегрального индекса, состоящая из четырех этапов, включающая разработку стратегической карты взаимодействия стратегических аспектов функциональных составляющих инновационной экосистемы университета.

Научная проблема заключается в исследовании теоретико-практических аспектов инновационной экосистемой высших учебных заведений Израиля, разработки механизма её управления и методика оценки развития.

Теоретическая значимость заключается в том, что применение концептуальных основ формирования инновационной экосистемы университета развивает научно-методологический аппарат организации научно-инновационной деятельности и способствует целенаправленности процессов управления результатами интеллектуальной деятельности.

Практическая значимость определяется высокой степенью возможности применения результатов исследования, касающихся решения научной и практической проблемы оценки и управления инновационной экосистемой в сфере высшего образования. Разработанные автором схема механизма управления инновационной экосистемой университета и комплекс мероприятий для его координационного центра, подход к разработке стратегии формирования и развития инновационной экосистемы университета, методика оценки развития инновационной экосистемы являются практически применимы для совершенствования системы управления инновационной деятельностью в высших учебных заведениях Израиля.

Внедрение научных результатов. Научные исследования в виде выводов и рекомендаций были представлены на научных конференциях и в журналах: 4 статьи (3,3 а.л.), опубликованные в научных журналах категории "В", 3 статьи (2,0 а.л.), опубликованные в научных журналах других баз данных, 4 доклада (1,9 а.л.), представленных на зарубежных конференциях и 1 доклад (0,45 а.л.) – на конференциях, проведенных в Республике Молдова.

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LIST OF ABBREVIATIONS

ARE - Academic research and entrepreneurship
ARWU - Academic Ranking of World Universities
B2B - business-to-business
BII - Bloomberg Innovation Index
BSC - Balanced Scorecard
CHE - Council for Higher Education
GCI - World Competitiveness Index
GEM - Global Entrepreneurship Monitor (international research program)
GERD - Gross domestic expenditure on R&D
GII - Global Innovation Index
IAS - Israeli Academy of Sciences
ICT - Information and Communications Technology
IDF - Israel Defense Forces
IE - Innovation Ecosystem
UIE - University Innovation Ecosystem
IFS - Israeli Science Foundation
IFS - Israeli Science Foundation
IIA - Israel Innovation Authority
IN - Interactions and Networks
IP - Intellectual Property
IPOs - Initial Public Offerings
IT - Information Technology
ITTN - Israel Technology Transfer Network
MIT - Massachusetts Institute of Technology
MNCs - Multinational Technology Companies
NECI - National Entrepreneurship Context Index
NIS - National Innovation System
ILS - Israeli currency (new name shekel)
OCS - Office of the Chief Scientist
OECD - Organization for Economic Cooperation and Development
PBC - Planning and Budgeting Committee of the Council for Higher Education
PEST – Political, Economics, Socio-culture, Technological
PSED - Panel Study of Entrepreneurial Dynamics
QS - World University Rankings

R&D - Research and Development
RIS3 model - Research and Innovation Strategies for Smart Specialization
SIR - SCImago Institutions Rankings
STC - Science and Technology Complex
SWOT - Strengths, Weaknesses, Opportunities, Threats
TAU – Tel Aviv University
THE - Times Higher Education
TNCs - Transnational companies
TTC - Technology Transfer Company
UCLA - University of California, Los Angeles
UNESCO - United Nations Educational, Scientific and Cultural Organization
VCs - Venture Capital Institutions

INTRODUCTION

Actuality and importance of research theme. Globalization, internationalization, intellectualization and digitalization taking place today in the world economy require the search and application of new models of growth and development, even those with a long history and firmly rooted social institutions. Particular attention in this direction should be paid to the transformation of higher education, which, like no other institution, reflects the ability of the economy to generate, transfer and use knowledge. The goals of sustainable development, the ideas of global education, new information technologies and the resulting change in the traditional structure of labor markets led to a review of the tasks of education, traditional forms and methods of teaching, and contributed to a change in the educational paradigm as a whole.

Scientific and innovative activities in universities are traditionally a source of new developments, but they become innovations only in the conditions of their market commercialization, the success of which depends on the effective management of the interaction processes of interaction between science and the market. Nowadays, the significance of a higher educational institution is determined by the level of development of scientific and innovative structures, the ability to commercialize scientific and technical ideas and developments, the degree of influence of a scientific and educational institution on the innovative economy of the region and the country as a whole.

With the spread of the concept of open innovation and the understanding of the role of education in innovative development, the concepts of the knowledge ecosystem and the innovation ecosystem arose. Universities that successfully combine educational and research activities are a key element of the ecosystem. New possibilities of the educational environment contributed to the application of the ecosystem approach to identify areas for improving the innovative and educational activities of universities, substantiate specific areas and forms of interaction between universities, business and the state, and develop relevant educational programs. The ecosystem approach began to be applied in education as a response to the growing complexity and diversity of processes that determine the functioning of educational and innovation systems. Considering the educational system through the prism of the interaction of its elements among themselves and with the environment, the ecosystem approach allows a shift in emphasis from the characteristics of individual elements of the system to the relationship between them and the features of their interaction. The more stable and diverse the connections, the more development options the educational system has and the more adaptive it is to changing conditions.

The study of the Israeli innovation ecosystem directly reflects the complexity, variability, flexibility and mobility of the modern process of innovation development, both in functional and spatial aspects. An innovation ecosystem is being formed within the framework of Israeli higher

educational institutions with the aim of unlocking their innovative potential, successfully organizing the commercialization of scientific research and development, which meets the needs of modern society and contributes to the innovative development of the country.

Despite considerable attention to this problem, many issues of the organization of innovation activity remain unresolved, first of all, this concerns the methodology for assessing and managing the university innovation ecosystem. The provisions presented above determine the relevance and significance of the chosen topic of the dissertation work.

Study degree of the research theme. At the moment, the innovation ecosystem of higher education institutions is considered a relatively young phenomenon and, accordingly, an area of research. Despite this, there is a significant amount of published work by scientists and researchers, recognized experts, who have defined key terms and established a conceptual framework.

Issues of the theory of innovation, theoretical concepts and approaches to the innovation ecosystem are given considerable attention in the works of a number of researchers: A. Tensley, J.F. Moore, R. Adner, R. Kapoor, B. Mercan, D. Goktas, D.S. Oh, C. Wessner, et al. Various aspects of the development of national innovation systems and innovation ecosystems are considered in the works of H.W. Chesbrough, D.J. Jackson, N. Rubens, M.G. Russell and other authors.

Works by Israeli authors S. Lach, Sh. Parizat, D. Wasserteil covered to the study of the problems of Israeli innovation policy, the creation of a venture capital industry in Israel, and, above all, the penetration of Israeli technologies into the world market.

H. Etzkowitz, Y. Cai, D.B. paid attention to the innovative development of the university and its role in national and regional innovation systems. Audretsch, P. Benneworth, G.J. Hospers, R. Cowan, E. E. Lehmann, A.L. Wal, R. Boschma et al.

The conceptual foundations of the innovation ecosystem of the higher education institutions innovation ecosystem and the directions for the development of this concept are presented in scientific works: M. Guerrero, K. Dunn, F.T. Rothaermel, G.H. Moraes, D.S. Agung, L. Jiang, S. Shane, E.G. Carayannis, M. Zedtwitz, F. Pirnay, as well as Israeli scientists H. Messer-Yaron, Y. Niv, I. Pinto, U. Kirsch, D. Getz, R. Klein, E. Barzani, E. Leck, and others.

Many scientists and practitioners have been studying the problems of managing an innovation ecosystem, including universities: E. Autio, J. Levie, S. Heaton, D. S. Siegel, D. J. Teece and others.

By their scientific studies, the Moldovan scientists Cojocaru I., Rosca A., Rusu A., Guzun M., Stratan A., Șavga L., Novac A., Gribincea C., Duca A., Dumitrasco M. and other authors consider the processes of innovative development of the Republic of Moldova, aimed at the development and/or implementation of innovations, improvement of innovative potential,

cooperation between enterprises (including SMEs) and research institutions in the Republic of Moldova. The significance of the innovation activity of Moldovan higher education institutions and a number of barriers on this path are reflected in the works of Andrițchi V., Suslenco A., Prisacăru V., Cosciug C., Simciuc E., Cuciureanu G., Minciună V., Călugăreanu I. and others. The scientific interest in solving the problems of developing of innovative activity at the level of the country and higher education is given considerable attention; however, the matters related to the evaluation management of the innovation ecosystem in the field of higher education are not sufficiently disclosed.

The contribution of economists is the basis for further research, development of theoretical provisions and practical recommendations in the field of assessment and management of the innovation ecosystem of higher education institutions. However, all aspects of the organization of innovative activity in the university are not taken into account, taking into account increasing competition, globalization, as well as the current state of the economy. This necessitates the improvement of assessment methods, tools and improvement of innovation management mechanisms, especially at the stages of formation and development of the innovation ecosystem of universities.

Purpose of research consists in the scientific substantiation of the methodological provisions of the management mechanism and the development of scientific and practical recommendations for assessing the development of the higher educational institutions innovation ecosystem in Israel to improve their competitiveness.

Objectives of research. The designated goal of the dissertation research led to the formulation of the following tasks:

- to reveal the conceptual aspects of the innovation ecosystem;
- to explore approaches to the formation and development of the university's innovation ecosystem;
- to describe approaches to assess the innovation ecosystem of higher education institutions;
- to conduct an analysis of Israel's national innovation system;
- to diagnose the innovation ecosystem of higher educational institutions in Israel;
- to analyze the factors of the external and internal environment of the innovation ecosystem of higher educational institutions in Israel;
- to develop a mechanism for managing the innovation ecosystem of higher education institutions;
- to form an approach to the development of a strategy for the formation and development of the innovative ecosystem in Israeli higher education institutions;

- to develop a methodology for assessing the development of the university's innovation ecosystem.

Hypothesis of research. The working hypothesis of the dissertation research is the assumption that the formation and development of an innovative ecosystem within higher education institutions contributes to the development of universities' research activities. This will increase the effectiveness of universities' activities in the development of innovations, training of personnel for the implementation of innovative activities, commercialization of intellectual property results, additional financing, and speed of identification and development of talents. Furthermore, the aforementioned modifications create conditions that will make Israeli education more attractive and aligned with international standards.

As part of the hypothesis, the author assumes that the mechanism for managing the university innovation ecosystem, aimed at its development, will be effective if the following conditions are met:

- maintaining a balance between teaching, fundamental, applied research and academic entrepreneurship at the university;
- creating of favorable conditions for the interaction of participants in the innovation process;
- identifying and coordinating organizational and resource opportunities between the participants of the innovation ecosystem;
- providing conditions for the creation and functioning of the management center of the innovation ecosystem;
- forming of the structure of the innovation ecosystem should take place according to the principle of a self-organizing system that has the ability to self-develop and self-regulate in the face of a changing environment;
- involving of the governing structures of higher educational institutions, government and business structures to develop strategic directions for the development of the ecosystem;
- providing of legal regulation (including internal management regulations), the appropriate organizational structure of the university, innovative infrastructure, a high level of entrepreneurial culture, etc.

Generalization of the methodology and justification of the selected research methods.

The methodological base relies on general scientific methods of comparison, questioning, studying sources, general logical methods of analysis and synthesis, deduction, modeling, generalization, as well as interdisciplinary and particular scientific methods, including graph theory.

The research methods in the dissertation research are:

- theoretical description methods: analytical, comparative and descriptive methods;

- theoretical methods-actions: dialectical method of cognition of the innovation ecosystem of higher educational institutions, identification of existing approaches and concepts;
- empirical methods-descriptions: practical study of the Israeli higher education system and ratings of Israeli higher educational institutions; dissertation research; observation; questioning; studying the strategies of the world's leading universities and Israeli universities;
- empirical methods-actions: studying the influence factors of the external and internal environment on the formation and development of an innovation ecosystem of higher educational institutions, drawing up a phased forecast for its development within the framework of a specific strategy.

Scientific originality and novelty:

- the definition of the university innovation ecosystem has been clarified and its features have been identified: the intermediary role of the ecosystem between the university and the external market environment was determined with the assistance of the association of scientific and educational institutions, business partners and government organizations;
- a model of the university innovation ecosystem was developed, taking into account the relationship between educational, research and entrepreneurial activities;
- a scheme of the mechanism for managing the university innovation ecosystem was defined as a set of processes, principles and methods that ensure the achievement of goals for the creation and promotion of innovations, which implies the implementation of a coordination center of complex events;
- an approach to the development of a strategy for the formation and development of the innovative ecosystem of the university was formed. It includes stages, goals, objectives and activities adapted for implementation at the institutional level in Israel's higher education system;
- a methodology for assessing the development of the innovative ecosystem of higher education institutions was developed and proposed for implementation. It is based on the calculation of the integral index and consists of four stages. The methodology includes the development of a strategic map of the interaction of strategic aspects of the functional components of the university innovation ecosystem.

Abstract of thesis chapters, focusing on the investigations and their need for the achievement of the purpose and the objectives of the research.

The doctoral dissertation is presented on 168 pages of the main text. The structure of the doctoral dissertation includes an introduction, four chapters, conclusions and recommendations, a bibliography of 276 sources, 26 tables, 34 figures and 62 appendices.

In the introduction, the relevance and significance of the research topic, the degree of study of the topic are argued, the purpose and objectives are indicated, the research hypothesis is reflected, the research methodology, elements of scientific novelty, the research problem, the theoretical and practical significance of the work are presented, a summary of the dissertation chapters content is given.

Chapter I "Theoretical foundations of the innovation ecosystem of higher educational institutions as an object of management" investigates scientific approaches to the content of the innovation ecosystem. The theoretical aspects of the concept of the innovation ecosystem from the point of view of the interaction of various actors were also considered. Approaches to the formation and development of the university innovation ecosystem are disclosed and its main elements are described. Approaches to the assessment of the higher educational institutions innovative ecosystem are characterized.

Chapter II "Materials and methods of research" presents the content of the methodological foundations of the study, namely, the methods, technologies and research tools are characterized. The methodology for formulating conclusions based on the results of the study is described.

Chapter III "Analysis of the national innovation system and diagnosis of the innovation ecosystem of Israeli higher education institutions" analyzes the national innovation system, characterizes and evaluates higher education in Israel, as well as diagnostics of the innovation ecosystem of higher educational institutions are given. The factors of formation and development of innovation ecosystems based on universities are analyzed.

Chapter IV "Improvement of the mechanism for management and evaluation of the development of the innovative ecosystem of higher education institutions" presents the essence and scheme of the mechanism for managing the university's innovation ecosystem and reveals the content of its structural elements, formed an approach to the development of a strategy for the formation and development of the university innovation ecosystem, and develops a methodology for assessing the development of the innovation ecosystem of higher educational institutions and the methodology for calculating the integral index.

In the conclusions and recommendations at the theoretical and practical levels, the results of the research are summarized, key conclusions are formulated and presented, recommendations are given in accordance with the purpose of the given topic of the dissertation research.

1. THEORETICAL FOUNDATIONS OF THE INNOVATION ECOSYSTEM OF HIGHER EDUCATIONAL INSTITUTIONS AS A CONTROL OBJECT

1.1. Conceptual aspects of the innovation ecosystem

Recently, the sharing of economic categories "entrepreneurship", "ecosystem", "entrepreneurial ecosystem", "innovation", "innovation ecosystem" has become widespread. The definition of terms that characterize the essence of any concept is the starting point for formulating the goals, structure and scope of further research. Therefore, the purpose of this paragraph is to reveal the essence of the multilateral concept of an innovation ecosystem, to characterize the fundamental aspects of the concept of an innovation ecosystem, to determine the factors influencing the development of an innovation ecosystem.

The concept of "ecosystem" was introduced into scientific circulation by A. Tensley¹ in 1935 to designate a relatively stable system that includes: a community of living organisms and their habitat, a system of connections that exchange matter and energy between them.

Ecosystems differ from systems in their openness, dynamism, speed of decision-making, the essential importance of the internal interaction of participants, internal incentives, etc., which are presented in Table 1.1.

Table 1.1. The difference between the terms "system" and "ecosystem" [developed by the author based on²]

Criterion	System	Ecosystem
Interdependence of components (subjects, objects)	Interdependent	Interdependent
Dependence on other systems	Do not depend	Adapt
Permeability	Closed	Open

From the point of view of systems science, the term "system" refers to a specific set of components (subjects, objects) that are interdependent, but independent of other systems. The constituent elements of the ecosystem depend on the external environment and exist under its influence, but at the same time, the ecosystem itself can influence the external reality and subsequently transform it in a dynamic way. The ecosystem can be considered only as a single whole, and not fragmentarily, because each element of the system has a functional influence on other elements. Participants in the ecosystem belong to different sectors of the economy. Ecosystems are adapted for interactive value co-creation, while systems are not. The ecosystem can develop by constantly adapting its components to changing environmental conditions³.

¹ TANSLEY, A.G. *The use and abuse of vegetational terms and concepts*. In: Ecology, 1935, nr. 16 (3), p. 284–307. [accessed 02.06.2020]. Available at: <https://doi.org/10.2307/1930070>

² RITALA, P., ALMPANOPOULOU, A. *In defense of 'eco' in innovation ecosystem*. In: Technovation, 2017, nr. 60-61, p. 39-42. ISSN 0166-4972.

³ SMORODINSKAYA, N., RUSSELL, M., KATUKOV, D., STILL, K. *Innovation ecosystems vs. innovation systems in terms of collaboration and co-creation of value*. In: Proceedings of the 50th Hawaii international conference on system sciences, 2017. [accessed 07.10.2019]. Available at: <http://hdl.handle.net/10125/41798>.

Ecosystems differ from traditional systems in their openness, dynamism, speed of decision-making, the essential importance of the internal interaction of participants, internal incentives, etc. Ecosystems can be viewed as open social systems⁴ that allow interaction between their internal elements and the environment.

Thus, the ecosystem can be seen as a complex and dynamic system capable of transforming and adapting to the external environment, consisting of various participants who work together to create new value.

Over time, the concept of an ecosystem began to be actively used in other areas and sectors of science. In the humanities, social and economic sciences, the ecosystem approach entered largely due to the need to imagine the process of interaction between groups consisting of various elements that have a connection and components of the environment. An example of an ecosystem approach in economics is the business system. By business ecosystem, J.F. Moore⁵ understood a network of organizations (suppliers, market intermediaries, consumers and competitors). Relations between companies, in his opinion, are built similarly to an ecosystem in nature, and with the help of interaction (even if companies are not partners, but competitors), you can achieve greater results than one by one⁶. Organizations form a network of interdependencies, a system of mutual support and collaboration to create a new innovation. This format of cooperation ensures the competitiveness of each member of the business ecosystem and helps to support a new product or service, satisfying the needs of the client.

Creating an innovation ecosystem is essential to promoting innovation, stimulating economic growth, and improving people's lives. By encouraging open innovation, knowledge sharing, and collaboration, innovation ecosystems can help overcome barriers to innovation, such as resource constraints, lack of expertise, and market fragmentation. They can also create an enabling environment for startups and small businesses to thrive, attract talent and investment, and stimulate economic growth and social progress. This requires a coordinated effort by various stakeholders, including government, industry, academia, and civil society, to create an environment that supports innovation and encourages collaboration and knowledge sharing.

Many authors working with the concept of "innovation ecosystem" (IE) repeat the postulates of Moore, adding an innovative component to them. The author has identified some theoretical approaches to the content of IE and they are reflected in Table 1.2.

⁴ SCOTT, W.R., DAVIS, G.F. *Organizations and organizing: Rational, natural and open systems perspectives*. New York: Routledge, 2016. 464 p. ISBN 978-0131958937.

⁵ MOORE, J.F. *The death of competition: leadership and strategy in the age of business ecosystems*. New York: Harper Business, 1997. 320 p. ISBN 10-0887308503.

⁶ MOORE, J. F. *Business ecosystems and the view from the firm*. In: The antitrust bulletin, 2006, nr. 51(1), p. 31-75. ISSN 0003-603X.

Table 1.2. Approaches to the study of innovation ecosystems [developed by the author based on ⁷⁻¹³]

Approach Name	Interpreting the innovation ecosystem	Analysis of the features of the approach
"Joint Decision-Making Mechanisms" (R. Adner ⁷)	Collaborative mechanisms through which the central firm and other participants in the ecosystem combine their individual offerings into a single consumer-facing solution.	One of the very first interpretations, which is used by subsequent researchers
"Interdependent structure" (Adner, Kapoor ⁸)	The interdependent ecosystem structure consists of a central firm and other participants (consumers, suppliers, various regulators, and firms that produce related goods and services). IE members can support or discourage the central company from innovating.	An ecosystem brings together stakeholders who often have different goals and expectations
"Enabling environment for innovation" (Mercan, Göktas ⁹)	The entirety of economic actors, their economic interactions, and non-economic elements combine to form a favorable environment for the emergence of new ideas, the implementation of innovations, and their dissemination. Individuals within a developed ecosystem have the ability to collaborate beyond their own companies and leverage collective knowledge towards innovative solutions.	The presence of economic agents and non-economic components contributes to the creation of an enabling environment for innovation
"Central firm or platform" (Pellikka, Ali-Vehmas ¹⁰)	An interconnected network consisting of a central firm or platform and business and non-profit organizations centered around it that interact with each other to create and capture new value through innovation	The focal point of the ecosystem may not only be a single company, but also a collaborative platform for joint action.
Ecosystem Participants and Individual Actors (Oh et al. ¹¹ , Wessner ¹²)	Between individual actors and / or organizations there is a complex of relations with the common goal of ensuring innovative and technological development	IE includes ecosystem members and individual actors with certain values for the development of innovation
"Integration Approach" (Granstrand, Holgersson ¹³)	An evolving set of actors, activities, artifacts, institutions, relationships, as well as complementary and substitutive relationships that play a significant role in the innovation activity of the central firm and the entire ecosystem as a whole	IE consists of components: actors, activities, artifacts (new products and services), institutions, relationships within and between components

The table presents several approaches to the interpretation of the innovation ecosystem. Each

⁷ ADNER, R. *Match your innovation strategy to your innovation ecosystem*. In: Harvard Business Review, 2006, nr. 84, p. 98-107. ISSN 0017-8012.

⁸ ADNER, R., KAPOOR, R. *Value Creation in Innovation Ecosystems: How the Structure of Technological Interdependence Affects Firm Performance in New Technology Generations*. In: Strategic Management Journal, 2010, nr. 31(3), p. 306-333. ISSN 0143-2095.

⁹ MERCAN, B., GOKTAS, D. *Components of innovation ecosystems: a cross-country study*. In: International research journal of finance and economics, 2011, nr. 76(16), p. 102-112. ISSN 1450-2887.

¹⁰ PELLIKKA, J., ALI-VEHMAS, T. *Managing Innovation Ecosystems to Create and Capture Value in ICT Industries*. In: Technology Innovation Management Review, 2016, nr. 6(10), p. 17-24. ISSN 1927-0321.

¹¹ OH, D.S., PHILLIPS, F., PARK, S., LEE, E. *Innovation Ecosystems: A Critical Examination*. In: Technovation, 2016, nr. 54, p. 1-6. ISSN 0166-4972.

¹² WESSNER, C. *Innovation Policies for the 21st Century: Report of a Symposium*. Washington, DC: The National Academies Press, 2007. 222 p. ISBN 978-0-309-10316-9.

¹³ GRANSTRAND, O., HOLGERSSON, M. *Innovation ecosystems: A conceptual review and a new definition*. In: Technovation, 2020, nr. 90, p. 2-12. ISSN 0166-4972.

of the explanations highlights its different features. Collaboration and cooperation of participants influences the creation of more integrated solutions and is a common theme for several approaches. Another key topic is the interdependence of ecosystem members and the ways in which they interact to develop innovations. A central firm or platform can contribute to the creation and promotion of innovations, setting common goals and bringing together different organizations and individuals, creating new opportunities for creation Values.

The table also lists the various components of the innovation ecosystem. The understanding of the composition of the innovation/entrepreneurial ecosystem in the scientific literature has changed over time, remaining fairly homogeneous in its essence (Appendix 3). D. Isenberg in his study noted that the entrepreneurial system consists of many elements (leadership, culture, stock markets, advanced buyers, etc.)¹⁴, between which there are complex relationships. B. Spigel singled out the supporting culture, investment capital, mentoring as the main elements¹⁵. As an independent element of the ecosystem, E. Stam singled out the entrepreneurial talent, knowledge, and culture that exist in the region¹⁶. The innovation ecosystem also includes institutions (the rules by which the ecosystem functions and provides support to the entrepreneur), which are divided into formal (laws, regulations governing the operation of the innovation / business environment) and informal institutions (social and cultural practices)¹⁷, that form social interaction in the process of creating an idea and its commercialization. The innovation ecosystem develops by constantly adapting its components to changing situations¹⁸. Each element of the ecosystem has a functional influence on other elements and in a certain way regulates the processes within the system in order to maintain the necessary equilibrium state. This is because innovation is a complex and multifaceted process that requires coordination and interaction between different stakeholders and factors. Therefore, it is important to consider the elements of the ecosystem to create a favorable and effective environment for innovation. Neglecting any one element can lead to shortcomings or gaps in the innovation ecosystem, which can hinder the development and implementation of innovative ideas and products.

¹⁴ ISENBERG, D.J. *How to Start an Entrepreneurial Revolution*. In: Harvard Business Review, 2010, nr. 88(6), p. 41-50. ISSN 0017-8012.

¹⁵ SPIGEL, B. *The relational organization of entrepreneurial ecosystems*. In: Entrepreneurship theory and practice, 2017, nr. 41(1), p. 49-72. ISSN 1042-2587.

¹⁶ STAM, E. *Measuring entrepreneurial ecosystems*. In: Entrepreneurial ecosystems. New York: Springer, 2018, p. 173-197. ISBN 978-3-319-45654-6.

¹⁷ POCEK, J. *Which Types of Institutions Influence the Development of Entrepreneurial Ecosystems? A Legal Systems Perspective*. In: International Review of Entrepreneurship, 2020, №18(3). ISSN 1099-9264. [accessed 21.11.2021]. Available at: https://www.researchgate.net/publication/350855144_Which_Types_of_Institutions_Influence_the_Development_of_Entrepreneurial_Ecosystems_A_Legal_Systems_Perspective

¹⁸ LONG, C., HU, Q. *A Review of Research on Innovation Ecosystem Development*. In: Frontiers in Business, Economics and Management, 2022, nr. 4(2), c. 147-152. ISSN 2766-824X.

Summarizing the provisions of various researchers, the author concluded that Innovation ecosystem is a set of interrelated elements, such as: innovators of ideas, participants (actors), and their relationships, institutions, resources (material resources, labor resources, financial capital, and others), cultural and social component (social encouragement of the development of innovations and entrepreneurship, culture, etc.), innovation infrastructure. Their aim is to create and disseminate new ideas, knowledge, technologies, processes, products, and services. According to the author, an integrated and integrated approach to the development of the innovation ecosystem is needed to ensure the availability of all necessary elements and the joint work of all participants to create innovations.

Let us single out the fundamental aspects of the innovation ecosystem concept (Figure 1.1), which are considered in the literature from the point of view of the interaction of various actors around a certain central entity in order to create innovations (Appendix 1).

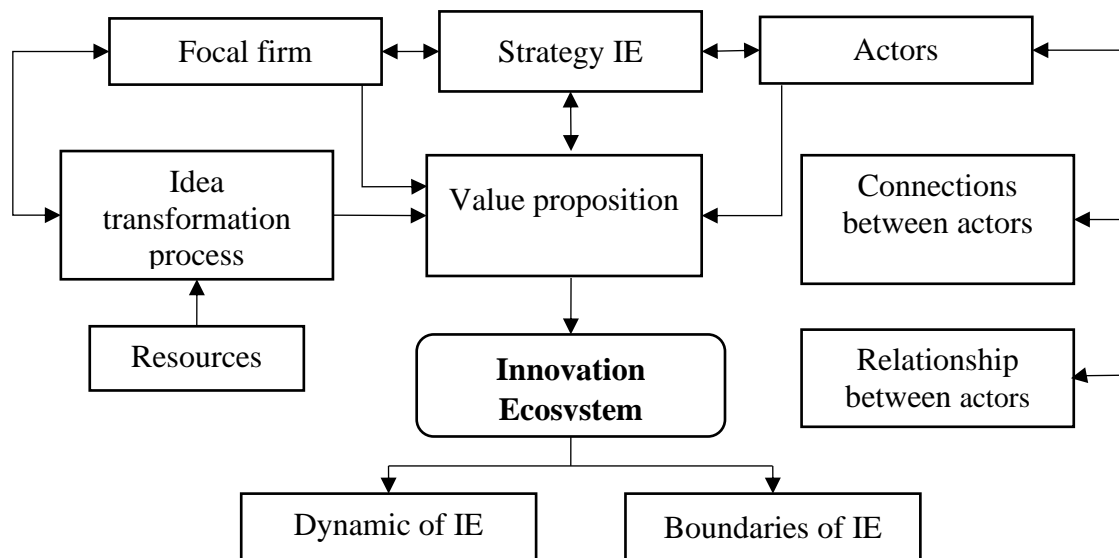


Figure 1.1. Fundamental aspects of the innovation ecosystem concept [developed by the author based on^{19 20}]

Focal firm. The focal firm plays a key role in the innovation ecosystem as it drives innovation by initiating and coordinating collaborative activities with other participants. Around focal firm (orchestrator or potential orchestrators) an innovation ecosystem is being built²¹. It can

¹⁹ HAN, J. et al. *Enhancing the understanding of ecosystems under innovation management context: Aggregating conceptual boundaries of ecosystems*. In: Industrial Marketing Management, 2022, nr. 106, p. 112-138. ISSN 1873-2062.

²⁰ JACOBIDES, M. G., CENNAMO, C., GAWER, A. *Towards a theory of ecosystems*. In: Strategic management journal, 2018, nr. 39(8), p. 2255-2276. [accessed 11.10.2022]. Available at: <https://doi.org/10.1002/smj.2904>

²¹ CHEN, J., HU, Y., GAO, Y., WANG, Q., LIU, Z. *Orchestrating an innovation ecosystem: The role of hub firms and ecosystem based on dynamic capabilities*. In: 2019 International Conference on Strategic Management Proceedings. Francis Academic Press, 2019. [accessed 11.10.2022]. Available at: DOI: 10.25236/icsm.2019.043.

be an actor or a company²², digital platform^{23 24}, business unit²⁵ and etc. The results of the activities of the focal firm and the innovation ecosystem are determined by the nature of the activities of all its participants.

Actors. Actors can be individuals, companies, universities, research institutes, technology platforms, venture capital and similar funds²⁶, governments, suppliers, manufacturers, start-ups, small and medium-sized enterprises, etc. All of them are interconnected by their functions, that is, the exchange of knowledge, information, technologies and others (Appendix 2). The result of the activity of the key actors of the ecosystem influences and determines the success / failure of its value proposition and each member of the ecosystem separately.

Idea transformation process. An innovation ecosystem is a description of innovation as a process of transforming an idea into a marketable product or service. The key idea around which an ecosystem begins to form can be the creation of a new product, a new technology, the development of digital platforms, etc. Ideas can be implemented as commercial and non-commercial (social) innovations. IE covers the process of moving from an idea/invention to its commercialization (promotion to the market) and is a means for co-creation and introduction to the market of inventions²⁷. The innovation process is non-linear and requires feedback at every stage of innovation creation. These qualities of the process will define the ecosystem as a complex system.

The innovation ecosystem and the innovation process are interdependent and closely related because IE provides the necessary inputs and support for the innovation process. The innovation process, on the other hand, is a sequence of actions related to the creation and implementation of new ideas or products. To achieve success, it relies on the resources and support of the innovation ecosystem. The innovation ecosystem can influence the direction and scale of the innovation ecosystem. process, and the innovation process, in turn, can influence the development and dynamics of the ecosystem.

Value proposition. The value proposition is the defining element and common goal of the

²² LINGENS, B., MIEHÉ, L., GASSMANN, O. *The ecosystem blueprint: How firms shape the design of an ecosystem according to the surrounding conditions*. In: Long Range Planning, 2021, nr. 54(2). [accessed 21.11.2021]. Available at: <https://www.sciencedirect.com/science/article/pii/S0024630120302429>

²³ HELFAT, C.E., RAUBITSCHKE, R.S. *Dynamic and Integrative Capabilities for Profiting from Innovation in Digital Platform Based Ecosystems*. In: Research Policy, 2018, nr. 47(8), p. 1391-1399. ISSN 0048-7333.

²⁴ CUSUMANO, M. A., GAWER, A. *The elements of platform leadership*. In: MIT Sloan management review, 2002, nr. 43(3), p. 51-58. ISSN 0360-8581.

²⁵ PELLIKKA, J., ALI-VEHMAS, T. *Managing Innovation Ecosystems to Create and Capture Value in ICT Industries*. In: Technology Innovation Management Review, 2016, nr. 6(10), p. 17-24. ISSN 1927-0321.

²⁶ WESSNER, C.W. *Entrepreneurship and the innovation ecosystem policy lessons from the United States*. In: Local Heroes in the Global Village, Springer, Boston, MA, 2005. p. 67-89. ISSN 1613-8333.

²⁷ *The Global Competitiveness Report 2015–2016*. World Economic Forum, Geneva, 2015. 393 p. [accessed 11.04.2020]. Available at: https://www3.weforum.org/docs/gcr/2015-2016/Global_Competitiveness_Report_2015-2016.pdf.

participants IE²⁸. An innovation ecosystem allows its members to work together to create value that they could not create alone, and extract value from new, complex value propositions²⁹.

Connections between actors IE. IE members have common goals and a shared vision of the desired change³⁰. On their basis, there are stable relationships that are formed in the network between individuals and organizations. IE is characterized by direct and reverse connections, incoming and outgoing flows of substances and energy (ideas, value, people, information, capital and other resources). The links between ecosystem participants can be different: financial, distribution, research, information, protective (security), industrial and commercial, etc.

Innovation ecosystems can be closed or open. The specific content of these ecosystems may vary depending on their objectives and focus. Closed innovation ecosystems rely on internal research and development (R&D) to generate new ideas and bring them to market³¹. This approach involves a high degree of control over the innovation process and intellectual property and may be suitable for organizations that require a high level of confidentiality or have limited external resources.

Open innovation ecosystems typically involve a variety of actors, including individuals, organizations, and institutions that work together to create and share knowledge and innovation³². The innovation ecosystem is an open, self-organizing, self-regulating, and self-developing system that is characterized by its complexity. The result of the interrelations of actors is: the joint creation of innovations or the formation of an innovative environment based on inter-firm or inter-organizational networks³³; the formation of various communities in which its members combine their resources on mutually beneficial principles in order to jointly achieve innovative results; adaptation of all participants to the new organizational order. The innovation environment is a physical and virtual space. It is a platform for innovation, participants and networks involved in the innovation process, a regulatory framework that supports or hinders innovation, and cultural and social norms that shape attitudes and behaviors toward innovation. Creation of stable connections between people, organizations and their solutions can arise shared vision and inter-

²⁸ WALRAVE, B., TALMAR, M., PODOYNITSYNA, K.S., ROMME, A.G.L., VERBONG, G.P.J. *A Multi-level Perspective on Innovation Ecosystems for Path-breaking Innovation*. In: Technological Forecasting & Social Change, 2018, nr.136, p. 103–113. ISSN 0040-1625.

²⁹ DATTEE, B., ALEX, O., AUTIO, E. *Maneuvering in poor visibility: how firms play the ecosystem game when uncertainty is high*. In: Academy of Management Journal, 2021, nr. 61(2), p. 466–498. ISSN 0001-4273.

³⁰ RUSSELL, M.G., STILL, K., HUHTAMÄKI, J., YU, C., RUBENS, N. *Transforming innovation ecosystems through shared vision and network orchestration*. In: Proceedings of the Triple Helix IX International Conference: Silicon Valley: Global Model or Unique Anomaly?, 11-14 Julie, 2011, California: Stanford, 2011. p. 1-21.

³¹ KONIETZKO, J., BOCKEN, N., HULTINK, E. J. *Circular ecosystem innovation: An initial set of principles*. In: Journal of Cleaner Production, 2020, nr. 253, p. 377-387. ISSN 0959-6526.

³² RADZIOW, A., BOGERS, M. *Open innovation in SMEs: Exploring inter-organizational relationships in an Ecosystem*. In: Technological Forecasting & Social Change, 2019, nr. 146, p. 573–587. ISSN 0040-1625.

³³ WESSNER, C.W. *Entrepreneurship and the Innovation Ecosystem Policy Lessons from the United States*. In: Local Heroes in the Global Village, Springer, Boston, MA, 2005, p. 67-89. ISSN 1613-8333.

company networks, as well as a network community, whose members combine their resources on mutually beneficial principles and can achieve innovative results. The general idea is that effective collaboration and interaction between the participants of the innovation ecosystem can lead to positive results and benefits for all participants.

Bacon E. and others distinguish two approaches to the study of the open innovation ecosystem: one relies on geographically close ecosystems, the other on the creation and capture of value³⁴. Within the framework of these statements, the concept of an innovation ecosystem either explores the process of joint creation of co-creation, or a set of institutional conditions for the formation of territorial ecosystems.

Relationship between actors. The innovation ecosystem is characterized by dynamic and complex relationships among actors through collaboration³⁵, coordination, co-creation³⁶, convergence and complementarity. The result of these relationships is the creation of conditions for joint development and a mechanism for sharing benefits.

Resources. The ecosystem allows the central entity to expand the boundaries of its own capabilities by attracting resources from other participants in the ecosystem (for example, knowledge). They can be funds, talents, material resources, information, etc. Universities and research institutes can provide enterprises with a large number of relevant professional talents to promote the sustainable development of IE³⁷.

Innovation Ecosystem Strategy. Typically, a focal firm develops a strategy in the context of an ecosystem that coordinates the flow of knowledge and takes into account the interests of all its members³⁸ and problems in the process of emergence and further development of the ecosystem.

Ecosystem boundaries can be established according to certain criteria³⁹: by boundaries of innovation ecosystems determine the dominant objects, which can be a leading firm, technology and digital platforms; by geographical coverage (local, regional, national or global); by level (global, world (supranational), national, regional, corporate, individual or local (within organizations, clusters, etc.)); by time scale (from the beginning of occurrence to the future or

³⁴ BACON, E., WILLIAMS, M.D., DAVIES, G.H. *Recipes for success: Conditions for knowledge transfer across open innovation ecosystems*. In: International Journal of Information Management, 2019, nr. 49, p. 377-387. ISSN 2684012.

³⁵ SARAGIH, H.S., TAN, J.D. *Co-innovation: A review and conceptual framework*. In: International Journal of Business Innovation and Research, 2018, nr. 17(3), p. 361-377. ISSN 1751-0252.

³⁶ KETONEN-OKSI, S., VALKOKARI, K. *Innovation ecosystems as structures for value co-creation*. In: Technology Innovation Management Review, 2019, nr. 9(2), p. 25-35. ISSN 1927-0321.

³⁷ FENG, L., LU, J., WANG, J. *A Systematic Review of Enterprise Innovation Ecosystems*. In: Sustainability, 2021, nr. 13(10), p. 2-26. ISSN 2071-1050.

³⁸ IANSITI, M., LEVIEN, R. *Strategy as Ecology*. In: Harvard Business Review, 2004, nr. 82(3), p. 68-78. ISSN 0017-8012.

³⁹ COBBEN, D., OOMS, W., ROIJAKKERS, N., RADZIOWON, A. *Ecosystem types: A systematic review on boundaries and goals*. In: Journal of Business Research, 2022, nr. 142, p. 138-164. ISSN 1873-7978.

static versus dynamic interactions); by permeability (open or closed); by types of flows (knowledge, values, materials, etc.) and others. The ecosystems are based on mechanisms of self-development, but if the boundaries are permeable, the limits of the ecosystem are difficult to determine due to the possible participation of individual companies in several ecosystems.

Dynamics of the ecosystem. The innovation ecosystem is dynamically developing as a result of interaction between its participants, new needs and transforming due to new circumstances. Ecosystem dynamism creates opportunities to create and capture value⁴⁰.

Different types of ecosystems are considered in the economic literature: industrial, entrepreneurial⁴¹, social, innovative, national, university entrepreneurial ecosystem⁴² (Appendix 4). Another classification considers the following types: product⁴³, service ecosystem⁴⁴, knowledge⁴⁵, business ecosystems, innovation and digital ecosystems. Some authors distinguish ecosystems: innovations, platforms, products and services, interests, commerce, software ecosystems, innovation clusters⁴⁶, startup ecosystems. Innovation ecosystems can be divided into several innovation ecosystems, in which case they can compete or complement each other⁴⁷. An example could be startup ecosystem, venture ecosystem, university ecosystem, etc.

Comparing the innovation ecosystem with other ecosystems⁴⁸, one can see similarities and differences. Thus, a business ecosystem is a network structure consisting of a central organization (may be a platform) that provides the actors interacting with it with joint resources and benefits. The knowledge ecosystem is the actors grouped together to share knowledge in order to obtain benefits. The innovation ecosystem is a synthesis of the two previous⁴⁹. The business ecosystem

⁴⁰ HELFAT, C.E., RAUBITSCHKE, R.S. *Dynamic and Integrative Capabilities for Profiting from Innovation in Digital Platformbased Ecosystems*. In: Research Policy, 2018, nr. 47(8), p. 1391–1399. ISSN 0048-7333.

⁴¹ STAM, F.C., SPIGEL, B. *Entrepreneurial Ecosystems*. In: U.S.E Discussion Paper Series, 2016. [accessed 14.07.2020]. Available at: <https://econpapers.repec.org/paper/usetkiwps/1613.htm>

⁴² PILINKIENE, V., MACIULIS, P. *Comparison of different ecosystem analogies: The main economic determinants and levels of impact*. In: Procedia-social and behavioral sciences, 2014, nr. 156, p. 365-370. DOI: 10.1016/j.sbspro.2014.11.204. ISSN 1877-0428.

⁴³ YIN D., MING, X., ZHANG, X. *Sustainable and Smart Product Innovation Ecosystem: An integrative status review and future perspectives*. In: Journal of Cleaner Production, 2020, nr. 274, p. 1-19. ISSN 0959-6526.

⁴⁴ VARGO, S.L., AKAKA, M.A., WIELAND, H. *Rethinking the process of diffusion in innovation: A service-ecosystems and institutional perspective*. In: Journal of Business Research, 2020, nr. 116, p. 526–534. ISSN: 0019-8501.

⁴⁵ JÄRVI, K., ALMPANOPOULOU, A. *Organization of Knowledge Ecosystems: Prefigurative and Partial Forms*. In: Research Policy, 2018, nr. 47(8), p. 1523–1537. ISSN 0048-7333.

⁴⁶ SMORODINSKAYA, N., RUSSELL, M., KATUKOV, D., STILL, K. *Innovation ecosystems vs. innovation systems in terms of collaboration and co-creation of value*. In: Proceedings of the 50th Hawaii international conference on system sciences, 2017. [accessed 07.10.2019]. Available at: <http://hdl.handle.net/10125/41798>.

⁴⁷ ADNER, R., KAPOOR, R. *Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations*. In: Strategic Management Journal, 2010, nr. 31 (3), p. 306–333. ISSN 0143-2095.

⁴⁸ PILINKIENĖ, V., MAČIULIS, P. *Comparison of different ecosystem analogies: The main economic determinants and levels of impact*. In: Procedia-social and behavioral sciences, 2014, nr. 156, p. 365-370. ISSN 1877-0428.

⁴⁹ VALKOKARI, K. *Business, innovation, and knowledge ecosystems: How they differ and how to survive and thrive within them*. In: Technology Innovation Management Review, 2015, nr. 5(8), p. 15-24. ISSN 1927-0321.

has the goal of obtaining value, and the goal of the innovation ecosystem is to create new value, so the first can evolve into the second. In the business ecosystem, the emphasis is on competition, and in the innovation ecosystem on cooperation. It is the interdependence between different actors based on their cooperation, co-development and co-creation of value that distinguishes the innovation ecosystem from the business ecosystem⁵⁰. The digital ecosystem aims to create added value for customers by optimizing data and workflows from various internal departments, tools, systems, as well as customers, suppliers and external partners.

Through entrepreneurship, people create opportunities for innovation, which means introducing something new. It can be an idea, product, technology, model or service. On the other hand, turning a great idea into a business opportunity is entrepreneurial. The ratio of entrepreneurial and innovation ecosystems is as follows: the former are aimed at the emergence of new firms, the latter are aimed at the joint creation of value⁵¹. An innovation ecosystem is used to support entrepreneurship.

The formation of ecosystems is associated with various goals and motives. Innovation ecosystems, like entrepreneurship or knowledge ecosystems, are closely related to their ability to explore and adopt new knowledge. However, the motives for knowledge sharing differ depending on the type of ecosystem. If innovation ecosystems are aimed at interdisciplinary and intersectoral collaboration⁵², which results in new competencies and resources, entrepreneurial ecosystems are more focused on the coordination and development of social networks in certain geographic contexts, and knowledge ecosystems are organized around the collaborative search for knowledge in a specific learning context. The innovation ecosystem as a dynamic and adaptive organism creates, consumes and transforms knowledge into innovative products. Each of these ecosystems has different goals and objectives, actors (participants), environment and various interactions between them.

According to the author, the differences between innovation ecosystems and other types are co-evolution and relationships between IE participants, the key position of information and communication technologies, and actions in the “open innovations” paradigm. Similarities are a large group of actors, one or more of whom play a leadership role; the presence of interconnection

⁵⁰ VASCONCELOS GOMES, L. A. et al. *Unpacking the innovation ecosystem construct. Evolution, gaps and trends*. In: Technological Forecasting and Social Change, 2018, nr. 136, p. 30-48. ISSN 0040-1625.

⁵¹ THOMAS, L.D., SHARAPOV, D., AUTIO, E. *Linking Entrepreneurial and Innovation Ecosystems: The Case of AppCampus*. In: Entrepreneurial Ecosystems and the Diffusion of Startups. Glos: Edward Elgar Publishing LTD, 2018, p. 35–64. ISBN 978 1 78471 005 7.

⁵² SCHROTH, F., HÄUßERMANN, J.J. *Collaboration Strategies in Innovation Ecosystems: An Empirical Study of the German Microelectronics and Photonics Industries*. In: Technology Innovation Management Review, 2018, nr. 8(11), p. 4-12. ISSN 1927-0321.

and interdependence between actors; uniting around the value proposition; the need to adapt participants to the characteristics of the ecosystem.

The concept of an innovation ecosystem has led to the development of approaches that help in comprehending the groups of factors that affect the growth of such ecosystems, as illustrated in Table 1.3.

Table 1.3. Factors influencing the development of innovation ecosystems [developed by the author based on⁵³⁻⁵⁷]

Determining Factors	Description of a group of factors
Benefits of innovation	Constant transformation of technologies and resources into new products with lower costs, adaptation to a changing environment and the creation of new niches ⁵³
Strategies	Development of processes, work with partners and potential followers, creation of an innovative strategy that takes into account the risks inherent in the ecosystem ⁵⁴
Infrastructure	The creation and diffusion of innovations and entrepreneurial activities are shaped by local infrastructure, its externalities, specialized services, and levels of trust associated with relationships between agents ⁵⁵
Human resources	Availability of talented people; concentration of researchers, entrepreneurs and various institutions; having an entrepreneurial culture ⁵⁶
Policy change	Implementation of a new macroeconomic policy by the government that promotes communication and cooperation among innovative actors to promote innovation, accelerate the innovation process and reduce costs and risks ⁵⁷

The table lists the different factors that determine the effectiveness of an innovation ecosystem. The innovation ecosystem is aimed at the commercialization of innovations. One of the main goals of the emergence of IE was the emergence of an approach that promotes the introduction of innovative products and services to the market (the innovation advantage factor). However, sustainable development and successful innovation activities in the long term are impossible without strategic management (strategic factor). To create innovations in the context of innovation ecosystems, a special infrastructure is important (a set of organizations and institutions for servicing and supporting the process of creating innovations), which contributes to the emergence of a synergistic effect (infrastructure factor). The ecosystem approach makes new

⁵³ IANSITI, M., LEVIEN, R. *Strategy as Ecology*. In: Harvard Business Review, 2004, nr. 82(3), p. 68–78. ISSN 0017-8012.

⁵⁴ ADNER, R. *Match your innovation strategy to your innovation ecosystem*. In: Harvard Business Review, 2006, nr. 84, p. 98–107. ISSN 0017-8012.

⁵⁵ FISCHER, B., FACCIN, K., MEISSHER, D., de VASCONCELOS GOMES, L. A. *Innovation ecosystems: theory and evidence*. In: Innovation & Management Review, 2019. [accessed 04.08.2020]. Available at: DOI:10.13140/RG.2.2.10996.50565

⁵⁶ OH, D.S., PHILLIPS, F., PARK, S., LEE, E. *Innovation Ecosystems: A Critical Examination*. In: Technovation, 2016, nr. 54, p. 1-6. ISSN 0166-4972.

⁵⁷ FENG, L., LU, J., WANG, J. *A Systematic Review of Enterprise Innovation Ecosystems*. In: Sustainability, 2021, nr. 13(10), p. 2-26. ISSN 2071-1050.

demands on people, whether they are representatives of production, public administration, science or civil society (the human factor). When developing economic policies, it is necessary to introduce integrated thinking, promote the quantitative and qualitative expansion of actors' ties, increase the number of interaction centers, promote the targeted elimination of internal and external communication gaps, etc. (policy change factor). According to the author, these factors are interconnected and need to work together to create a supportive and effective innovation ecosystem. Successful innovation requires the coordination of these different factors, as well as the ability to adapt to a constantly changing environment.

Disclosure of the essence of the term "innovation ecosystem" has become the subject of much discussion in the economic scientific literature and in practice. Firstly, this concept is used indiscriminately⁵⁸, which casts doubt on its contribution to science and the possibility of transferring theory to practice. Secondly, criticism is built around reducing the concept of the innovation ecosystem to a static and deterministic framework, rather than recognizing its dynamic and complex nature, to the interdependence and mutual influence of its various components.

Based on the analysis of scientific works, in this paragraph, the author has implemented the goal of revealing the essence of the innovation ecosystem as a community of actors to bring joint innovations to the market based on interaction and relationships, relevant approaches and fundamental aspects of the concept of the innovation ecosystem, and also identified factors influencing the development innovation ecosystem. IE research can be focused both on individual aspects of the innovation ecosystem (knowledge transfer, connections and configuration) and on its individual participants (from the perspective of universities, central firm, small and medium enterprises, etc.).

1.2. Approaches to the Formation and Development of the University innovation ecosystem

The main goal of higher education institutions is the creation and dissemination of knowledge, its accumulation and transmission to the next generations, as well as the development of people's ability to use their own knowledge in life and in professional activities. Higher education can be seen as a focus of knowledge and its application, as an institution that contributes greatly to economic growth and development by stimulating innovation and skills development. Innovation is a tool for necessary and positive changes that are associated with the transformation of society (or innovation in society) and the transformation of the university (or innovation in the university)⁵⁹.

⁵⁸ RITALA, P., ALMPANOPOULOU, A. *In defense of 'eco' in innovation ecosystem*. In: Technovation, 2017, nr. 60–61, p. 39–42. ISSN 0166-4972.

⁵⁹ CAI, Y., MA, J., CHEN, Q. *Higher Education in Innovation Ecosystems*. In: Sustainability, 2020, nr. 12(11), p. 43–56. ISSN 2071-1050.

The purpose of this paragraph is to reveal approaches to the formation and development of innovation ecosystems of higher education institutions.

At present, significant changes are taking place in the field of higher education, which are necessary for its further sustainable development. On this path, the role of the university in society, its mission and key tasks are changing. The university, in addition to its traditional educational role (first mission), conducts scientific research and bases its education on this research (second mission) and transfers knowledge and technology to industry and society through the commercialization of innovations (third mission)⁶⁰.

Universities carrying out the third mission are called "entrepreneurial" ⁶¹. The main criteria for classifying a university as an entrepreneurial one is freedom in the development of strategic goals; combining the three missions of the university: educational, research and economic and social development; possession of a significant degree of autonomy and non-control of the state and business; focusing on new sources of funding, creating new business organizations, and demonstrating entrepreneurial behavior. These universities carry out activities to stimulate the promotion of innovations to the market, including patenting, licensing; management of intellectual property rights; assisting in the creation of new enterprises (spin-of, start-up). Universities also conduct joint research with various enterprises and organizations, engage in consulting, networking, entrepreneurship training, etc. The entrepreneurial university forms an entrepreneurial ecosystem, promising technological markets, and becomes a platform for creating the country's economic superiority at the global level. Classic examples of entrepreneurial universities are the Massachusetts Institute of Technology (MIT), Stanford University and a number of European universities.

University 4.0 is technologically connected with the digital-communicative revolution, which allows to form a new platform for the preservation and transfer of knowledge, for intellectual communication and thinking, for the creation of "smart" systems: industries, cities, states. This university should act as an intermediary for integration processes between different sectors of society⁶². Research and innovation activity of the university involves a significant increase in the integration potential of the university and its social mission, the formation of the university as a large multifunctional ecosystem (Appendix 5).

Thus, at present, there are obvious trends in the development of universities and higher

⁶⁰ MIGUEIS, R., PAOLUCCI, E. *Role of universities of science and technology in innovation ecosystems: towards mission 3.1*. Leuven: Cesaer, 2018. 36 p. ISBN 978-92-79-68006-9.

⁶¹ ETZKOWITZ, H. *The evolution of the entrepreneurial university*. In: International Journal of Technology and Globalization, 2004, nr. 1(1), p. 64–77. ISSN 1476-5667.

⁶² GIESENBAUER, B., MÜLLER-CHRIST, G. *University 4.0: Promoting the transformation of higher education institutions toward sustainable development*. In: Sustainability, 2020, nr. 12(8), p. 3371. [accessed 02.11.2022]. Available at: <https://doi.org/10.3390/su12083371>

education, including the change in the types of universities (entrepreneurial, research, innovation-technology, networking, etc.) due to strengthening in scientific activity and experimentation, the transition from competition to partnership, the combination of new and traditional formats of training, the redevelopment of educational premises in the format of Open Space, etc.

The literature highlights the key role of educational institutions in the development of innovation ecosystems. It is expressed in the formation of human capital⁶³ ⁶⁴, conducting collaborative research with industry (leading to an increase in the number of patents, including joint ones, and scientific publications)⁶⁵, in the creation of new knowledge-intensive enterprises. The European University Association⁶⁶ focuses on regional participation of universities, Y. Cai⁶⁷ ⁶⁸ understands the role of universities in the innovation ecosystem as crucial, as they are not only the source of scientific and technological research but also serve as hubs for interdisciplinary collaboration, industry partnerships, entrepreneurship education, and the transfer of knowledge and technology to society, contributing to economic growth and social development (Appendix 6).

The concept of "ecosystem" is particularly relevant to the main directions of the university as an educational, entrepreneurial, and innovative ecosystem, as it emphasizes the interdependent relationship between various actors and elements within the university environment, including students, faculty, staff, industry partners, community stakeholders, and resources. By viewing the university as an ecosystem, it becomes clear that each of these elements has a unique role to play in creating a dynamic and thriving environment that supports learning, research, and entrepreneurship.

For the university, the concept of "ecosystem" is associated with its main areas of activity: educational, entrepreneurial, and innovative. Each of these areas plays a unique role in the formation and development of a dynamic environment that supports learning, research, and entrepreneurship.

The educational ecosystem is aimed at the comprehensive development of its participants (the formation of the necessary educational and professional skills, training in interpersonal

⁶³ BENNEWORTH, P., HOSPERS, G.J. *The new economic geography of old industrial regions: Universities as global-local pipelines*. In: Environment and Planning, 2007, nr. 6, p. 779–802. ISSN 2399-6552.

⁶⁴ PINTO, I. *Spotlight - Radical Education Organizations*. Israel: Representing the Institute for Future Studies in Education, 2021. 68 p. (Herber)

⁶⁵ COWAN, R., ZINOVYEVA, N. *University effects on regional innovation*. In: Research Policy, 2013, nr. 3, p. 788–800. ISSN 0048-7333.

⁶⁶ REICHERT, S. *The Role of Universities in Regional Innovation Ecosystems*. In: EUA study, Brussels: European University Association, 2019, p. 22-47. ISBN 9789078997030.

⁶⁷ CAI, Y., FERRER, B.R.; LASTRA, J.L. *Building University-Industry Co-Innovation Networks in Transnational Innovation Ecosystems: Towards a Transdisciplinary Approach of Integrating Social Sciences and Artificial Intelligence*. In: Sustainability, 2019, nr. 11(17), p. 46-56. ISSN 2071-1050.

⁶⁸ CAI, Y., MA, J., CHEN, Q. *Higher Education in Innovation Ecosystems*. In: Sustainability, 2020, nr. 12(11), p. 43-56. ISSN 2071-1050.

communication skills), providing all ecosystem participants with a specific experience that is applied throughout life.

“Entrepreneurial-university ecosystem”⁶⁹ focuses on the complex of relationships between elements of the university environment and representatives of the business sector, which can stimulate economic development through the transfer of knowledge; a combination of entrepreneurial culture and social responsibility⁷⁰; integrating a culture of innovation into all layers of the educational institution, supporting the creation and growth of start-ups. An example of a university entrepreneurial ecosystem is MIT, where the process of creating innovations goes from generating ideas to creating innovative companies. This concept is constantly evolving in several directions: university entrepreneurship⁷¹ or academic entrepreneurship⁷² and its relationship to innovation; education and entrepreneurship training to develop entrepreneurial thinking⁷³ etc.

The presence of business representatives contributes to the development of various forms of commercialization of technologies and innovations at the university: custom-made R&D and the creation of university spin-offs⁷⁴. At the same time, it is possible to more effectively form various sites aimed at the development of projects and their subsequent commercialization. (Business incubator⁷⁵, accelerator, techno-park) in the university environment. The process of involving real practitioners from the business environment for the evaluation, coordination and possible financing of student entrepreneurial initiatives is also more simplified. New types of relationships between universities, the state and business in the context of the development of a society based on knowledge are revealed in such studies as the innovation system⁷⁶, Triple Helix

⁶⁹ XIE, Y., ZHANG, W. *Construction and Measurement of University-based Entrepreneurial Ecosystem Evaluation Index System: A Case Study of Zhejiang University in China*. In: ASEE American Society for Engineering Education, 2019. ISSN 2153-5868. [accessed 02.06.2020]. Available at: <https://peer.asee.org/32541>

⁷⁰ SORENSEN, M.P. et al. *The Responsible University: Exploring the Nordic Context and Beyond*. Springer Nature, 2019. 318 p. ISBN 978-3030256456.

⁷¹ ROTHARMEL, F.T., AGUNG, D.S., JIANG, L. *University entrepreneurship: a taxonomy of the literature*. In: Industrial and corporate change, 2007, nr. 4, p. 691-791. ISSN 1464-3650.

⁷² SHANE, S. *Academic entrepreneurship: University spinoffs and wealth creation*. New York: Edward Elgar Publishing, 2004. 352 p. ISBN 978 1 84542 221 9.

⁷³ AUDRETSCH, D.B. *From the entrepreneurial university to the university for the entrepreneurial society*. In: The Journal of Technology Transfer, 2014, nr. 39(3), p. 313-321. ISSN 8929912.

⁷⁴ PIRNAY, F., SURLEMONT, B., NLEMVO, F. *Toward a typology of university spin-offs*. In: Small business economics, 2003, nr. 4, p. 355-369. ISSN 1573-0913.

⁷⁵ CARAYANNIS, E.G., ZEDTWITZ, M. *Architecting global-local, real-virtual incubator networks as catalysts and accelerators of entrepreneurship in transitioning and developing economies: lessons learned and best practices from current development and business incubation practices*. In: Technovation, 2005, nr. 2, p. 95-110. ISSN 0166-4972.

⁷⁶ FREEMAN, C. *The National System of Innovation in historical perspective*. In: Cambridge Journal of Economics, 1995, nr. 19, p. 5-24. ISSN 0309-166X.

model⁷⁷, open innovation⁷⁸, RIS3 model⁷⁹ (Research and Innovation Strategies for Smart Specialization).

If the entrepreneurial ecosystem of the university is focused on helping people turn their ideas into new enterprises and start-ups, to raise the entrepreneurial level of the city / region / country by positioning universities as centers of entrepreneurship, then the innovation ecosystem is focused on supporting and promoting innovations (new technologies, products, and knowledge) in the university community and beyond. The university innovation ecosystem (UIE) promotes cooperation and knowledge exchange between various stakeholders in creating new ideas, solving complex problems, transferring technologies, and turning research into real results, organizes processes of unity, integration, and coordination of resources of other members of the innovation ecosystem (state, enterprise, etc.) around the university on mutually beneficial terms.

The university innovation ecosystem (UIE) as an open system has a specific place in the larger innovation ecosystem based on partnerships⁸⁰. The university innovation ecosystem includes two different components: research driven by fundamental, applied research, and commercial driven by the market⁸¹ (Appendix 7). In other words, the UIE acts as an intermediary between the university and the external market environment, combining research (knowledge) with the production and distribution (business) of new products (values). Innovation ecosystems of modern universities⁸² responsible for promoting and stimulating innovation for the development of not only new enterprises, but also society.

The university innovation ecosystem is, according to the author, a set of relationships between the subjects of the innovation process, the participants of which have different competencies and capabilities. They constantly exchange knowledge, manage its flows, distribute and use this knowledge and experience, pool resources with other participants to support the creation and development of innovative ideas and technologies. They are interdependent on each other and interact through partnership agreements to bring these ideas to market.

⁷⁷ ETZKOWITZ, H., ZHOU, C. The triple helix: University–industry–government innovation and entrepreneurship. Routledge, 2017. ISBN 978-0415964517.

⁷⁸ CHESBROUGH, H.W. *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School, 2003. 227 p. ISSN 0017-8012.

⁷⁹ LANDABASO, M. *Research and innovation strategies for smart specialisation*. European Commission. Paris: European Commission, DG REGIO, Thematic Coordination and Innovation, 2012. [accessed 09.09.2019]. Available at: https://unece.org/fileadmin/DAM/ceci/documents/2012/ICP/TOS_ICP/Landabaso.pdf

⁸⁰ ISRAELI, M. *The university's innovative ecosystem: management aspects*. In: Materials of the XXVI international scientific-practical conference “Education: tradition and innovation” April 29 2021. Prague: WORLD PRESS s.r.o., 2021, p. 44-48. ISSN 978-80-88005-64-3.

⁸¹ JACKSON, D.J. *What is an Innovation Ecosystem?* National Science Foundation, Arlington. [accessed 10.09.2021]. Available at: <http://urenio.org/wp-content/uploads/2011/05/What-is-an-Innovation-Ecosystem.pdf>.

⁸² BRUNO, B., AURORA, Z., DIEGO, S. *Orchestrating university innovation ecosystem: the case of a brazilian university*. In: Revue Internationale d'Intelligence Économique, 2020. [accessed 08.09.2021]. Available at: https://www.researchgate.net/publication/342437042_ORCHESTRATING_UNIVERSITY_INNOVATION_ECOSYSTEM_THE_CASE_OF_A_BRAZILIAN_UNIVERSITY

The university ecosystem is able to develop at different levels: at the macro and micro levels. At the macro level, the university ecosystem is created and developed to promote and market (international/national/regional) own or joint developments. At the same time, the university acts as an important component of other ecosystems⁸³ (for example, entrepreneurial, innovative, etc.). The university as an open system can participate in various ecosystems depending on the goals and commercialization of research developments (Appendix 8). Ecosystem participants are interdependent from each other and interact on the basis of partnership agreements in the process of commercialization. This allows you to create unique intellectual, industrial, infrastructural, informational, cultural and other values. As a result of interactions, the university develops and maintains the sustainability of academic entrepreneurship. An important condition for this is the preparation of the market for innovative products of the university at the local, regional and international levels.

At the micro level, the goal of the university ecosystem is to create conditions for the organic and fruitful interaction of the elements of the innovation ecosystem. Ecosystems at the micro level arise from university entrepreneurship (academic entrepreneurship) and are associated with the activities of individuals, universities and companies, which should be “vertically connected”⁸⁴ to macro level results in terms of regional, national economic indicators (development, R&D intensity and social benefits).

The university ecosystem in terms of structure can be defined as entrepreneurial, but it is aimed at the innovative development of the university (an institutional entrepreneur in the innovation ecosystem⁸⁵). In an entrepreneurial/innovative institution of higher education, teaching, research and social activities are interconnected⁸⁶. In other words, the elements of entrepreneurship and innovation in the university ecosystem are closely intertwined.

There is no consensus in the scientific literature regarding the elements and structure of the ecosystem of an innovative/entrepreneurial university, as well as ways for effective functioning and development. Based on the content of approaches to the study of innovation ecosystems, the author believes that an integrated approach to the analysis of all elements of university innovation

⁸³ FUSTER, E., PADILLA-MELÉNDEZ, A., LOCKETT, N., DEL-ÁGUILA-OBRA, A.R. *The emerging role of university spin-off companies in developing regional entrepreneurial university ecosystems: The case of Andalusia*. In: Technological Forecasting and Social Change, 2019, nr. 141, p. 219–231. ISSN 0040-1625.

⁸⁴ HAYTER, C.S., NELSON, A.J., ZAYED, S., O’CONNOR, A.C. *Conceptualizing academic entrepreneurship ecosystems: A review, analysis and extension of the literature*. In: The Journal of Technology Transfer, 2018, nr. 43(4), p. 1039-1082. ISSN 8929912.

⁸⁵ CAI, Y., MA, J., CHEN, Q. Higher Education in Innovation Ecosystems. In: Sustainability, 2020, nr. 12(11), p. 43-56. ISSN 2071-1050.

⁸⁶ GIBB, A., HOFER, A.R., KLOFSTEN, M. The entrepreneurial and innovative higher education institution. HEInnovate-A review of the concept and its relevance today. 2018. [accessed 07.11.2022]. Available at: https://heinnovate.eu/sites/default/files/heinnovate_concept_note.pdf.

ecosystems will make it possible to identify the general conditions for their creation, operation and development.

Further consideration of the structure of the university innovation ecosystem by the author will be considered in the following sequence: the purpose of the innovation ecosystem and the process of commercialization, the subjects of the UIE and the network of their interaction, the specifics of the environment: formal and informal institutions, resources, infrastructure, culture.

Goals of the innovation ecosystem. One of the primary objectives of a higher education institution is to establish the nucleus of the regional innovation ecosystem. Ensuring the effectiveness of the innovation process in the university can be achieved through the formation of an innovation ecosystem, which is aimed at the commercialization of innovations (a specific commercial result) and will contribute to the accelerated technological, economic and socio-cultural development of the region.

The process of commercialization. Commercialization is essential in the innovation ecosystem as it helps link research with practical applications, turning academic research into tangible products and services for the benefit of society. The university innovation ecosystem in the process of commercialization should provide a continuous connection between all links in the process of creating innovations: from the formation of an idea (search, evaluation and selection of promising projects and developments) to the introduction of innovation (in the form of technologies / products / services) to the market. This requires the attraction of financial and other funds, the legal consolidation of the rights to university research (licensing of intellectual property), the creation of a spin-off (which can turn into a separate start-up) and entry into the market.

The process of commercialization of innovations is carried out mainly by the technology transfer center or office. The university development is transferred to this organization, and it is engaged in the further implementation of the project on a professional basis. All issues of licensing, patenting and intellectual property management are within the scope of the employees of this organization. This allows developers to fully focus on creating innovation. In the process of commercialization, some functions can be combined in one technology transfer center, some can be provided by partners in the innovation ecosystem.

Increasing the efficiency of research and entrepreneurial functions directly affects the innovative level of the university. Increasing the amount of research and increasing the number of projects/technologies using external elements of the ecosystem contributes to increased innovation, the development of interdisciplinary cooperation, the stimulation of economic growth, the satisfaction of social needs, the increase in competitiveness, which can contribute to the success and influence of the university and its stakeholders.

Universities can be seen as one of the most striking examples of a multi-component and polystructural ecosystem. According to the author, there is no universal model of the university innovation ecosystem, which will have the same structure. The main structural elements of the UIE in each university have their own characteristics and depend on various factors of the external and internal environment.

In Figure 1.2 the author presented the innovation ecosystem model of the university, highlighting its main elements (participants, innovation policy, infrastructure, resources, culture), which are characteristic of any ecosystem.

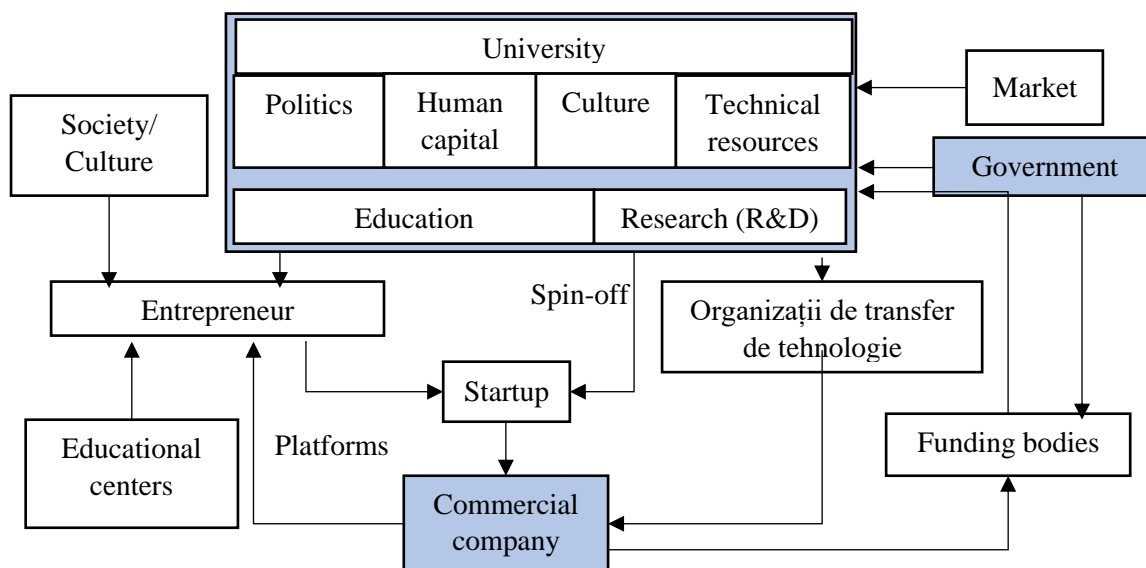


Figure 1.2. Innovation ecosystem model of the university [developed by the author based on⁸⁷]

In connection with the change of the innovation process itself from linear to more and more "cyclical", it becomes insufficient to know only the R&D algorithm. There is a need for close collaboration with a large number of subjects (participants and stakeholders) to form the ideas necessary for consumers.

Subjects of the university innovation ecosystem. In general, two groups of subjects of the university innovation ecosystem can be distinguished: external and internal. The first group includes the state (state and regional bodies), business partners (large industrial enterprises, small and medium-sized businesses, university graduates), research organizations, other universities, venture partners, investors, social organizations, etc.

The university innovation ecosystem unites various participants in a common network of cooperation to create innovations and promotes the generation of ideas, their development and

⁸⁷ ISRAELI, M. BLAGORAZUMNAYA, O. *The innovative ecosystem of Israel's universities as a vector of sustainable development*. In: The international scientific conference „The modern paradigms of the national and global economy development” 30 – 31.10. 2020. Chisinau: Moldova State University, 2020, p.33-38. ISSN 978-9975-152-70-9.

mutual exchange⁸⁸. Network interaction ensures the unification of individual elements of the UIE into a new kind of integrity, through the processes of interaction between subjects on the basis of social ties (Appendix 9).

The development of university-industry partnerships affects the ability to adopt and adapt technologies⁸⁹. At the same time, it is important not just to formally sign agreements, but to create relationships of trust and strive to form a common vision. Universities are involved in joint research with manufacturing enterprises⁹⁰, which inevitably leads to an increase in the number of patents or other intellectual property instruments, scientific publications, as well as in the opening of new enterprises.

The development of institutional partnerships (for example, city halls or local government, business associations, local companies, non-governmental organizations and others) are important ways to shape the university ecosystem⁹¹. The main role of the state is to support research at an early stage, as well as to create conditions for the development of commercialization of innovations that are convenient for market participants. Social projects to support talented youth, provide open access to knowledge, promote entrepreneurial and innovative activities have a positive impact on society due to the unique ability to combine interdisciplinary approaches with applied research and innovation. Thus, building a successful innovative university ecosystem requires the cooperation and input of all stakeholders inside and outside the university.

The second group of UIE subjects includes: scientific staff (professors, research associates, etc.), students (students, doctoral students, postgraduate students) engaged in research work; administration and employees of structural units that ensure the process of creating and commercializing innovations.

A university scientist can act as an academic entrepreneur who, in addition to research, commercializes his results (by patenting and/or creating a business). The academic entrepreneur acts both as an intellectual actor (i.e. researcher) and an entrepreneurial actor (i.e. spin-off creator). As a research scientist, he receives research results and publishes them in scientific journals. The

⁸⁸ ISRAELI, M. *Management aspects of the university's innovative ecosystem*. In: Materials of the IX international scientific and practical conference "Actual problems of the development of vertical integration of the education system, science and business: economic, legal and social aspects" December 29, 2020. Voronezh: ANOO VO "Voronezh Institute of Economics and Law", 2020, p. 10-16.

⁸⁹ WU, J. *Cooperation with competitors and product innovation: Moderating effects of technological capability and alliances with universities*. In: *Industrial Marketing Management*, 2014, nr. 2, p. 199–209. [accessed 01.05.2019]. Available at: DOI: 10.1016/j.indmarman.2013.11.002.

⁹⁰ BERCOVITZ, J., FELDMAN, M. *Fishing upstream: firm innovation strategy and university research alliances*. In: *Research Policy*, 2007, nr. 36(7), p. 930– 948. ISSN 0048-7333.

⁹¹ MORAES, G. H. S. M. D., FISCHER, B. B., CAMPOS, M. L., SCHAEFFER, P. R. *University ecosystems and the commitment of faculty members to support entrepreneurial activity*. In: *BAR-Brazilian Administration Review*, 2020, nr. 17(2). [accessed 07.02.2022]. Available at: https://www.researchgate.net/publication/341251155_University_Ecosystems_and_the_Commitment_of_Faculty_Members_to_Support_Entrepreneurial_Activity

academic entrepreneur as an "entrepreneur" operates on a commercial basis, for example, profiting from patent developments. In the innovation ecosystem, the academic entrepreneur is the link between the scientific (knowledge-oriented) world and the commercial (innovation-oriented) world. But in order to commercialize their developments, an academic entrepreneur must overcome cultural and motivational barriers (Table 1.4).

Table 1.4. Cultural and motivational barriers to the development of technology commercialization [developed by the author based on⁹²]

The barriers	Reasons for the occurrence
Scientific/educational activity versus technology transfer	Associated with contradictions between indicators of participation of scientists in research and educational process
The role of researcher versus the role of entrepreneur	Associated with the desire to avoid bureaucratic costs in the commercialization of technologies through the university, as well as the frequent actual non-participation of the university in the active promotion of the development or patent
Lack of business skills	Profound differences between business and scientific culture. Inability to draw up contracts and projects in terms of commercial benefits
Lack of understanding by university developers of the features and formats of responsibility	Arise when using investment funds, including commercial R&D
Lack of understanding of the real processes of implementation of developments in the industry	Lack of knowledge of industrial quality standards, planning horizons, result requirements, standard software, certifications

The problem of insufficient motivation of scientists to participate in commercial developments is typical for various universities. Universities policy should be directed towards the interest of researchers in commercialization and make it an advantage for their projects.

The innovation ecosystem creates a suitable environment for commercialization, in particular, formal (laws, regulations) and informal (culture) institutions, the necessary resources and infrastructure.

Formal Institutions. The practice of most of the world's leading universities shows the ability to combine scientific goals and the commercialization of scientific developments at the strategy level. The strategy ensures the unity of the applied tools: regulations, incentive system, ongoing activities, partnerships, and so on. To create it, it is necessary to determine the place and role of the university in a larger innovation ecosystem: what technologies can be created, who can become a customer, who can finance development, what partners are needed for this.

Informal Institutions. Creating an entrepreneurial culture in universities is one of the

⁹² BLAGORAZUMNAYA, O., ISRAELI, M. *Innovative culture as one of the directions of innovative activity of the university*. In: EcoSoEn, 2019, nr. 3-4, p. 45-54. ISSN 2587-344X.

important aspects of the formation and development of an innovation ecosystem⁹³. The innovative culture of the university (a set of norms, values, rules and ways of introducing and perceiving innovations, communication channels, etc.) must be considered taking into account the system of sociocultural relations not only at the university, but also in the region in order to be a regulator of innovative behavior. By spreading an entrepreneurial culture through the development of courses and programs on entrepreneurship on campus⁹⁴ with the involvement of external stakeholders, the formation of an innovation ecosystem at the university takes place.

Resources. The university innovation ecosystem will work successfully only if its research units have the necessary resources (material, intangible, human, financial, etc.). In many countries with developed innovation ecosystems, research and education policy is aimed at gradually reducing public funding for R&D. This forces universities to develop work with industry and look for alternative sources (public, private, corporate). At the same time, the resources invested in research will continue to be profitable due to the implementation of innovative products. In this case, the research and commercial sectors of the university's innovation ecosystem reach an equilibrium state. Commercialization sometimes requires access to specialized resources that universities do not always have. Mutually beneficial relationships of cooperation and mutual assistance in the form of networking, allow you to strengthen the resources of the UIE by redistributing the resources of other actors.

Innovation infrastructure. Innovation infrastructure plays a critical role in the university ecosystem by providing the physical and organizational resources necessary to support innovation and entrepreneurship. In different regions and countries, there are peculiar sets of organizations that support innovation, which form elements of the national innovation infrastructure (Appendix 10). The innovation infrastructure provides a sequence of stages in the commercialization of innovations and links between the subjects of the ecosystem. It includes: a technology park, incubators, various centers (technology transfer center, development licensing, etc.), campus accelerators, science parks, student entrepreneurship centers, start-up support systems, etc. Innovation infrastructure can provide researchers with access to state-of-the-art facilities, equipment, and technical expertise necessary for cutting-edge research and development.

In recent years, open innovation platforms⁹⁵ have become widespread, facilitating the integration of innovation, education and research activities. They are based on modern digital

⁹³ BLAGORAZUMNAYA, O., ISRAELI, M. *Innovative culture as one of the directions of innovative activity of the university*. In: EcoSoEn, 2019, nr. 3-4, p. 45-54. ISSN 2587-344X.

⁹⁴ MILLER, D., ACS, Z. *The campus as entrepreneurial ecosystem: The University of Chicago*. In: Small Business Economics, 2017, nr. 49 (1), p. 75-95. ISSN 1573-0913.

⁹⁵ RHO, S., Lee, M., MAKKONEN, T. *The role of open innovation platforms in facilitating user-driven innovation in innovation ecosystems*. In: International Journal of Knowledge-Based Development, 2020, nr. 11(3), p. 288-304. ISSN: 2040-4476.

management tools and form a qualitatively new space for joint production and dissemination of innovations. These platforms reflect partnership agreements not only in the field of education, but also training in innovative entrepreneurship skills, in which people and material resources are reasonably combined and transparent for students and teachers.

Universities face various challenges in balancing traditional and new missions and challenges associated with creating or participating in innovation ecosystems. As a result, the organizational models of universities in many countries are in transition⁹⁶. Therefore, according to the author, for the construction and functioning of the university innovation ecosystem, it is necessary to ensure the fulfillment of a number of conditions: the focus of innovation on the needs of consumers; development of partnerships both within the organization and with external participants; adoption of innovative thinking by teachers (understanding the ongoing changes that stimulate innovation); development of interdisciplinary research, teaching the skills of innovative entrepreneurship to students of higher educational institutions. These conditions must be met on the basis of building trusting relationships between all participants in the ecosystem.

Summarizing the studies carried out, it should be emphasized the importance of creation an innovative ecosystem in the university. It is important to emphasize that increasing the efficiency of research and entrepreneurial functions directly affects the innovative level of the university. Increasing the amount of research and increasing the number of projects/technologies using external elements of the ecosystem contributes to increased innovation, the development of interdisciplinary cooperation, the stimulation of economic growth, the satisfaction of social needs, the increase in competitiveness, which can contribute to the success and influence of the university and its stakeholders.

The process of creation and distribution of innovations is possible only with the interaction of all its structural elements with the participation of advanced production and its latest technologies, high-tech methods, processes and means of production. The increasing complexity of organizational and coordination activities requires more systematic innovative approaches to the formation and development of innovation ecosystems of higher education institutions. All UIE participants should be given the right to use alternative, independent mechanisms to take into account their interests in governance, evaluate the performance of the university's innovation ecosystem and evaluate events to discuss them.

1.3. Approaches to assessing the innovation ecosystem of higher education institutions

In the knowledge economy, higher education becomes a powerful tool for the technical

⁹⁶ GUERRERO, M. *Entrepreneurial universities: Emerging models in the new social and economic landscape*. In: *Small Business Economics*, 2016, nr. 47(3), p. 551-563. ISSN 1573-0913.

renewal of the economy, which increases the importance of the innovative activities of higher education institutions. The efficiency of the innovation process can be increased through an innovation ecosystem, where the university is the center around which the resources of its participants are grouped. The combination of participants (state, university, science, business, and others) in an ecosystem can be different, so it is important to evaluate its functioning and performance.

The assessment of the innovation ecosystem is driven by the search for ways to expand the entrepreneurial and innovative activities of universities, the diversity of its participants, the complexity of their connections and relationships, the interdisciplinary nature, the integration of universities into the innovation regional and national ecosystem, the growth of university spin-off companies and start-ups, and capacity building by attracting talent. and others. Hence, the purpose of this paragraph is to systematize approaches to assessing the development of the innovation ecosystem and its continuous improvement at the university level.

The relevance of approaches to assessing innovation ecosystems is not a stable and unchanging characteristic⁹⁷ and is considered in the literature from different points of view. The concept, principles, framework of ecosystems in relation to the study of socio-economic relations are debatable. Hence, methodological complexity arises in terms of assessing the level of their development, the impact on the environment in which they originate and operate. Business ecosystem assessment methods are applied at the national and regional levels. For example, at the national level, the assessment is carried out using various Global Entrepreneurship Monitor (GEM) indicators with a focus on people and processes, the Panel Study of Entrepreneurial Dynamics (PSED) focuses on the environment. At the regional level, ecosystem assessment is carried out using various methodologies that allow to identify differences, limitations and development opportunities in the regions. But all these techniques cannot be applied to the entrepreneurial university ecosystem.

An analysis of the scientific literature showed that various types of approaches can be used to assess the innovation ecosystem of a university (Figure 1.3.).

⁹⁷ YAN, J., FENG, L., STEBLYANSKAYA, A., KLEINER, G., RYBACHUK, M. *Biophysical Economics as a New Economic Paradigm*. In: International Journal of Public Administration, 2019, nr. 15-16, p. 1395-1407. [accessed 02.09.2020]. Available at: DOI: 10.1080/01900692.2019.1645691.

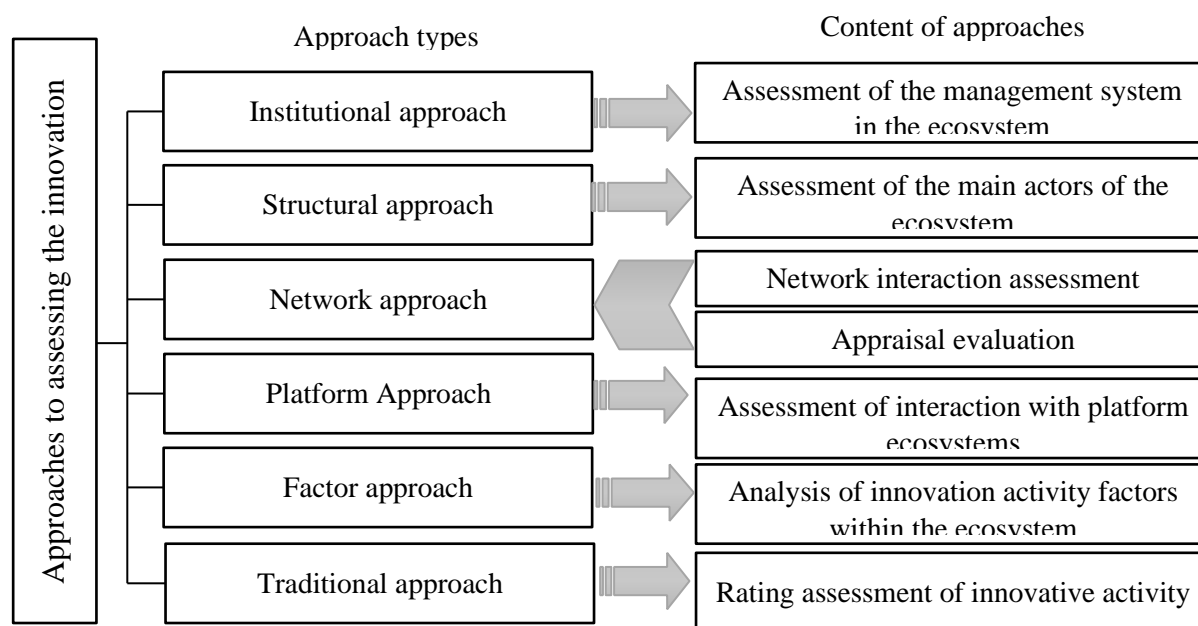


Figure 1.3. Approaches to assessing the university ecosystem [developed by the author based on ⁹⁸]

The institutional approach involves an assessment of the innovation strategy and policy of universities, taking into account the goals and interests of each participant in the ecosystem, which will allow adapting, recognizing and promoting a multilateral non-linear approach to research and innovation⁹⁹. The adoption of joint management decisions is based on the management of knowledge, and the transfer of information between partners in the ecosystem. Governance in IE relies primarily on non-contractual mechanisms that allow ecosystem participants to specialize in specific roles or functions, and not necessarily defined by formal contracts. The managerial aspect of the UIE assessment includes an assessment of the level of technology transfer and commercialization of innovations and an assessment of student entrepreneurship policy¹⁰⁰.

Structural approach can only be used to describe, not manage, an ecosystem. It is based on an analysis of the structure of the innovation ecosystem to obtain its “portrait”, which is unique for each IE and at each moment in time. Within the framework of this approach, the ecosystem structure is a set (decomposition) of elements, which can then be grouped according to a functional principle. But the more elements in the ecosystem, the less detailed its characteristics.

The entrepreneurial university is at the center of the innovation ecosystem and is connected to various internal and external groups or individual actors that interact to produce knowledge and

⁹⁸ ISRAELI, M. *Methodological approaches to assessment of innovative ecosystems of higher educational institutions*. In: Материалы VIII ежегодной научно-практической конференции Северо-Кавказского федерального университета “Университетская наука - региону”, 2021, nr. 8, c. 13-24. ISSN 978-5-6043630-1-0.

⁹⁹ MIGUEIS, R., PAOLUCCI, E. *Role of universities of science and technology in innovation ecosystems: towards mission 3.1*. Leuven: Cesaer, 2018. 36 p. ISBN 978-92-79-68006-9.

¹⁰⁰ SHWETZER, C., MARITZ, A., NGUYEN, Q. *Entrepreneurial ecosystems: A holistic and dynamic approach*. In: Journal of Industry-University Collaboration, 2019, nr. 1(2), p. 79-95. ISSN 2631-357X.

develop new technologies in a region or country. The analysis of the ecosystem structure includes the selection of the main participants, stakeholders (stakeholders) involved in the management and support of the university's entrepreneurial activities, as well as the definition of procedures and tasks for their partnership. The heterogeneity of ecosystems usually arises from the fact that their participants may be from different industries and sectors¹⁰¹ and play different roles in the ecosystem. The important point is to identify the organization as the leader of the ecosystem (heads of universities or heads of leading industry organizations) that will provide leadership and determine the direction of joint action. Stakeholder analysis and information about them will determine who, how and at what stage of ecosystem development should participate. Stakeholders can be involved in the assessment process itself, but their participation should be considered in light of their goals, knowledge, competencies and interests.

The network approach. The complexity of the innovation process lies in the high cost of creating a product, the complexity of its production, the necessary conditions for this and the availability of knowledge on key development issues. That is why a network community of a formal or informal nature is being formed, facilitating the interaction and exchange of key resources between participants in the innovation ecosystem and is aimed at developing new technologies, protecting them and financing new projects.

The intensity and quality of interactions between participants, as well as the emergence of new organizations in the network and their contacts, become more important for assessing the level of development of IE. The level of interaction differs between the subjects of the ecosystem and is determined by such indicators as the volume of knowledge creation, the speed of knowledge dissemination, its transformation into innovations and the dissemination of innovations¹⁰².

The university needs to create interactions in the ecosystem, as IE aims to create, consume and transform knowledge into innovative products. Interactions can take place both within the same university with many actors, and other participants in the ecosystem: between the state and the university, between business and the university, between graduates and the university, technology transfer networks and the university. The innovation management system and the market potential of innovations are also important for describing ecosystem interactions and the role distribution of participants.

Cooperation between universities and industry is mostly local¹⁰³ due to geographical

¹⁰¹ THOMAS, L.D., AUTIO, E. *Innovation Ecosystems in Management: An Organizing Typology*. In: Oxford Research Encyclopedia of Business and Management, 2020. ISSN 9780190224851. [accessed 03.09.2021]. Available at: <https://doi.org/10.1093/acrefore/9780190224851.013.203>

¹⁰² MERCAN, B., GOKTAS, D. *Components of innovation ecosystems: a cross-country study*. In: International research journal of finance and economics, 2011, nr. 76(16), p. 102-112. ISSN 1450-2887.

¹⁰³ FRITSCH, M. *Do regional systems of innovation matter?* In: The New Economy in Transatlantic Perspective: Spaces of Innovation. London: Routledge, 2005, p. 189–206. ISBN 9780203420966.

proximity¹⁰⁴. Taking into account the achievements of universities in working with regions is important for assessing the contribution (involvement) of universities to regional development. Therefore, it is necessary to assess the cooperation between universities and the region based on the coordination of interests, their roles in relation to each other in the ecosystem.

The assessment of network interaction between universities and the regional community consists in training the local population and their continuous professional retraining, consulting activities of universities, research and development with regional business partners on the basis of collaboration, licensing of research and development results, creation of university and industrial R&D laboratories for certain activities, creation of spin-offs¹⁰⁵. Examples of a system for assessing the contribution of universities to regional and innovative development are the E3M Project of the European Commission (development of a system of indicators to assess the third role of European universities)¹⁰⁶; VINNOVA project of the Swedish Federal Agency for the Development of Innovation Systems (development of a model for assessing the cooperation of universities with society as a whole)¹⁰⁷; London ecosystem project with Imperial College¹⁰⁸.

Impact assessment. Interactions and relationships between IE participants, the flow of knowledge between science and industry is the basis for measuring impact assessment. The impact assessment determines the strength, scale and consequences of the cross-impact of ecosystem participants. Jarrod Ormiston views impact assessment as "a transdisciplinary practice that evolves and brings together many practices such as strategy, operations, accounting, marketing, motivation, and organizational learning"¹⁰⁹.

For universities, the impact can be distinguished both taking into account the time factor (short-term, medium-term and long-term impact), and the profile characteristics of its activities: education and development of human capital (with a focus on local or regional development); knowledge transfer, research and commercialization (with local or regional partners); strategic development and knowledge infrastructure (with the participation of local, regional, national or

¹⁰⁴ JIAO, H., ZHOU, J., GAO, T., LIU, X. *The more interactions the better? The moderating effect of the interaction between local producers and users of knowledge on the relationship between R&D investment and regional innovation systems*. In: Technological Forecasting and Social Change, 2016, nr. 110, p. 13–20. ISSN 0040-1625.

¹⁰⁵ FRITSCH, M., SLAVTCHEV, V. *Universities and Innovation in Space*. In: Industry and Innovation, 2007, nr. 14(2), p. 201–218. ISSN 1469-8390.

¹⁰⁶ E3M Project – European Indicators and Ranking Methodology for University Third Mission. [accessed 02.09.2022]. Available at: www.e3mproject.eu/index.html.

¹⁰⁷ BÖLLING, M., ERIKSSON, Y. *Collaboration with society: The future role of universities? Identifying challenges for evaluation*. In: Research Evaluation, 2016, nr. 25 (2), p. 209–218. ISSN 1471-5449.

¹⁰⁸ BUDDEN, P., MURRAY, F. *MIT's stakeholder framework for building & accelerating innovation ecosystems*. [accessed 10.03.2021]. Available at: <https://innovation.mit.edu/assets/MIT-Stakeholder-Framework-Innovation-Ecosystems.pdf>.

¹⁰⁹ ORMISTON, J. *Blending practice worlds: Impact assessment as a transdisciplinary practice*. In: Business Ethics A European Review, 2019, nr. 4, p. 424. [accessed 08.09.2020]. Available at: DOI: 10.5465/AMBPP.2017.14578abstract.

foreign partners); entrepreneurship and business development support (within the region or with the involvement of local or regional partners).

The indicators for each profile are considered in terms of Inputs and "Results" indicators and "Impact" indicators¹¹⁰. Innovative ideas, scientific developments, information and other intellectual resources are input streams (Inputs) in the university ecosystem, and implemented innovations will be the output of the system.

Platform Approach considers innovation platforms as new formats of interaction and interconnections between universities, business and society ("knowledge triangle"), as well as other participants in the ecosystem on the basis of partnership. Platform partners co-create new value, network effects, and a culture and motivation for open innovation^{111, 112}. Innovative platforms (digital and physical) enable the upload and exchange of information, decision making, and encourage interaction, communication, and partnership among IE members.

To assess the innovation ecosystem based on this approach, according to the author, it is necessary to take into account the various conditions for organizing innovation processes and interaction on different platforms, methods and models for building a platform¹¹³, development of strategies for platform activities and their coordination, results of platform creation (for example, the effect of the flow and serendipity)¹¹⁴. Therefore, the assessment of IE should consist in determining the indicators of interaction between organizations, the level of skills of strategic and operational management of the platform, the necessary additional services, software, the availability of infrastructure to stimulate scientific and educational activities¹¹⁵.

Factor approach. An assessment of the presence and importance of conditions (factors) is necessary for the successful transfer and exchange of knowledge in the context of cooperation between ecosystem participants, as well as the level of development of IE. Factors of influence on the development of the innovation ecosystem and entrepreneurial activity of the university can be

¹¹⁰ JONKERS, K., TIJSEN, R., KARVOUNARAKI, A., GOENAGA, X. *A regional innovation impact assessment framework for universities*. [accessed 05.09.2022]. Available at: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC109020/jrc109020_iiu27.pdf.

¹¹¹ MARKKULA, M. *The Knowledge triangle: Renewing the University Culture*. In: *The Knowledge Triangle: Re-inventing the Future*. Finland: Multiprint Oy, 2019, p. 11–31. ISBN 978-2-87352-006-9.

¹¹² KAUTONEN, M., PUGH, R., RAUNIO, M. *Transformation of regional innovation policies: From 'traditional' to 'next generation' models of incubation*. In: *European Planning Studies*, 2016, nr. 4. p. 620–637. [accessed 01.09.2019]. Available at: DOI: 10.1080/09654313.2017.1281228.

¹¹³ ZHANG, S. *The Thought and Practice in Teaching Reform of Soil Mechanics*. In: *International Journal of Modern Education & Computer Science*, 2013, nr. 29, p. 55-59. ISSN 2305-3623.

¹¹⁴ RAUNIO, M., NORDLING, N., KAUTONEN, M., RÄSÄNEN, P. *Open Innovation Platforms as a Knowledge Triangle Policy Tool – Evidence from Finland*. In: *Foresight and STI Governance*, 2018, nr. 2, p. 62–76. [accessed 06.06.2019]. Available at: DOI: 10.17323/2500-2597.2018.2.62.76.

¹¹⁵ RAUNIO, M., NORDLING, N., KAUTONEN, M., RÄSÄNEN, P. *Open Innovation Platforms as a Knowledge Triangle Policy Tool – Evidence from Finland*. In: *Foresight and STI Governance*, 2018, nr. 2, p. 62–76. [accessed 07.10.2020]. Available at: DOI: 10.17323/2500-2597.2018.2.62.76.

external and internal¹¹⁶. A significant proportion of factors is manifested through the strategic parameters of the external environment, landmarks, strong and weak signals. To a greater extent, they characterize the space surrounding the ecosystem and should be taken into account when implementing the appropriate management technology (primarily, strategic management). These factors often characterize entire areas, sectors of the environment, and can be specified by dozens of indicators. The ecosystem approach meets the principle of interdisciplinarity and is characterized by the presence of natural, social, political, economic, digital and cultural factors.

In the scientific literature, there is a problem of the lack of a detailed systematization of the factors of development of innovation ecosystems of universities, due to the increased attention of researchers to digital, platform forms and models of ecosystem interactions. The issues of determining the factors of influence on the formation and development of innovation ecosystems of universities are considered in the scientific articles of some scientists. Stam¹¹⁷ developed the synthesizing model for measuring ecosystems, in which he identified ten main components of an entrepreneurial ecosystem (formal institutions, entrepreneurial culture, physical infrastructure, demand, networks, leadership, talent, finance, new knowledge and intermediate services). These elements are used to compile the Entrepreneurial Ecosystem Index and its impact on results. Yanjie Xie has developed an index system for assessing the university entrepreneurial ecosystem, which is based on ecological diversity, synergistic symbiosis, network interaction and self-evolution¹¹⁸. The university entrepreneurial ecosystem requires cooperation between stakeholders both inside and outside the university, and their mutual influence is built on a number of identified interaction factors. Graham R.¹¹⁹ conducted a comparative analysis of several entrepreneurial university ecosystems and identified the conditions for their success. Graham R.'s research revealed a number of factors supporting and developing the potential of universities and the growth of their innovation ecosystems.

During the coronavirus pandemic, digital technologies and the development of the digital space were rapidly developing, there was a transformation in the forms of interaction between the subjects of the ecosystem as a whole and its local elements, there was an increase in the need for

¹¹⁶ MEYER, M. H., LEE, C., KELLEY, D., COLLIER, G. *An Assessment and Planning Methodology for University-Based: Entrepreneurship Ecosystems*. In: The Journal of Entrepreneurship, 2020, nr. 29(6), p. 259-292. ISSN 0971-3557.

¹¹⁷ STAM, E. *Measuring entrepreneurial ecosystems*. In: Entrepreneurial ecosystems. New York: Springer, 2018, p. 173-197. ISBN 978-3-319-45654-6.

¹¹⁸ XIE, Y., ZHANG, W. *Construction and Measurement of University-based Entrepreneurial Ecosystem Evaluation Index System: A Case Study of Zhejiang University in China*. In: ASEE American Society for Engineering Education, 2019. ISSN 2153-5868. [accessed 02.06.2020]. Available at: <https://peer.asee.org/32541>

¹¹⁹ GRAHAM, R. *Creating university-based entrepreneurial ecosystems: evidence from emerging world leaders*. Massachusetts Institute of Technology, 2014. 141 p. [accessed 12.12.2019]. Available at: <https://www.rhgraham.org/resources/MIT:Skoltech-entrepreneurial-ecosystems-report-2014-.pdf>

innovations and their prompt implementation. The learning process, research and commercialization are closely related to various factors in the development of an entrepreneurial university and have a great influence on the formation of an ecosystem. With the help of a factorial approach, it is possible to identify the influence of the external and internal innovation environment, strategic and current problems that higher education institutions often face in the formation and development of the UIE.

Traditional approach represents the assessment of entrepreneurial universities based on international or national rankings. There are no direct indicators of the characteristics of university ecosystems in international university rankings yet. According to the author, this approach is not effective enough, since international university rankings use various methods and indicators for assessing innovation activity, which reflect only certain aspects of the functioning of ecosystems.

In the international ranking Times Higher Education there are indicators related to the volume of research funding by third-party companies, and its separate indicator Industry Income¹²⁰ reflects the level of scientific research of the university and the effectiveness of the process of their commercialization. An indicator of the university's reputation among employers and the business community is used by the QS World University Rankings¹²¹. The interaction between the university and employers is reflected in a separate QS (Graduate Employability Rankings) rating. Bibliometric and patent data reflects Thomson Reuters Top 100: The world's most innovative universities¹²²; the presence of startups in Forbes. Startup Schools: America's Most Entrepreneurial Universities¹²³; Triple Helix Association initiatives at The Global Entrepreneurial University Metrics initiative¹²⁴ (GEUM). Objects of innovation infrastructure associated with universities are reflected in the international rankings UBI Global: Top Business Incubation Rankings¹²⁵; Innovation U2.0 Reinventing University Roles in a Knowledge Economy¹²⁶ and others.

With all the undoubted advantages of general and regional international rankings, they also

¹²⁰ *THE Methodology*. [accessed 07.10.2021]. Available at: <https://www.timeshighereducation.com/news/ranking-methodology-2016>.

¹²¹ *QS Employer Reputation Methodology*. [accessed 15.09.2021]. Available at: <http://www.iu.qs.com/university-rankings/indicator-employer/>

¹²² *Thomson Reuters Top 100: The world's most innovative universities*. [accessed 07.11.2021]. Available at: <http://thomsonreuters.com/en/articles/2015/reuters-top-100-worlds-most-innovative-universities.html>.

¹²³ *Forbes. Startup Schools: America's Most Entrepreneurial Universities 2015*. [accessed 10.11.2021]. Available at: <http://www.forbes.com/sites/liyanchen/2015/07/29/americas-most-entrepreneurial-research-universities-2015/#271f48bb1084>.

¹²⁴ *The Global Entrepreneurial University Metrics initiative*. [accessed 07.12.2021]. Available at: <https://www.triplehelixassociation.org/news/the-global-entrepreneurial-university-metrics-initiative>.

¹²⁵ *UBI Global: Top Business Incubation Rankings: Benchmark & Ranking Methodology*. [accessed 07.12.2021]. Available at: <http://ubi-global.com/research/>.

¹²⁶ *Innovation U 2.0 Reinventing University Roles in a Knowledge Economy*. [accessed 19.09.2021]. Available at: http://www.innovation-u.com/InnovU-2.0_rev-12-14-14.pdf.

have disadvantages: a rather complex system of criteria involving expert assessments, which makes their verification either partially (THE) or completely (QS) impossible, and also makes it difficult to interpret the number of points scored by the university (this is an abstract a quantity that cannot be expressed in any natural units); the impossibility to apply the received number of points in any particular field of knowledge (including innovative activity); different methods for calculating quantitative and qualitative indicators; the criteria applied are not always justified; different levels of economic development of universities in different countries and culture¹²⁷. Therefore, it is necessary to closely monitor the situation around higher education, the policy in this area, in order for the ratings to become a reliable tool for monitoring the work of universities in the field of innovation.

The study of various approaches allows the author to draw a conclusion about the need for an integrated approach to assessing the innovation ecosystem of universities. An integrated approach to the analysis of innovation ecosystems requires the study of institutions, participants, networks of their interaction, the specifics and influence of environmental factors (culture, resources, technologies, and so on), as well as the internal environment. In order to conduct further research and determine UIE indicators, the author has achieved the goal set at the beginning of the paragraph to disclose approaches to assessing the university ecosystem.

1.4. Conclusions to chapter 1

1. According to the results of the analysis of scientific literature, the author concludes that the ecosystem can be considered as a complex, open and dynamic system capable of transforming and adapting to the external environment. This system consists of interrelated and interacting elements with each other and the environment, the content of which may vary depending on the goals and orientation of a particular ecosystem. An example of these goals is the co-creation of value, the creation of an interconnected network of actors who work together to achieve mutual benefit, the promotion of innovation, and the maintenance of growth.

2. As a result of theoretical analysis, it can be argued that the innovation ecosystem covers the main aspects: the interaction of actors and their interconnection on the basis of cooperation in the form of a network community (organization). The goal of the organization is to create innovations based on the generation of new ideas (common value proposition), the creation, support and promotion of innovations, the creation of a favorable environment for attracting talent

¹²⁷ LAPUȘIN, R., ISRAELI, M. *Assessment the rating of innovative activities of higher educational institutions: on the example of Israel*. In: Journal of Research on Trade, Management and Economic Development. Chisinau: UCCM, 2020, Vol. 7, nr. 1(13), p.59-70. ISSN 2345-1424.

and investment, the prosperity of start-ups and small businesses. At the same time, the innovation ecosystem is characterized by openness, complexity, self-organization, self-regulation, self-development. An innovation ecosystem can be built around a focal firm and takes into account the interests of business, education, civil society, small and medium-sized enterprises, etc.

3. According to the author, a comprehensive and integrated approach to the formation of an innovation ecosystem is needed to create an environment that supports the ideas, development and scaling of innovative ideas and technologies. An integrated approach intended to promote cooperation and coordination among various stakeholders, including government, industry, academia and the community. According to author, it is of great importance to emphasize that the innovation ecosystem should be located not on the functional roles of actors, but on the collaborative nature of their interactions with each other and potential participants. The use of a comprehensive and integrated approach ensures the availability of all the necessary elements: knowledge and technology, actors and networks, mutual exchange of resources between numerous partners, innovative infrastructure, institutions, including special regulatory environments, social encouragement of entrepreneurship, culture, etc.

4. The author formulated a more complete concept of the university innovation ecosystem : a complex of relationships between the subjects of the innovation process, the participants of which have various competencies and capabilities, constantly exchange knowledge, manage their flows, distribute and use this knowledge and experience, combine resources with other participants to support the creation and development of innovative ideas and technologies, interdependent on each other and interact on the basis of partnership agreements to bring these ideas to market.

5. According to the author, the innovation ecosystem is beginning to acquire practical importance in the field of higher education, gradually becoming the core or integrator of regional and national innovation systems. The uniqueness of universities lies in their ability to link education, research and innovation capacity, providing human resources and skills, funding and infrastructure, networks and leadership. Universities carry out several activities that promote innovation, including research, research cooperation, patenting, licensing, consulting, networking, entrepreneurship training and assistance in the creation of new enterprises. Therefore, universities can be considered as one of the most striking examples of a polystructural ecosystem.

6. The author has developed a model of the university's innovation ecosystem, which includes: human capital (teaching community, research team, administrative and managerial staff, students and graduate students); entrenched regulations and procedures; tangible and intangible assets; organizational structures, including functional networks and organizational and economic mechanisms, and others. Nevertheless, according to the author, at the moment there is no universal model of the university innovation ecosystem with a generally accepted structure, since it depends

on the characteristics of the higher education institution and various factors of the external and internal environment.

2. MATERIALS AND METHODS OF INVESTIGATION

2.1. Methodological foundations of the study: methods and tools

This dissertation research is based on a comprehensive methodological approach that makes it possible to describe the object of research (university innovation ecosystem), taking into account the experience of research in all areas at the intersection of which it is located. These studies can be called interdisciplinary, which dictated the need to develop hybrid research methods in some cases.

The methodological basis in the dissertation research is theoretical and empirical research. In the theoretical part of the work, in the first chapter, the main trends were analyzed and the significance and degree of study of the research problem were determined. The author used analogy as a means of cognition. Its defining features are the identity of objects and forms of reasoning, on the basis of which a conclusion about similarity in a general sense appears. Another significant method for the purposes of this study is the integrative research method, which combines the study of theoretical data from different fields of knowledge - higher education and innovative economics based on the transfer of knowledge between universities and enterprises.

The comparison method was also used, in which objects are compared and conclusions are drawn about their similarity or difference. This method serves as the basis for subsequent generalizations. Comparison takes place according to certain accepted criteria, which leads to the identification and limitation of research objects. Such a comparison is aimed at highlighting the general and the particular in the object, which makes it possible to choose the most effective directions within the framework of the research problem.

The thematic map of this study is characterized by the following topics:

- 1) theoretical approaches to the content of the innovation ecosystem;
- 2) fundamental aspects of the concept of innovation ecosystem;
- 3) composition and structure of innovation ecosystems;
- 4) characteristics of types of ecosystems;
- 5) approaches to the formation and development of innovation ecosystems of higher educational institutions;
- 6) characteristics of university models;
- 7) the role of educational institutions in the development of innovation ecosystems;
- 8) clarification of the concept of university innovation ecosystem;
- 9) macro and micro level of development of the university ecosystem;
- 10) characteristics of the elements of the structure of the university's innovation ecosystem;
- 11) systematization of methodological approaches to the assessment of the innovation ecosystem of higher education institutions.

An analytical review of the typology of approaches to the concept of "innovation ecosystem" made it possible to demonstrate the diversity and completeness of interpretations of this concept in existing studies and to approach its comprehensive understanding. The fundamental aspects of the innovation ecosystem concept together provide insight into what constitutes an innovation ecosystem and what does not. The author considers the integration approach to understanding the innovation ecosystem to be the most promising due to his desire for completeness of coverage (higher education, economics, innovation). However, other approaches also do not lose their relevance, since the reality of innovation ecosystems is quite wide, and their analysis in accordance with the tasks set can focus on various particular aspects. The practical significance of the concept of "innovation ecosystem" in the realm of higher education is gaining momentum, as it is based on the real experiences of contemporary companies, regions, and states.

The information base used in the dissertation research is formed from terms and definitions related to entrepreneurial and innovation ecosystems, the concept of Industry 4.0 and University 3.0, the Triple Helix concept, the concept of open innovation, as well as the terms of network forms of interaction. Most of these concepts in innovation studies have emerged in the context of societal development and emphasize new kinds of relationships between universities and economic development. In an era of innovation ecosystems with such hallmarks as sustainable social transformation, collaborative innovation and transnational knowledge sharing, there are new social requirements for higher education. Universities intensify their activities in the processes of creating intellectual capital in the form of research, generation and transfer of knowledge and thus ensure the competitiveness of the country. The participation of a research university in national and regional innovation development programs enhances its potential as a basic element of national and regional innovation ecosystems. The analysis and synthesis of the role of universities in a number of countries was used as the main research method. Based on a comparative analysis, conclusions were drawn regarding the role and functions of higher education institutions in the innovation ecosystem.

The various sources used make it possible to reasonably state that the introduction of the "innovation ecosystem" concept signifies a shift towards a new paradigm in the administration of higher education institutions. This paradigm must have its own philosophy, a different behavior in strategic and operational management. This requires the use of advanced methods:

- 1) management of the organization for the effective management of all types of resources (human resources, financial, material and technical) and the results of innovative activities (new technologies, models, prototypes, intellectual property objects, innovative products and services, personnel for various sectors of the economy and scientific and innovative activities);

- 2) management of scientific and innovative activities, such as the creation of a system for the search and cultivation of professionals with the inclinations of researchers, the creation of conditions for conducting interdisciplinary research, the creation of innovation and technology councils with entrepreneurs and other interested participants, which ensure the formation of new scientific and technical areas;
- 3) modern methods and tools of educational activities (including together with potential customers of personnel and technologies), including the use of the possibilities of the network economy to create new learning practices, the introduction of the principles of interactive learning, the introduction of programs for the development of business competencies and entrepreneurial culture that ensure the advanced development of students based on modern achievements of science, technology and entrepreneurship.

The use of improved methods, mechanisms and management tools will ensure the organizational and resource sustainability of a higher educational institution, create conditions for high-quality and dynamic reproduction of scientific and innovative potential.

A comparative analysis of scientific research using the analytical and synthetic approaches allowed the author to conclude that an integrated approach is needed to assess the innovation ecosystem of universities. However, the relevance of approaches is not a stable and unchanging characteristic. Due to the vitality and systemic nature of the phenomenon of ecosystems, the latter can be assessed from various points of view.

The creation of methodological tools for assessing the UIE is necessary to improve the system of innovation management at universities, especially at the early stages of the innovation process; will allow the formation and make organizational decisions; focus the necessary resources on effective tools that enhance the process of commercialization of the university's scientific developments.

The third chapter of the dissertation research is devoted to the study of practical aspects - a research program has been implemented aimed at studying the current situation in the field of innovation at the country level and formulating the prerequisites and conditions for the further development of the innovation ecosystem of Israeli universities. The analysis is based on the use of certain logical constructions, methods and selected research tools, which leads to the division of the object into elements, to study each of them and then generalize. Then, using the method of generalization, the author singled out some properties of the system under study. Generalization in this study is characterized by the transition from individual elements to their totality and further from a smaller scale to a larger one. Based on this, the author formulated conclusions or gave an assessment to the studied object of research.

This study combines a wide range of methods and tools that are based on reliable and up-to-

date data from various sources of information. The study reflects the problems and phenomena that characterize both the Israeli higher education market and the innovation market. The innovative trajectory of the development of the Israeli economy involves purposeful systematic transformations in all spheres of the development of society, institutional, structural and technological changes in the national economy aimed at increasing its global competitiveness. The topic of the dissertation research revealed the main aspects related to innovation processes at the national level of Israel, and the role of higher education institutions in this process.

The methodology for studying the Israeli innovation ecosystem consists in a comparative analysis of the main indicators of the countries' innovation activity, presented in international innovation indices. In order to get an idea of the countries leading in innovative development, as well as to pay attention to the peculiarities of building their national innovation systems, the author used the international indices the Global Innovation Index, World Competitiveness Index, Bloomberg Innovation Index. These indices in dynamics showed the degree of innovative development of Israel. Each of the indices has its own method of calculation. The Global Innovation Index is calculated on two groups of indicators. The first group includes resources and conditions for innovation, namely: research and institutions, human capital, infrastructure, business and domestic market development. It is customary to refer to the second group who achieved practical results, such as the development of technologies and the results of creative activity. The World Competitiveness Index is a global study and the accompanying ranking of countries in the world in terms of economic competitiveness according to the World Economic Forum. The GCI methodology includes indicators that highlight the role of innovation and human capital. Bloomberg's annual Innovation Index is compiled by analyzing seven categories, including research and development spending, patent activity, manufacturing capacity, and the concentration of high-tech public companies. The indicator of spending on science is used by Bloomberg to compile an annual ranking of the most developed innovative economies in the world. The results of this rating show the general ability to develop innovative technologies in each state. The National Entrepreneurship Context Index (NECI) evaluates the effectiveness and influence of national entrepreneurial ecosystems by evaluating twelve different business environmental factors.

Since international indices may not quite clearly characterize the features of a country's national development and its innovation ecosystem, the author analyzed the elements of the innovation cycle: fundamental and applied science, research and development (R&D), funding structures, and the innovation commercialization system. In the comparative characteristics of countries, the development indicators of countries are objective, as they are based on reference and statistical data.

When using the comparison method, objects are compared and conclusions are drawn about their similarity or difference. This method serves as the basis for highlighting the general and the particular in the object, which allows you to choose the most effective directions within the framework of the research problem. Comparison takes place according to certain accepted criteria, which leads to the identification and limitation of research objects.

The model of the national innovation system of Israel developed by the author consists of fundamental elements and can be used to evaluate and analyze other systems. When building the model, a review of special scientific literature was used, as well as observational data related to the socio-cultural, institutional, technological, methodological and educational aspects of entrepreneurship, start-ups and their ecosystems.

The analysis of the national innovation systems of the world leaders made it possible to identify a number of patterns by which a successful innovation ecosystem is built. Among them, the most significant are:

1. Implementation of large investments in human capital: encouragement of talented specialists in various knowledge-intensive fields.
2. Cooperation between science and the business sector: innovations are considered from the point of view of their future commercial application.
3. Providing funding for all stages of R&D: both small grants and large equity investments in innovative companies are encouraged.
4. State assistance: development of innovation policy, creation of regulations and tax incentives to organize support and growth of scientific research and development.

In the dissertation research, the resource opportunities and prospects of Israel for the formation and development of an innovation ecosystem of universities were analyzed. The author presents a complete picture reflecting the state of the Israeli higher education market and the processes taking place in it in the context of the development of innovation ecosystems.

When studying the world rankings in the field of higher education, the study used such traditional methods as forecasting, analysis, generalization, classification and analogy. As part of the analysis of the achievements of Israeli universities in the field of innovation assessment, the methods and indicators used in such world rankings as Times Higher Education (THE), QS World University Rankings, Academic Ranking of World Universities (ARWU), Ranking Web of Universities, Scimago SIR were analyzed. Based on the results of the analysis of the international assessment of various aspects of innovation activity and comparison of universities, it was determined that most of the assessment methods use the data accumulated by the research group from a fairly wide range of open sources of information: materials from the websites of both the universities themselves and state educational bodies and other organizations, data from national

and international scientometrics, as well as information obtained in the course of direct questioning of universities. The assessment of the criteria and methods used in the ratings for calculating indicators is in most cases carried out with the involvement of the world's leading experts. Methodological problems remain the development of formats for interaction with the evaluated universities and the choice of methods for verifying the data received from them, as well as the need to simplify the process of obtaining and processing the rest of the information involved in the research, ensuring its relevance and reliability.

In the formation and development of innovation ecosystems, universities and participating organizations are required to take joint actions. These actions involve significant changes in the structure of the university, its staff, curricula, as well as in the education system. Therefore, at the first stage, it is necessary to assess the state of the university innovation ecosystem, and then outline ways for its improvement.

To analyze the innovation ecosystem, the author singled out the enlarged structural elements of the university innovation ecosystem: scientific, personnel, organizational and financial. An integrated approach to the analysis of innovation ecosystems made it possible to study their participants, their networks of interaction, the specifics and influence of environmental factors (culture, resources, technologies, and so on), as well as the internal environment.

The process of formation and development of innovation ecosystems should be studied and analyzed on an ongoing basis. This is due to changes not only in the educational environment (the educational landscape is changing), but also has an impact on the local economy through such positive consequences as the practice of international educational cooperation and partnerships, the implementation of joint curricula and programs, improving the quality of educational products, and research programs. However, it is necessary to take into account the negative consequences of such processes as the migration of minds abroad, the loss of national characteristics of higher education services, and others.

The information and empirical base of the study was the statistical data of UNESCO, the Ministry of Education of Israel, the statistical data of Israel and foreign countries, the data of the official websites of Israeli higher educational institutions and a selection of foreign universities. The analysis of statistical data complemented the comparative analysis and helped to form a more accurate picture of the phenomena studied.

The instrumental and methodological apparatus is presented by the methods of comparative analysis and analogies (when analyzing the Israeli and foreign experience of higher education achievements), system analysis and synthesis (when determining the key characteristics of the university's innovation ecosystem, formulating the basic definitions of the "innovative university ecosystem" study, as well as determining methods, specific characteristics of the concepts under

consideration, quantitative and qualitative analysis, graphical interpretation of data (when interpreting statistical information within the framework of the study).

Using these methods, problems and phenomena that characterize entrepreneurial and innovation ecosystems in general are identified, which also affect the innovation ecosystems of higher education institutions. The topic of the dissertation research revealed the main aspects related to the innovation system of Israel, as well as the process of formation and development of the innovation ecosystem of higher education institutions.

To study the situation in the innovation ecosystem of Israeli universities, the author used the following methods:

1. Interviewing key employees of Israeli universities. The questions in the interview questionnaire were divided depending on the positions held by the respondents: the administration of the university, employees of departments related to innovation.
2. Questioning. More than 100 people took part in the survey. The questionnaire was offered in two languages: Hebrew and English. The questionnaires are anonymous, which ensures the maximum sincerity and objectivity of the respondents' assessments. The questionnaire is divided into semantic blocks, which makes it possible to systematize the answers of the respondents and provide full coverage of the entire subject of the dissertation research. Questions are formulated, for the most part, in open and semi-closed forms and imply free expression of opinion by respondents.
3. Expert review. Leading Israeli scientists and specialists were involved in the peer review, which formed the field of research in the field of higher education services and innovative economics. The following criteria were used in the selection of experts:
 - 1) experts have published articles and are widely cited in well-known journals within the last 10 years;
 - 2) experts represent different areas in the field of this study (higher education services, commercialization of university research, innovation management);
 - 3) experts are interested in conducting in-depth research in the field of innovation management and educational services.

The adoption of effective, evidence-based decisions by higher education institutions is impossible without a comprehensive objective assessment of not only the level of development of the innovation ecosystem itself, but also all the diverse factors influencing it. All factors that form the innovation ecosystem of a higher education institution are interconnected and interdependent, and underestimation of one of them affects the others. The systemic interaction of a set of conditions and factors accelerates the innovation process, from research and development to mass production of an innovative product or the use of innovative technology. Identification and

analysis of factors of the external and internal environment will help to ensure the formation of a holistic innovation strategy of the university.

The author used PEST analysis, Michael Porter's model and SWOT analysis to determine the influence of various factors on the formation and development of the university's innovation ecosystem. PEST analysis helps to identify political, economic, socio-cultural and technological factors influencing the development of the UIE. The results of the analysis can be used to understand the overall picture of the business environment, more detailed planning, searching for new opportunities, and minimizing risks. Michael Porter's model is a tool for analyzing the competitive conditions prevailing in the market and allows you to assess the degree of influence of each of the five forces on the development of the UIE; SWOT - analysis was used to identify the strengths and weaknesses of the development of the university's innovation ecosystem, opportunities and threats of the external environment.

The university innovation ecosystem and the mechanism of its interaction are emphasized by the presence of internal and external factors. Internal factors include educational, scientific and practical aspects, such as interdisciplinary paradigms, student scientific and entrepreneurial groups, network communities, which are responsible for communication between different segments. The teaching and research activities of the university must be characterized by originality, creativity, initiative, ethics, professionalism and an entrepreneurial approach. External factors refer to the cooperative relationship between the university, enterprises and the state (in some cases, the Ministry of Defense) in a high-tech context. The goals and objectives of the external parties are very different. If business expects scientific results from the university that are significantly ahead of existing ones, new non-standard solutions, then government agencies (including the Ministry of Defense) are more traditional, and sometimes they can be content with some improvements to existing solutions. Research and commercialization of innovations are key determinants of economic growth. As a result, they contribute to the employment of the population, can serve as a means of solving problems at the state and global levels. For example, information technology is causing a revolution in teaching, research, manufacturing, and business. In order for each element of the university system to work for its goals, the ecosystems created in them are very important. It is believed that the better the ecosystem of the University, the more competitive it is.

Having determined the factors for the effective development of the university's innovation ecosystem, one can be able to link theory with the practical use of this concept. However, sustainable development and successful innovative activities of higher education institutions in the long term are impossible without strategic management (strategic factor). In order to generate innovations within innovation ecosystems, it is essential to establish a specialized infrastructure

and to meet new criteria for individuals, whether they are from the fields of science, business, public administration, or civil society (i.e. the human factor). For the development of the UIE, it is necessary to take into account not only strategic management, but also the trend of a constant increase in the number of factors under the influence of changes taking place in the field of higher education. Therefore, systematic monitoring should be carried out to identify new factors and their thorough analysis should be carried out.

Thus, this set of theoretical and empirical studies made it possible to fully reveal the essence and identify problems, challenges, trends and conditions for the future development of the university's innovation ecosystem, in order to propose the most effective practices for their assessment and management.

When writing the fourth chapter of the dissertation research, the author used three definitions - concretization, addition, transformation. With their help, the need to develop a management mechanism and a methodology for assessing the university innovation ecosystem was formulated and scientifically proven, with the application of which new, improved results of the innovation activities of universities can be achieved.

The mechanism for managing the university innovation ecosystem reflects a set of control actions, methods and ways of interaction of UIE subjects built in a given sequence to achieve the set goal. A new level of opportunities and responsibility requires new approaches and methods for organizing and managing processes in a higher educational institution. Among them are a project-based, systematic approach to university management; diversification of sources and the emergence of new forms of financing activities; change in the internal organizational structure; new business models of the university and others.

The goals of managing the university innovation ecosystem should be interconnected with the main goal of the university and be formed directly during the development of its overall strategy. A well-designed strategy should include a description of the institution's current position and the desired goal. Strategic goals are formulated correctly only when they are clear, realistically achievable and measurable. At the same time, the strategy should not be overly detailed.

When developing a strategy for the formation and development of the university innovation ecosystem, it is necessary to coordinate the interests and goals of all participants in the innovation process, to share areas of responsibility and cooperation with enterprises that are part of the chain of creating an innovative product. For this, soft (flexible) organizational and economic mechanisms can be used. These mechanisms will allow universities to independently form their new organizational structure, develop real development strategies that correspond to their potential, and, ultimately, carry out effective activities to create and implement the results of intellectual activity.

To assess the effectiveness and efficiency of the functioning of innovative processes and the ecosystem of the university as a whole, tools for measurement are needed. An analysis of the scientific literature showed that the existing methods for assessing the level of development of the innovation ecosystem of universities are characterized by quite significant differences, both in the areas of assessment and in the criteria, indicators and tools used.

The author has developed a methodology for assessing the development of the university's innovation ecosystem based on the Balanced Scorecard. This method allows you to translate the mission and overall strategy of the organization into a system of clearly defined goals and objectives, as well as indicators that determine the degree to which these goals are achieved.

The proposed assessment methodology allows a more detailed examination of the components of the UIE and determines its position in relation to other universities, both in general and in terms of specific criteria. This will make it possible to outline the directions for the development of the university's innovative activities, as well as to develop the necessary strategic and tactical decisions aimed at increasing the competitiveness and positioning of a particular university in world rankings.

The strategic importance of the mission of the world ratings under consideration is beyond doubt. However, the application of the methodology used in them to assess the innovation ecosystem at the level of individual universities or groups of universities (for example, in the region), according to the author, is very difficult and inefficient. This is due to the rather low weight of the innovation component of the rankings reviewed, as well as the impossibility of detailing the rankings and identifying indicators of potential opportunities for the development of the innovation environment of specific universities.

The methodology for assessing the development of the UIE proposed by the author is quite simple to understand, can be easily adapted to the goals of specific studies and does not require significant labor and material costs. Another important feature of the methodology is the ability to compare individual universities in terms of the level of development of the innovation ecosystem, both in general and in its individual components, including the comparison of specific evaluation criteria. The balanced scorecard assessment of the UIE development level allows the inclusion of additional qualitative indicators based on a survey of ecosystem participants and various experts. This makes it possible to evaluate the effectiveness of the interaction of all participants in the innovation ecosystem, to determine the list of evaluation criteria, the possibilities of using the evaluation results. The UIE Development Assessment will identify "weak points" and reserves for the development of innovative activities of universities, and will also help improve their competitiveness and position in national and world rankings.

Thus, the following research methods were used in the dissertation research: systemic, structural, sociological, multivariate comparative and factor analysis, methods of statistical processing of information and expert assessments, the method of describing organizational structures, expert methods, comparative and comparative analysis, mathematical modeling methods, tabular methods and graphical presentation of information, statistical data. In the process of writing the dissertation work, general scientific methods were also used: scientific abstraction, classification, comparison, analysis and synthesis, systematization, formalization, modeling, methods of comparative, structural-functional, system analysis.

2.2. Methodology for formulating conclusions and recommendations

The formulation of conclusions based on the results of the research in the chapters of the dissertation research and in its conclusion are the most important parts in which the quintessence of the material studied and the author's point of view on the problems and possible solutions are formulated. The final stage of this dissertation research convincingly demonstrates the results of the work. The main conclusions reflected in the final part of the dissertation are presented in the order in which the problematic issue was studied by chapter.

In the conclusion, the scientific information presented in the dissertation research is summarized, the results of solving the tasks set by the author are presented (Figure 2.1).

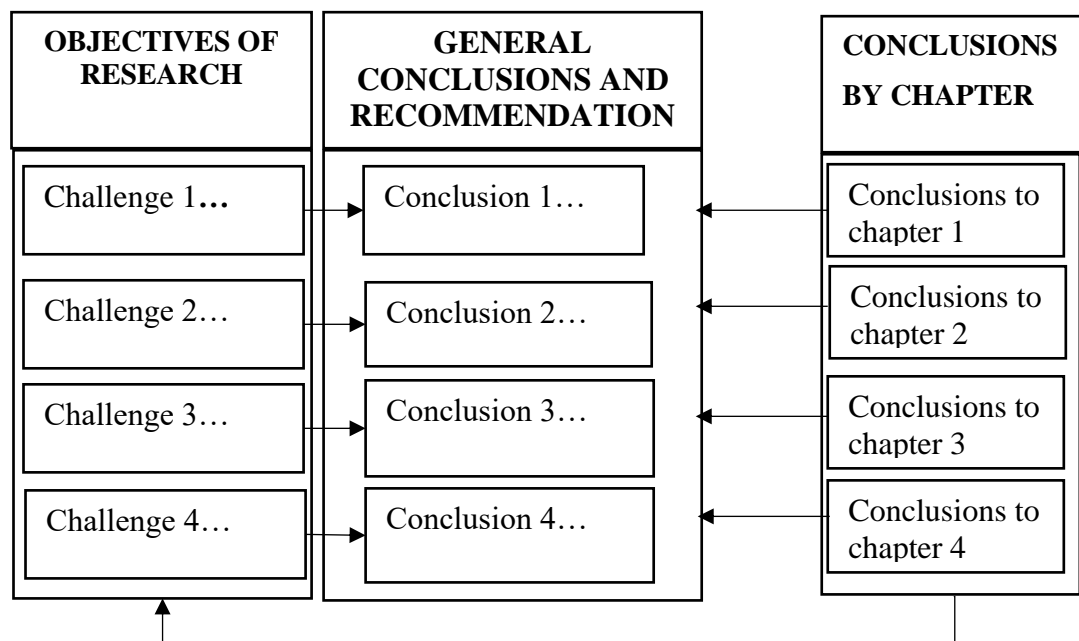


Figure 2.1. Scheme of connections between the tasks of the dissertation research and general conclusions [developed by the author]

In the course of the research, the author obtained intermediate results, which made it possible to supplement and connect each other in a logical sequence, to confirm the hypothesis put forward,

and led to the final overall result of the dissertation research. Conclusions and recommendations respond to the goals and objectives set, take into account the provisions submitted for defense, and also proceed from the structure of the dissertation.

The diverse range of methods used in the study allowed for a more precise formulation of scientific conclusions and recommendations. The methodology for drawing conclusions was based on the qualitative and quantitative results of the studies. Qualitative and quantitative data concerning the sphere of higher education were analyzed through the prism of international relations in the global educational market in the context of integration processes.

Based on the analysis performed by the author, a final decision was made, which was formulated as a conclusion, conclusions or practical recommendations for application at the national and institutional levels. The author briefly, clearly, scientifically singled out the new and significant that is the result of the study, gave him an exhaustive assessment and identified ways for further research.

The author was guided by the following principles when formulating conclusions:

- 1) conclusions should be formulated carefully, accurately;
- 2) conclusions should not be overloaded with digital data and particulars, but should include statements made by the author, and detailed substantiations of the conclusions should be contained in the text of the chapters after the research;
- 3) conclusions should be few and briefly substantiated;
- 4) conclusions should be a response to the main objectives of the study;
- 5) conclusions should be built in accordance with the presentation of scientific material in the dissertation research;
- 6) conclusions should take into account not only the existing conditions, but also those changes that should occur in the near future.

Guided by these principles, before formulating the final conclusions, the author re-checked the completeness of each individual part of the work and the evidence of the argument on the scale of the entire work as a whole. After that, conclusions were formulated on the essence of the problem posed, on side issues, on issues of practical significance and the use of the results obtained, as well as conclusions on further research.

2.3. Conclusions to the chapter 2

1. The goals and objectives formulated in the dissertation research dictated the need to use various methods and tools of scientific knowledge, such as scientific abstraction, classification and comparison of approaches to the formation and development of innovation ecosystems of

universities and their role in the development of the economy of the region and the country, analysis and compilation of data from reliable sources such as the OECD, the World Bank.

2. Methodological support in the dissertation research includes various methods for analyzing primary information collected for the purposes of this study and secondary information that exists in open sources and formulating the main conclusions and recommendations that take into account the peculiarities of research methods for assessing and managing the innovation ecosystem of higher education institutions.

3. Grouping and classification of information, induction and deduction, analysis and synthesis, the study of institutional mechanisms for managing the innovation ecosystem, as well as the evolutionary study of phenomena in the Israeli higher education system, led to the conclusion that scientific research in this area should be continued.

4. In order to facilitate the process of cognition, according to the author, it is advisable to pay attention to the study of the main theoretical approaches and concepts, using analytical, empirical research methods, more aimed at studying innovation ecosystems at the global and national levels. This approach will increase productivity and update the findings of scientific research.

3. ANALYSIS OF THE NATIONAL INNOVATION SYSTEM OF AND DIAGNOSTICS OF THE INNOVATIVE ECOSYSTEM OF HIGHER EDUCATIONAL INSTITUTIONS IN ISRAEL

3.1. Analysis of Israel's National Innovation System

At the present stage of economic development, innovations are the key to obtaining significant competitive advantages, and innovation is a promising area of activity for any state. The formation of a national innovation system is one of the main challenges for the country's economy in modern conditions. Despite sufficient world experience in building innovation systems, there is no exhaustive list of sufficient conditions to ensure the success of a national innovation system (NIS), since each country has individual characteristics (climatic, geopolitical, socio-cultural, resource, etc.). However, on the basis of an evolutionary approach to the development of innovations, the necessary conditions for the formation of national innovation systems are known: society's awareness of the need for innovation development, the choice of strategic priorities, a high level of funding for science (at least 4% of GDP per year), a high (worldwide) level of education, relevant legislation in areas of financing, taxation, establishment of innovative organizations, as well as reducing bureaucratic procedures in the field of innovative business, commercialization and technology transfer. The degree of Israel's innovative development can be characterized using various international indexes presented in Table 3.1.

Table 3.1. Israel's rank in international innovation indices [developed by the author based on ¹²⁸ ¹²⁹ ¹³⁰]

Years	Global Innovation Index (GII)	World Competitiveness Index (GCI)	Bloomberg Innovation Index (BII)
2015	22	27	16
2016	21	27	11
2017	17	22	10
2018	11	21	10
2019	10	24	5
2020	13	26	6
2021	15	27	7
2022	16	25	-

*The 2022 BII country ranking is not currently available

The data in the table show that Israel's ratings in international indices in the period from 2015 to 2022 do not improve steadily. In 2019, Israel ranked 10th out of 129 countries in the GII ranking, which characterizes world economies according to their innovative potential. But this

¹²⁸ *Global Innovation Index*. [accessed 18.06.2022]. Available at https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2021/il.pdf

¹²⁹ *World Competitiveness Ranking*. [accessed 18.06.2022]. Available at: <https://gtmarket.ru/ratings/imd-world-competitiveness-ranking>

¹³⁰ *Bloomberg Innovation Index*. [accessed 18.06.2022]. Available at: <https://nocamels.com/2021/02/israel-7th-spot-bloomberg-index-innovation/>

figure has declined between 2020 and 2022. Analysis of the structural parameters of the GII revealed the strengths and weaknesses of the Israeli NIS¹³¹ (Appendix 11). Israel is a leader in a number of dimensions that reflects the strength of its innovation ecosystem, such as heavy investment in R&D and quality scientific research¹³². But on other dimensions included in the index, such as the digital infrastructure and technological capabilities of the population, Israel lags behind when compared to other developed countries.

Since 2018, the methodology of the World Competitiveness Index (GCI) has included indicators that emphasize the role of innovation and human capital. Each state is evaluated on four main indicators of key aspects of the country's economic life: the state of the economy, the effectiveness of the government, the state of the business environment and infrastructure. From 2018 to 2021, there has been a decline in Israel's position in the GCI ranking from 21 to 27, but in 2022 it increased to 25.

The Bloomberg Innovation Index ranks countries based on seven equivalent metrics, including R&D spending, concentration of high-tech public companies, higher education performance, number of patents, and the value of a country's innovative products. Israel was ranked 5th out of 105 countries in 2019, but dropped to 6th in 2020 and 7th in 2021. The decrease in this indicator was influenced by such components as tertiary efficiency (34th place) and the productivity of Israel (18th place).

The National Entrepreneurship Context Index (NECI) is a composite indicator calculated as part of a study by the Global Entrepreneurship Monitor (GEM). It reflects the framework conditions for entrepreneurship in the country and assesses the conditions for the development of entrepreneurship and ecosystems (ease of starting and developing a business). Israel ranked 20th place in 2021¹³³ (Appendix 12).

The indicators ratings give an assessment of the country's position in the global innovation space, but it may not quite clearly characterize the features of the country's national development and its innovation system. Israel belongs to the developed states of the innovative type of development, which has a well-formed national innovation system¹³⁴.

The structure of Israel NIS was formed gradually, the forms and arrangement of its elements

¹³¹ *Global Innovation Index 2021*. [accessed 12.05.2022]. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2021/il.pdf.

¹³² *Israel Innovation Authority's 2019. Innovation Report*. Israel Innovation Authority. [accessed 03.04.2021]. Available at: https://innovationisrael.org.il/en/sites/default/files/Israel%20Innovation%20Authority-2019%20Innovation%20Report_eng.pdf.

¹³³ *Which are the best countries in the world for entrepreneurs in 2022?* World Economic Forum. [accessed 12.04.2023]. Available at: <https://www.weforum.org/agenda/2022/04/new-research-reveals-best-countries-entrepreneurs/>

¹³⁴ LEMARCHAND, G.A., LECK, E., TASH, A. *Mapping research and innovation in the State of Israel*. UNESCO Publishing, 2016, nr. 5, 345 p. ISBN 978-92-3-100147-5.

of Israel's public policy is to maintain its position as a leader in research and development, high technology, its unique entrepreneurial culture¹³⁷.

The Israeli innovation policy establishes, constantly adjusts and systematically organizes the relationships and interconnections between the constituent elements of the innovation ecosystem. It is based on long-term cooperation between government institutions, business (innovative industry) and academia (universities and research centers)¹³⁸. The state acts as a flexible stimulating agent: it concentrates on creating a wide range of technological opportunities, stimulates private agents to work in technology-intensive areas, and encourages their cooperation with each other and with the state¹³⁹.

Innovation in Israel can be seen as a tool, not an end in itself¹⁴⁰. Therefore, the state does not dictate the direction of development to the market. It has taken the role of an active assistant, contributing to the development of a multifactorial innovative economy. Through the created programs and the amount of allocated funds, the state indicates the development of the most promising areas. For example, programs dedicated to develop technological infrastructure (MAGNET, MAGNETON, NOFAR, TZATAM, KAMIN, MEIMAD, Industrial Research Institutes, MIDGAM Bank, KIDMA2.0 and others)¹⁴¹.

Government bodies play a key role in supporting and developing the Israeli innovation ecosystem and implementing elements of the government's innovation policy. The tools of state regulation and support include a combination of direct and indirect measures. Direct measures include direct public investment in the form of R&D grants or loans for the business sector or for intergovernmental research and development such as military research and development or technology acquisition. Indirect support instruments mainly include various tax incentives for companies engaged in research, development and innovation¹⁴².

The Israel Innovation Authority (IIA) (formerly the Office of the Chief Scientist) is an independent government agency. The mission of the Israel Innovation Authority is to connect the innovation ecosystem with the public sector¹⁴³. The objectives of this organization are to attract

¹³⁷ Israel Innovation Authority. Israel Innovation Authority Report 2017. [accessed 16.10.2021]. Available at: <http://economy.gov.il/English/NewsRoom/PressReleases/Documents/2017IsraelInnovationAuthorityReport.pdf>.

¹³⁸ DYDUCH, J., OLSZEWSKA, K. *Israeli Innovation Policy: an Important Instrument of Perusing Political Interest at the Global Stage*. In: Polish Political Science Yearbook, 2018, nr. 47(2), p. 272-290. ISSN 0208-7375.

¹³⁹ ATKINSON R.D., EZELL S.J. *Innovation Economics. The Race for Global Advantage*. London: Yale University Press, 2012. 131 p. ISBN: 0300168993.

¹⁴⁰ DYDUCH, J., OLSZEWSKA, K. *Israeli Innovation Policy: an Important Instrument of Perusing Political Interest at the Global Stage*. In: Polish Political Science Yearbook, 2018, nr. 47(2), p. 272-290. ISSN 0208-7375.

¹⁴¹ *The Israel Innovation Authority in Action*. Israel Innovation Authority, 2019. [accessed 17.09.2020]. Available at: <https://innovationisrael.org.il/en/search/content?keys=MAGNET%2C+MAGNETON%2C+NOFAR>.

¹⁴² *Innovation Authority – Strategy and Policy*, 2020. [accessed 12.08.2021]. Available at: <https://innovationisrael.org.il/en/contentpage/strategy-and-policy>.

¹⁴³ *Creation of the Israel Innovation Authority*. Israel Innovation Authority, 2020. [accessed 04.10.2021]. Available at: <https://stip.oecd.org/stip/policy-initiatives/2017%2Fdata%2FpolicyInitiatives%2F5295>.

new employees for the development of industrial R&D, provide various tools and funding platforms for local and international innovation systems. IIA Israel has six main innovation divisions (Appendix 13). Each division offers individual and comprehensive programs to stimulate successful innovative projects for both entrepreneurs and companies. The Israel Innovation Authority, through the Research and Development Fund, supports or shares up to 50% of the costs of research and development projects¹⁴⁴, provides a wide range of domestic and international programs and projects, ranging from nascent concepts within the pre-seed system, to incubators, start-ups and stand-alone industrial enterprises¹⁴⁵.

The Innovation Authority launched a five-year strategic program in 2018 that focuses on ten key strategic goals (Appendix 14). The implementation of the strategy contributed to the fact that Israel was able to build a fairly effective model of interaction between the state, science and business in the segment of the innovative economy.

Business as an element of NIS. For decades, the Israeli high-tech industry has been considered the growth engine of the Israeli economy. More than half (54%) of the country's total exports were to Israel's high-tech sector in 2021¹⁴⁶. The high-tech sector in Israel brings together electronics, pharmaceuticals, and aircraft manufacturing with service sectors such as software and research and development. Veteran companies in the industry are Intel, Teva, and Check Point. New high-tech fields have emerged in this sector: digital health, smart transportation, precision agriculture and industry 4.0.

The share of high-tech products in GDP has been on the rise for many years. In 2021, this indicator grew by 10%, but retained its relative share in GDP¹⁴⁷. In the past, high-tech output grew at a much higher rate than other sectors, but in recent years there has been a significant increase in high-tech services (Appendix 15). In 2022, the business performance of the Israeli high-tech industry declined. The total volume of venture capital investments (VC) in the amount of 15.5 billion US dollars corresponds to the indicators of 2014-2020. Funding in the cyber sector fell by more than 60% between 2021 and 2022.

The sectoral structure shows the highest concentration of innovations, start-ups and venture investments in such sectors as: information and communication technologies; medicine and

¹⁴⁴ *R&D Fund*. Israel Innovation Authority [accessed 14.11.2021]. Available at: <https://innovationisrael.org.il/en/program/rd-fund>.

¹⁴⁵ GETZ, D., GOLDBERG, I. *Best Practices and Lessons Learned in ICT Sector Innovation: A Case Study of Israel*. [accessed 17.03.2022]. Available at: <http://documents.worldbank.org/curated/en/526981530526619514/pdf/Best-Practices-and-Lessons-Learned-in-ICT-Sector-Innovation-A-Case-Study-of-Israel.pdf>.

¹⁴⁶ *Israeli high-tech dominant export industry, but investment needed*. [accessed 19.09.2021]. Available at: <https://www.israel21c.org/israeli-high-tech-becomes-dominant-export-industry-but-uncertainty-looms/>

¹⁴⁷ *Annual Innovation Report State of High-Tech 2022*. Israel Innovation Authority. [accessed 07.02.2022]. Available at: <https://innovationisrael.org.il/en/sites/default/files/Annual%20Innovation%20Report%20-%20State%20of%20High-Tech%202022.pdf>

pharmaceuticals; agriculture and biotechnology; natural resources and energy (including renewable energy and water technologies); defense and aerospace industries. The Israeli system has the highest percentage of companies founded in both the information technology and healthcare sectors, while at the same time the lowest share in the B2C and B2B sectors¹⁴⁸.

Employment in the high-tech sector has remained high for many years and increased in 2021 compared to 2020 by 10.4%. Israel continues to be the world leader in terms of high-tech employment ratio. Between 2012 and 2021, the number of people employed in the high-tech sector in Israel grew by more than 160,000 individuals, with a quarter of them employed in companies which not related to the high-tech industry. The share of employees in companies belonging only to the high-tech sector shows an increase in the age group of 30-34 years from 11% in 2017 to 14% in 2021¹⁴⁹. But the high-tech industry faces challenges in the area of human capital - recruiting and employing university graduates with no practical experience.

The territorial distribution of innovative industries is concentrated in the so-called "Israeli silicon wadi". The largest concentration of high-tech firms is concentrated in the Tel Aviv area, including small clusters around the cities of Raanana, Petah Tikva, Herzliya, Netanya, the academic city of Rehovot and its neighbor Rishon Lezion. High-tech clusters are also located in the northern part of Israel in Haifa and Caesarea, and in the south in Beersheba. The geographical proximity between R&D centers, industries and developed urban areas is a positive characteristic of the national innovation system. It has a concentrated human capital combined with infrastructure and very good domestic and international transport links.

Scientific sector as an element of NIS. Universities are one of the main participants in Israel's innovation system. Research and development in Israel is mainly carried out at the country's 8 universities, dozens of state and public research institutes, and hundreds of civilian and military enterprises¹⁵⁰. The activities of universities in the field of innovation will be discussed in more detail in paragraph 3.2.

The Israeli Academy of Sciences (IAS) promotes the development of the natural and human sciences, organizes contacts between scientists, advises the government on scientific issues and Israeli representation in international scientific organizations. IAS cannot exist separately from universities. Members of the IAS are university professors.

The innovation system in Israel is distinguished by a significant emphasis on the

¹⁴⁸ *How Does Israel's Innovation Ecosystem Compare to 9 Global Tech Hubs?* Start-up Nation Central, 2021. [accessed 12.04.2022]. Available at: <https://blog.startupnationcentral.org/general/how-does-israels-innovation-ecosystem-compare-to-9-global-tech-hubs/>

¹⁴⁹ *Israeli High-Tech 2022. Situation Report.* Israel Innovation Authority. [accessed 25.01.2023]. Available at: <https://innovationisrael.org.il/en/reportchapter/part-israeli-high-tech-2022-situation-report>

¹⁵⁰ *Israel Ministry of Foreign Affairs.* [accessed 11.04.2022]. Available at: https://mfa.gov.il/MFARUS/Pages/Israel_MFA_Russian.aspx.

development of human capital. Israel ranked 23rd in Human Development Index in 2022 (0,906)¹⁵¹. In terms of R&D personnel per 10,000 employed in the economy, Israel ranks second among other countries with 212 people (Figure 3.2).

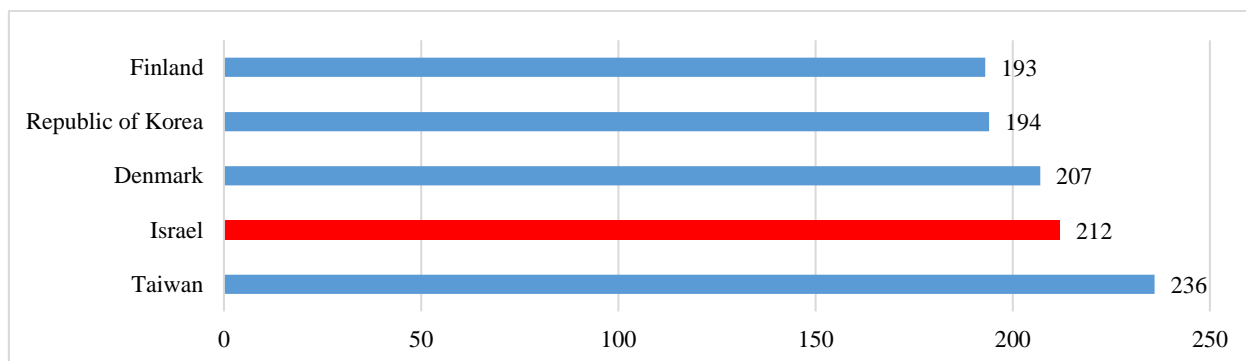


Figure 3.2. Number of personnel engaged in research and development, per 10000 employed in the economy [developed by the author based on ¹⁵²]

This indicator reflects the high potential of the Israeli NIS in terms of innovative activity of the personnel of various organizations.

Israel NIS acts as a link between the state, the scientific, technical and research sphere, private business and the industrial sector, and the banking system. It encompasses all the components of the innovation process, including fundamental and applied science, research and development (R&D), and funding mechanisms, and a system for commercializing innovations. The structure of domestic expenditures on research and development by type of work in Israel differs from other countries (Figure 3.3).

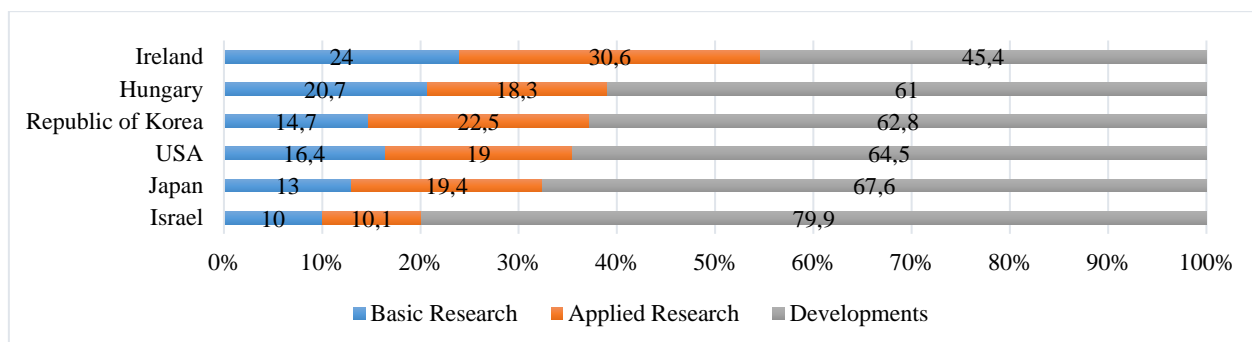


Figure 3.3. Structure of internal current costs for research and development by type of work, % [developed by the author based on ¹⁵³]

The share of internal current expenditures on fundamental and applied research is approximately equal and amounts to 10% and 10.1%, respectively; for developments - 79.9%.

¹⁵¹ *Human Development Index*. [accessed 01.07.2022]. Available at: <https://worldpopulationreview.com/country-rankings/hdi-by-country>

¹⁵² ГОХБЕРГ, Л.М., ДИТКОВСКИЙ, К.А., ЕВНЕВИЧ Е.И. *Индикаторы науки 2022: статистический сборник*. Москва: НИУ ВШЭ, 2022. 400 с. ISBN 978-5-7598-2376-6.

¹⁵³ ГОХБЕРГ, Л.М., ДИТКОВСКИЙ, К.А., ЕВНЕВИЧ, Е.И. *Индикаторы науки 2022: статистический сборник*. Москва: НИУ ВШЭ, 2022. 400 с. ISBN 978-5-7598-2376-6.

Funding for fundamental research is provided primarily by the state. Approximately 40% of these public funds are used for science development through national, binational and government research funds. Research funds funded by the Planning and Budgeting Committee (PBC) form the backbone of fundamental competitive research in Israel. Universities receive these funds as part of the Council for Higher Education¹⁵⁴. The 2017/18-2021/22 plan saw a significant increase in funding for PBC research funds to enable researchers to achieve significant advances and raise Israel's scientific status in the world¹⁵⁵.

There are three R&D sectors in Israel¹⁵⁶: commercial, scientific and government (Appendix 16). Each of the sectors in Israel operates in the context of technology transfer independently, according to its own goals and means. Domestic spending on research and development by science sector is divided into public, business, higher education and non-profit organizations. In 2021, internal R&D spending in the business sector was 88.9%; in the higher education sector - 8.7%; in the public sector - 1.5%; sector of non-profit organizations - 1%. Government funding for commercial projects in Israel is increasing every year.

A well-established system of technology transfer from science to industry has been created in the country. The transfer of knowledge is manifested in collaborative partnerships (consortia) between commercial enterprises and universities, supported by several government programs, as well as the transfer of human capital to companies via university graduates.

Figure 3.1 shows the processes of technology transfer in the form of two types of inter-firm links (forms of cooperation) between NIS elements. The first group covers processes and organizations that reflect the transformation of knowledge, the transfer of technologies and innovative products. These organizations include universities and research institutes that work closely with the business sector. The commercialization of scientific research and technology is carried out through the University-owned Technology Transfer Company - TTC. Technology transfer companies can be private, public or university.

Technology Transfer Company is engaged in the transfer of knowledge and technologies developed at universities. Technology transfer takes many forms: patenting, licensing, subsidiaries, research collaborations, and joint ventures. Most technology transfer companies are grouped under an umbrella structure "Israel Technology Transfer Network" (ITTN)¹⁵⁷, which was established in 2004 as a private non-profit organization. ITTN is the umbrella technology transfer

¹⁵⁴ Israel Ministry of Foreign Affairs. [accessed 22.05.2022]. Available at: https://mfa.gov.il/MFARUS/Pages/Israel_MFA_Russian.aspx.

¹⁵⁵ *Budgeting for Research Foundations, Council for Higher Education of Israel*. [accessed 12.02.2022]. Available at: <https://che.org.il/en/research-foundations/budgeting-research-foundations/>.

¹⁵⁶ *Technology Transfer in Countries in Transition: Policy and Recommendations*. WIPO, 2012. [accessed 19.11.2020]. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_transition_2_b.pdf.

¹⁵⁷ ITTN. [accessed 16.02.2022]. Available at: <http://www.ittn.org.il/about.php?cat=18&incat=0>.

organization for Israeli companies that are affiliated with the country's universities and research institutes. ITTN currently has 15 partner organizations.

The role of patents in innovation activity is to provide legal protection and incentives for inventors and companies to invest in research and development by granting exclusive rights to produce, use, and sell their inventions for a limited period of time. In 2021, Israel ranked 10th among countries in the number of applications filed with the U.S. Patent and Trademark Office, 13th in the number of patent cooperation treaty (PCT) applications, and 18th in applications at the European Patent Office.

The number of patent applications and granted patents of Israel in 2021 amounted to 9616. The growth compared to 2020 (5488) was about 20%. In the total number of applications, 17% were resident applications and 83% applications, submitted abroad (including 43% from USA, 27% from Europe %, 6% Asian applications)¹⁵⁸. The segmentation of patents by filing sector also indicates the stability of the distribution of patents registered in recent years (Appendix 17). In 2021, about 82.3% of registered patents were filed by companies, about 8.7% were filed by universities, 5.9% by private applicants, about 1% by hospitals or knowledge transfer companies, about 1.6% by public companies, and about 0.5% by public research bodies. The distribution of unique inventions by main patent areas is shown in Figure 3.4.

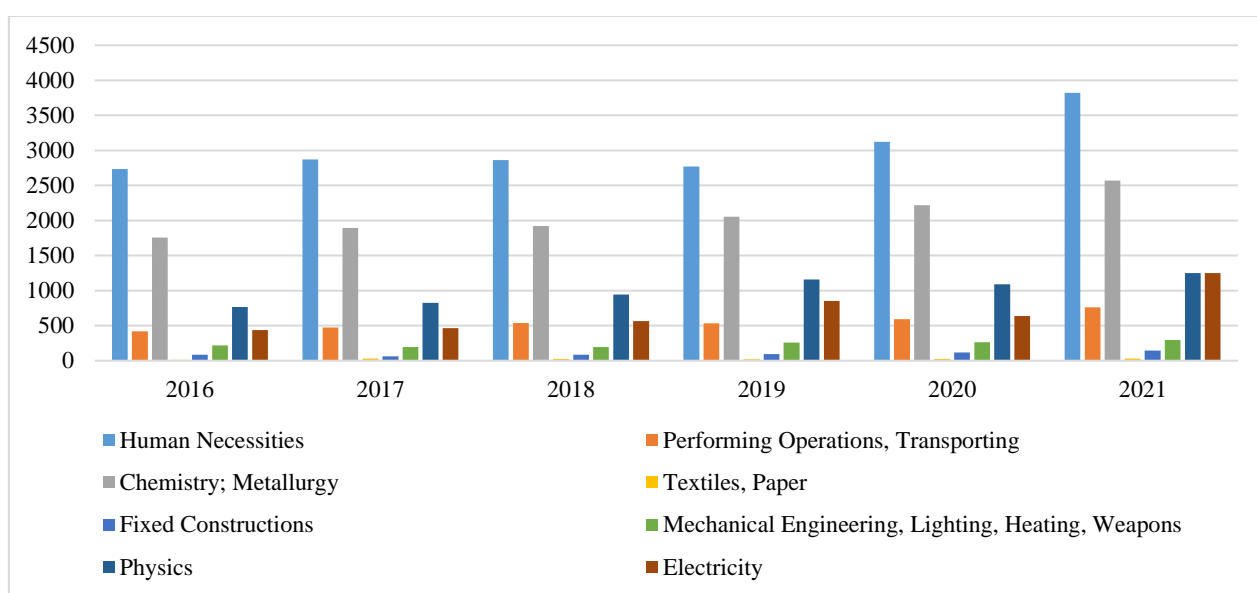


Figure 3.4. Patent Applications by Technical Fields, 2016–2021 ¹⁵⁹

By main patent area in 2021 39,8% on Human Necessities; 7,9% on Performing Operations, Transporting; 26,8% on Chemistry; Metallurgy; 0,3% on Textiles, Paper; 1,5% on Fixed

¹⁵⁸ World Intellectual Property Indicators, 2022. [accessed 14.05.2022]. Available at: <https://www.wipo.int/publications/en/details.jsp?id=4632&plang=EN>

¹⁵⁹ Israel Patent Office. Annual Report 2021. [accessed 27.01.2023]. Available at: https://www.gov.il/BlobFolder/reports/new-annual-reports/en/annual-reports_eng_main-annual-report-2021-eng.pdf

Constructions; 3,1% on Mechanical Engineering, Lighting, Heating, Weapons; Blasting; 13% on Physics; 7,5% on Electricity.

The second type of relationship between NIS agents relates to resource flows, which include public funding for university research, public and commercial investment (in technology incubators, as well as direct investment in start-ups).

The structure of domestic spending on research and development by sources of funding differs by country, as shown in Figure 3.5.

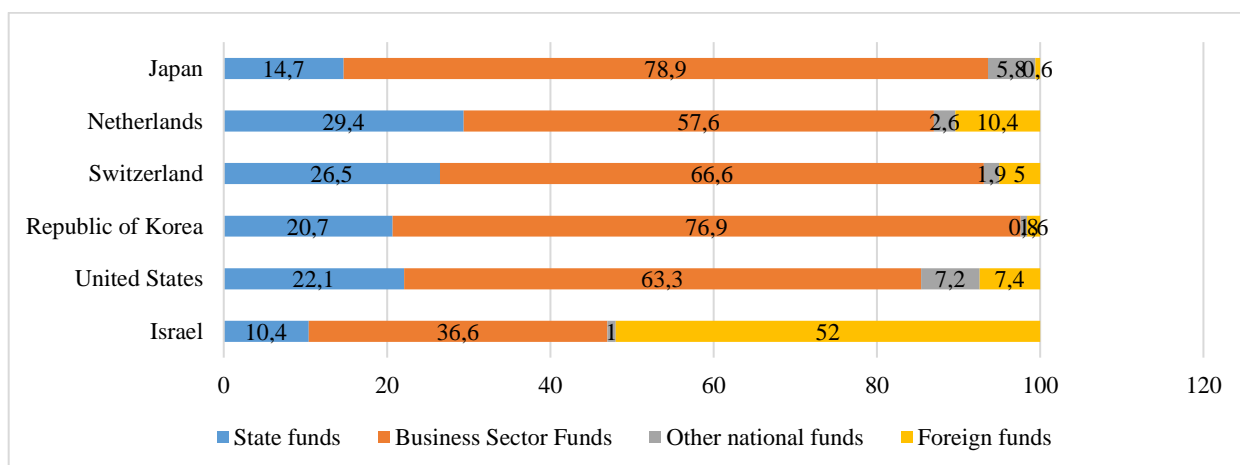


Figure 3.5. Structure of internal costs for research and development by funding sources, %
[developed by the author based on ¹⁶⁰]

Sources of funding for research and development can be divided into public, business sector funds, other national sources, foreign sources. Compared to other countries in Israel, foreign sources of funding are high and account for 52%, 36.6% are funds from the business sector. The share of public funds for R&D is the lowest among the OECD countries and is 10.4%.

In the model (Figure 3.1), next to the main elements (the state, business, universities), technology transfer organizations are represented: technological incubators, venture capital institutions (VCs). In the group of firms (business), in addition to high-tech companies, subgroups can be distinguished: small innovative firms, Start-up Firms, OTHER Local Firms, R&D Centers and foreign firms located outside the Israeli market.

Other entities involved in technology transfer comprise of technology parks, incubators, venture capital firms, start-up ecosystems, local businesses, and foreign companies' research and development centers (Appendix 18). These types of businesses perform different functions within the NIS and interact with other elements of the ecosystem. Technoparks in Israel, as in other countries, play the role of the core of the region's innovative development. Technoparks unite large technology companies and start-ups, universities and investment companies on the same territory,

¹⁶⁰ ГОХБЕРГ, Л.М., ДИТКОВСКИЙ, К.А., ЕВНЕВИЧ Е.И. *Индикаторы науки 2022: статистический сборник*. Москва: НИУ ВШЭ, 2022. 400 с. ISBN 978-5-7598-2376-6. <https://issek.hse.ru/mirror/pubs/share/589979442.pdf>

form an active business environment and provide platforms and infrastructure for innovative activities. Incubators are used to support the transfer of knowledge between research universities and industry.

The startup ecosystem in Israel is a consequence of the interplay between the government, venture capital firms, accomplished entrepreneurs, education system, business framework, incubators, and accelerators (Appendix 19). Israel has set a goal to move from a start-up country to a startup nation. To do this, a technology economy must be created that will excel other countries in the development of innovative technologies through the creation of start-ups. Israel ranked third in the Global Startup Ecosystem Ranking 2022 (Figure 3.6).

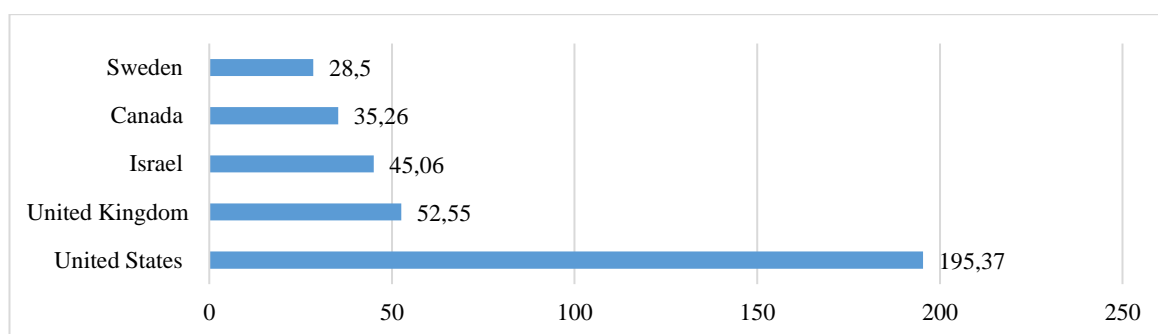


Figure 3.6. Israel's place in the Global Startup Ecosystem Ranking 2022 [developed by the author based on ¹⁶¹]

Israel's high ranking in the number of startups is explained by a close-knit entrepreneurial community, research and development opportunities, an educated population and strong government support. The leading investment areas for Israeli startups are cyber and fintech, which attracted the largest amount of capital in 2020. Tel Aviv took the 9th place among the cities in this ranking. The vast majority of the country's technology enterprises are concentrated within Tel Aviv.

Venture capital institutions. One of the main instruments for the development of innovations and technologies is venture financing (Appendix 20). The role of venture capital as an important factor in the creation of innovations was defined by the state policy of Israel in the early 1990s.¹⁶² Another important factor in the growth of the Israeli start-up industry is the availability of capital for investment. In 2021, Israeli startups closed 663 deals, 706 new companies created. In 2021, capital investment in startups was approximately \$27 billion, more than double the 2020 amount. Investment activity of venture capital in Israel in 2021 increased by 127% compared to 2020,

¹⁶¹ *Global Startup Ecosystem Ranking 2022*. <https://startupgenome.com/article/global-startup-ecosystem-ranking-2022-top-30-plus-runners-up>

¹⁶² WONGLIMPIYARAT, J. *Mechanisms behind the Successful VC Nation of Israel*. In: *Journal of Private Equity*, 2015, nr.4, p. 82-89. ISSN 10965572.

exceeding the mark of 10 billion euros¹⁶³. In 2022, funding for Israeli startups decreased by 40% and amounted to \$ 17 billion, which is significantly less than in 2021 (\$ 29 billion). One of the reasons is the poor performance of the public market, caused by high inflation rates in 2022. Despite this decline in capital raised, Israel managed to maintain its position as the fifth largest technology ecosystem in 2022¹⁶⁴.

“Other local firms” represent other than start-up companies which deal in high technology sectors or perform R&D. The sectors of mass production and agriculture are concentrated on the periphery and are characterized by lower productivity. Due to the concentration of high technology in the center of the country, skilled workers living on the periphery have less access to high-tech employment.

Multinational Technology Companies (MNCs) refers to foreign corporations that have become an integral part and major contributor to the Israeli tech ecosystem. They control R&D or own high-tech companies in Israel, and may also have large manufacturing facilities (such as Intel and HP). Multinational corporations have a total of 344 R&D Centers of Foreign in Israel. There were 362 active multinational corporations in Israel (in 2019), employing about 62,000 employees. But in recent years, the pace of opening new development centers by multinational corporations in Israel has slowed down. In 2020, only 4 new international development centers were opened compared to 2019 (23) and 2015 (46)¹⁶⁵. This is due to the creation of centers after the acquisition of local start-up companies by an international corporation; a reduction in the number of mergers and acquisitions of Israeli startups; an increase in the number of initial public offerings (IPOs) of Israeli companies on the stock exchange. Of the TNCs operating in Israel today, more than 70% are (or were) Israeli start-ups.

Many Israeli university graduates are employed by foreign research and development (R&D) centers. Israel ranks second only to the United States for both the ease of finding workers with the right skills and the availability of venture capital, which also supports a thriving and innovative private sector.¹⁶⁶ International collaboration in the realm of innovation facilitates robust connections between Israeli businesses and foreign markets.

In the context of the analysis of the national innovation system of Israel, let us consider the processes of formation and development of innovations in the Republic of Moldova.

¹⁶³ *Start-Up Nation Central*. [accessed 11.06.2022]. Available at: <https://startupnationcentral.org/news/start-up-nation-central-summarizes-2021-a-record-breaking-year-for-israeli-tech-25-billion-raised-and-an-unprecedented-number/>

¹⁶⁴ *Review of the Israel Tech Ecosystem 2022*. [accessed 15.03.2023]. Available at: <https://itrade.gov.il/uk/2023/02/06/review-of-the-israel-tech-ecosystem-2022/>

¹⁶⁵ *Israel Innovation Authority's 2021. Innovation Report*. Israel Innovation Authority. [accessed 07.09.2022]. Available at: <https://innovationisrael.org.il/sites/default/files/The%20Israel%20Innovation%20Report%202021.pdf>

¹⁶⁶ *The Global Competitiveness Report 2019*. [accessed 07.09.2020]. Available at: http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport2019.pdf

The Global Innovation Index (GII) characterizes the relatively low rating of the Republic of Moldova in recent years (Figure 3.7).

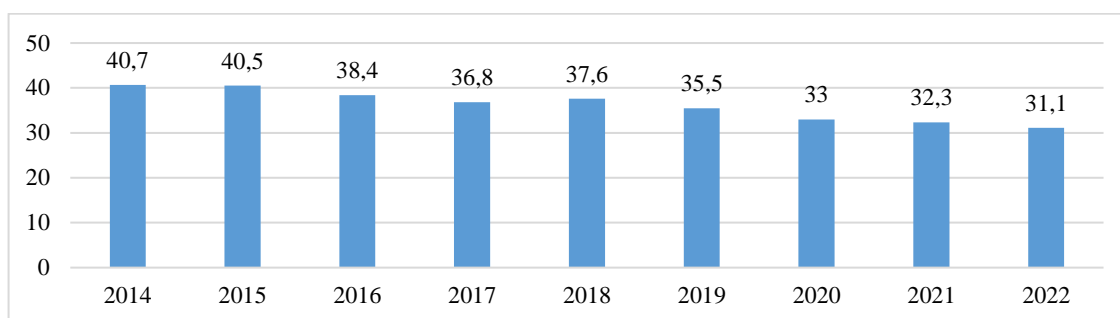


Figure 3.7. Dynamics of the innovation index in the Republic of Moldova 2014-2022

[developed by the author based on ^{167 168}]

The average value for the Republic of Moldova during this period was 37.6 points, with a minimum of 32.3 points in 2021 and a maximum of 40.7 points in 2014. The relatively sharp drop in this indicator is explained by the absence of many basic conditions that contribute to the development of innovation in the country. Among the obstacles are the existence of barriers for the cooperation of SMEs with other enterprises and research institutions in the Republic of Moldova¹⁶⁹, lack of business angels financing promising innovations, as well as the absence of self-learning organizations that turn ideas into real projects, models, products. There are no full-fledged specialized agglomerations as platforms, a breeding ground for the formation and development of innovations. There are separate technology parks (Academica, Inagro, Micronanoteh), incubators (Nord, Antreprenorul Inovativ, Media Garage, Inovatorul, Politehnica, Inno-Center, Inventica- USM, etc.), which are not united in a single environment by analogy with similar ones in the European Union.

However, the strengths of the Republic of Moldova in innovation, according to the GI, include a relatively high level of enrollment in higher education institutions, as well as indicators related to knowledge and technology results.

¹⁶⁷ Индекс инноваций Республики Молдова. [accessed 12.07.2022]. Available at: https://ru.theglobaleconomy.com/Moldova/GII_Index/.

¹⁶⁸ Global Innovation Index 2022. [accessed 22.02. 2023]. Available at: <https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2022-section1-en-gii-2022-at-a-glance-global-innovation-index-2022-15th-edition.pdf>

¹⁶⁹ STRATAN, A., NOVAC, A., VINOGRADOVA, N. *Cooperation for Innovation: Opportunities and Challenges for SMEs* (The Case of the Republic of Moldova). In: LUMEN Proceedings, 2020, nr.14, p. 01-20. <https://doi.org/10.18662/lumproc/ibimage2020/01>

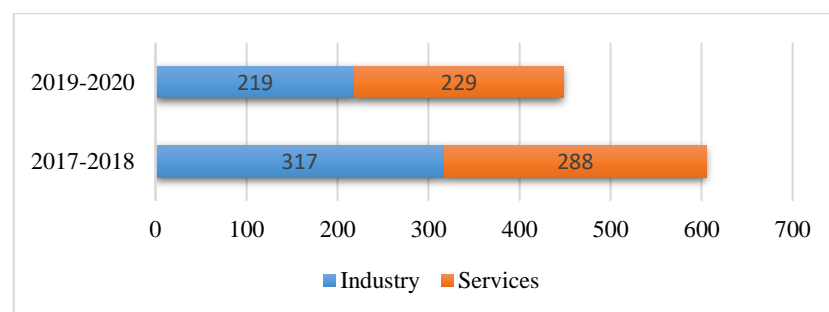


Figure 3.8. Number of innovative enterprises of the Republic of Moldova [developed by the author based on ¹⁷⁰]

*Innovative activity of enterprises of the Republic of Moldova in 2021-2022 will be published in December 2023

The data in Figure 3.8 show a decrease in the number of innovative enterprises in 2019-2020 compared to 2017-2018 by 26% (from 605 to 448). Of the total number of innovative enterprises, 50% carried out several types of innovations simultaneously (products, processes, methods of organization and marketing), 17% carried out product and / or process innovations, 34% carried out a method of organizing innovations and / or marketing. Innovation relates to the following areas: new business practices, new methods of organizing external relations, changes in product design or packaging, new forms of product promotion and placement. These areas relate mainly to innovations in management and marketing activities.

According to studies, an innovation system that meets modern requirements has not been created in the Republic of Moldova. The existing national innovation system is fragmented and incomplete¹⁷¹. The Republic of Moldova is at the stage of theoretical substantiation of the main issues of innovative development and the beginning of practical steps in the field of innovative activity. The Republic of Moldova, focusing on European practice, has developed a "Research Strategy until 2020"¹⁷² and "Strategy for Smart Specialisation"¹⁷³, which provides for the development of innovative measures aimed at improving the innovation process, rethinking the R&D system, and developing human, institutional and infrastructural potential. Based on the "Research Strategy until 2020" and the "Strategy in the field of R&D until 2020", the National

¹⁷⁰ *Innovation activity of enterprises in the Republic of Moldova in the years 2019-2020*. National Bureau of Statistics of the Republic of Moldova. [accessed 02.05.2022]. Available at: <https://statistica.gov.md/newsview.php?l=ro&idc=168&id=7222>

¹⁷¹ GRIȚCO, D. *Dezvoltarea inovațională a instituțiilor de învățământ superior*. In: Asigurarea viabilității economico-maneriale pentru dezvoltarea durabilă a economiei regionale în condițiile integrării în UE. 15-16 septembrie 2017, Bălți. Bălți, Republic of Moldova: Universitatea de Stat „Alecu Russol din Bălți, 2017, p. 148-151. ISBN 978-9975-50-215-3.

¹⁷² COJOCARU, I., ROSCA, A., RUSU, A., GUZUN, M. *Public Research and Innovation Infrastructure of the Republic of Moldova: Challenges and Opportunities*. In: Central and Eastern European EDem and EGov Days, 2018, nr.331, p. 421-430. ISBN 978-3-7089-1956-0.

¹⁷³ ȘAVGA, L., STRATAN, A. *The research and innovation strategy for smart specialisation - a new strategic approach for an innovation-based economic development of the Republic of Moldova*. In: Contemporary Issues in Economy and Technology CIET 2018. Ediția a 3-a, 1-2 iunie 2018, Split. Split, Croatia: University of Split, 2018, p. 8-19. ISBN 978-953-7220-29-7.

Research and Innovation Program for 2020-2023 has been developed. It provides a comprehensive vision and sets goals for the development of the national scientific and innovation system. Innovative ICT systems have been selected as their priority policy area, which will aim to strengthen the start-up system in Moldova by supporting the development of innovation networks and communities within the framework of national innovation or digital policies. In the Republic of Moldova, higher education institutions are also involved in the innovation process¹⁷⁴, but they do not innovate enough and use human potential¹⁷⁵.

However, in practice, the theory often fails to materialize. The problems associated with the development and implementation of innovations in the Republic of Moldova are similar to the problems that arise in the countries of Eastern Europe: lack of public confidence in innovations; weak involvement of business in innovation activities¹⁷⁶; weak funding¹⁷⁷; imperfect mechanism for the implementation of innovative activities; gap between science and industry¹⁷⁸; lack of consistency and an integrated approach to innovation¹⁷⁹; low innovative potential of enterprises; lack of personnel, a greater focus on the resource-based economy than on innovative development, etc. However, to transform into a knowledge-based economy, the country must overcome these obstacles. According to the author, the Republic of Moldova has the potential to create a strong and innovative system that can contribute to the economic growth and prosperity of the country.

The research conducted by the author led to the following conclusions:

1. Israel has managed to build a fairly effective model of interaction between the state, business and universities in the segment of the innovative economy. State bodies initiate and form the directions and conditions of innovation policy, provide financial, legal, and political support (domestic and foreign policy) mainly to the innovative private sector.
2. There is a system for organizing fundamental, applied research and technology transfer. Science, education and high-tech industry of Israel in the field of innovation are developing in a consolidated and systematic manner, based both on the accumulated national

¹⁷⁴ SUSLENCO, A. *Evaluation of the potential of higher education institutions in the context of achieving sustainability*. In: Postmodern Openings, 2022, nr.13(2), p. 118-142. ISSN 2068-0236.

¹⁷⁵ ANDRIȚCHI, V. *Problems versus prospects for the development of higher education in the Republic Moldova*. In: Education Sciences and Psychology, 2020, nr.1(58), p.115-123. ISSN 1512-1801.

¹⁷⁶ DUMITRASCO, M. *Innovation competitiveness of the country in global trade landscape: the case of republic of Moldova*. In: Ekonomika, 2018, nr. 64, p. 29-45. ISSN 0350-137X.

¹⁷⁷ CUCIUREANU, G., MINCIUNĂ, V. *Finanțarea științei în următoarea perioadă—cale de lichidare a cercetării organizate în Republica Moldova?* In: Revista de Știință, Inovare, Cultură și Artă „Akademos”, 2019, nr. 54(3), p. 27-32. ISSN 1857-0461.

¹⁷⁸ PRISACĂRU, V., COSCIUG, C., SIMCIUC, E. *Problems and solutions for creating a favorable innovation environment in the Republic of Moldova*. In: Fostering Knowledge Triange in Moldova: Conference Proceedings. Chișinău, 2016, p. 95-104. ISBN 978-9975-3069-5-9.

¹⁷⁹ GRIBINCEA, C., DUCA, A., GRIBINCEA, A. *The Republic of Moldova in the Context of Governing the Sustainable Innovation Process in the Region*. In: Handbook of Research on Challenges in Public Economics in the Era of Globalization, IGI Global, 2022, p. 319-347. DOI: 10.4018/978-1-7998-9083-6.ch018.

innovation potential and on international cooperation with leading countries.

3. Israel NIS is characterized by large foreign high-tech corporations, developed small innovative businesses, stock market and venture capital. This is reflected in the sources of innovation financing, which are dominated by foreign investment. Large multinational corporations are partnering with various Israeli companies (including local ones) that can provide them with solutions to achieve their sustainability goals in a wide range of areas.
4. Developed by Strategic Objectives 2018-2022 to transform the Israeli innovation system that is moving from a launch phase to a growth phase.

The analysis of innovation activity in Israel revealed a number of challenges:

1. Lack of staff makes it difficult for employers in the high-tech sector. The government can play an important role in tackling this problem by working with employers, including mature Israeli start-ups, to develop activities and opportunities to recruit and train graduates and inexperienced workers.
2. The share of public funds for R&D is the lowest among OECD countries. Private and foreign capital has fully taken over the role that was previously performed by the state. The role of the state needs to be redefined to meet existing market needs and create an opportunity for Israel's next quantum leap. This will allow Israel to maintain its high rankings in international indices and its position as a world technology leader.
3. Innovation is concentrated mainly in the high technology sector and Information and Communication Technologies. Weak industry competition hinders investment in innovation. The gap between the tech sector and the rest of the economy, which is slow to adopt new technologies, needs to be quickly bridged. To do this, strengthen ties between technology companies and other sectors of the economy.

3.2. Diagnostics of the innovation ecosystem of higher education institutions in Israel

The existing methods for assessing the level of development of the innovation ecosystem of universities are characterized by quite significant differences, both in the areas of assessment and in the criteria, indicators and tools used. At the same time, universities, as well as the higher education system as a whole, are faced with the need to form and develop an innovation ecosystem. In this situation, the adoption of effective, evidence-based decisions is impossible without a comprehensive objective assessment of the level of development of the UIE itself, but also the factors influencing it.

International ratings emphasize the high level of the Israeli education system. Israel today is one of the advanced states in terms of science and education. Its university system was formed according to the American model and is one of the youngest in the world, but at the same time one

of the most relevant and modern. The achievements of higher education in Israel demonstrate the following indicators. The share of the population aged 25-64 with tertiary education amounted to 49.7%¹⁸⁰ in 2021, and the corresponding figure for those aged 25-34 is shown in Figure 3.9.

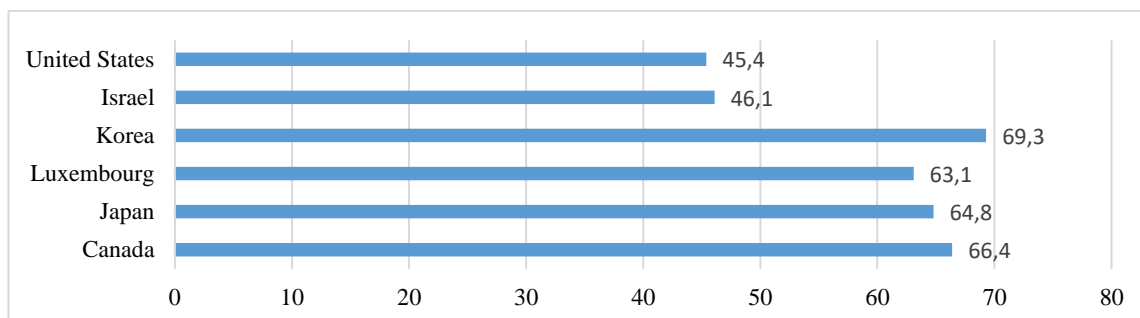


Figure 3.9. Share of people with tertiary education in OECD countries in 2021, %
[developed by the author based on ¹⁸¹]

In Israel, the proportion of the population aged 25–34 years with higher education (46.1%) is lower compared to some countries (Korea, Canada, Japan, Luxembourg), but this figure is higher than in the United States (45.4%).

In the ranking of countries in the world according to the Education index¹⁸² in 2022 Israel ranked 22th, and in the Ranking of National Higher Education Systems 2020¹⁸³ – 18th place among 50 countries. These indicators demonstrate a high rating of the higher education system, but there are opportunities for further development to higher rating positions.

The higher education system in Israel includes universities and colleges. In Israel in 2021-2022, out of 59 higher education institutions, 10 Universities are Public: 9 Research Universities and 1 Open University, 31 Academic Colleges and 21 Teacher Training Colleges (public)¹⁸⁴. University status is a matter of prestige, increased government funding for research and teaching, and the ability to conduct research, award academic degrees, and represent the Israeli academic community. The need for higher education in Israeli society is practically not decreasing, as the number of students is constantly increasing (Figure 3.10).

¹⁸⁰ *Educational attainment of 25-64 year-olds*. OECD. [accessed 22.02.2023]. Available at: https://stats.oecd.org/Index.aspx?DataSetCode=EAG_NEAC#

¹⁸¹ *Population with tertiary education*. OECD, 2021. [accessed 21.03.2023]. Available at: https://www.oecd-ilibrary.org/education/population-with-tertiary-education/indicator/english_0b8f90e9-en

¹⁸² *Education Index 2022*. [accessed 03.05. 2020]. Available at: <https://gtmarket.ru/ratings/education-index/education-index-info>.

¹⁸³ *Universitas 21: Ranking of National Higher Education Systems 2019*. [accessed 13.11.2012]. Available at: <https://gtmarket.ru/ratings/u21-ranking-of-national-higher-education-systems/info>.

¹⁸⁴ *Council for Higher Education of Israel*. [accessed 11.07.2022]. Available at: <https://che.org.il/en/>.

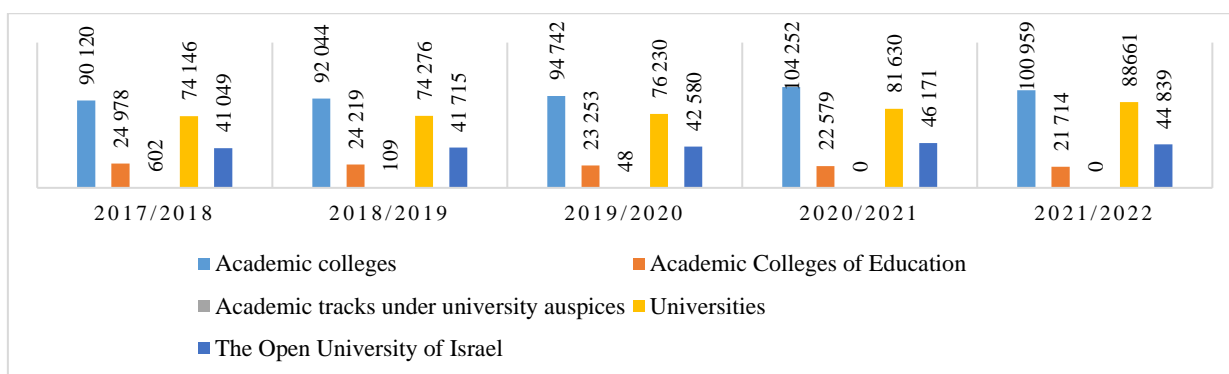


Figure 3.10. Students in Institutions of Higher Education by Type of Institution [developed by the author based on¹⁸⁵]

In the 2021/22 academic year, the average annual growth in the number of students compared to 2019/2020 was 5.1%, and the average annual growth among senior students was 1.48%. The number of students at universities is shown in Appendix 21. Tel-Aviv University has the largest number of students compared to other universities and their number has not changed much during the study period.

There are three academic degrees in the Israeli higher education system: first (bachelor), second (master) and third (doctor). In colleges, students receive a bachelor's degree (in some master's). Most universities offer a full range of graduate and undergraduate degrees - bachelor's, master's and doctoral degrees. Israel pays significant attention to all levels of education (Appendix 21).

Structural and organizational changes should be carried out in the higher education system of Israel by 2028¹⁸⁶. The system of higher education will consist of 4 levels, which will work not only in parallel, but also complement each other. The highest academic level will be represented by at least two elite universities, which will be included in the top twenty of the best educational institutions in the world. At the second level, there will be research universities, which will have the authority to award all academic degrees. At the remaining levels, there will be academic colleges and two-year community and professional colleges that will modernize existing institutions of higher education.

As part of the analysis of international experience in the field of evaluating the effectiveness of innovative activities of universities, the methods and indicators used in such world rankings as THE, QS, ARWU, Web, SIR were analyzed. The places of Israeli universities in these rankings for 2019-2022 are shown in Appendix 22. Israeli universities strive to participate in world rankings and achieve certain results. In 2021, Tel Aviv University ranked 191 in the THE ranking among

¹⁸⁵ Idem. *Council for Higher Education of Israel*. [accessed 11.07.2022]. Available at: <https://che.org.il/en/>.

¹⁸⁶ *Israel 2028. Vision and Strategy for Economy and Society in a Global World*, March 2008. [accessed 22.09.2020]. Available at: <http://www.usistf.org/wp-content/uploads/2014/03/Israel-2028.pdf>.

the 1400 universities studied in the world, but it has declined in 2022. Hebrew University of Jerusalem ranks best among Israeli universities in the QS ranking (177 in 2021), but its ranking has declined in 2022 (198); in the ARWU rankings, he rose to 77th place in 2022, although he was ranked 90th in 2021.

Based on the above data, there is no stable dynamics of rating growth for most universities. This can be explained by the lack of consistency in the approach to the development of measures to stimulate scientific, research and educational activities.

The share of scientific and innovative activities of universities is different in each of the rankings (Appendix 22). For example, in the university rankings according to Times Higher Education (THE)¹⁸⁷ the share of indicators of scientific and innovative activity is 62.5%, including scientific research (volumes, income, reputation) - 30%, scientific citation - 30% and income from innovation - 2.5%, respectively. World University Rankings QS provides for the use of such indicators for innovative activity as: academic reputation (40%); reputation among employers (10%); the number of citations per one scientific and pedagogical worker (in the Scopus database) (20%). Differences in shares are explained by the peculiarities of the methods for assessing rating indicators. As an example, the author chose the QS ranking in 2022, which reflects the criteria for ranking Israeli universities (Figure 3.11).

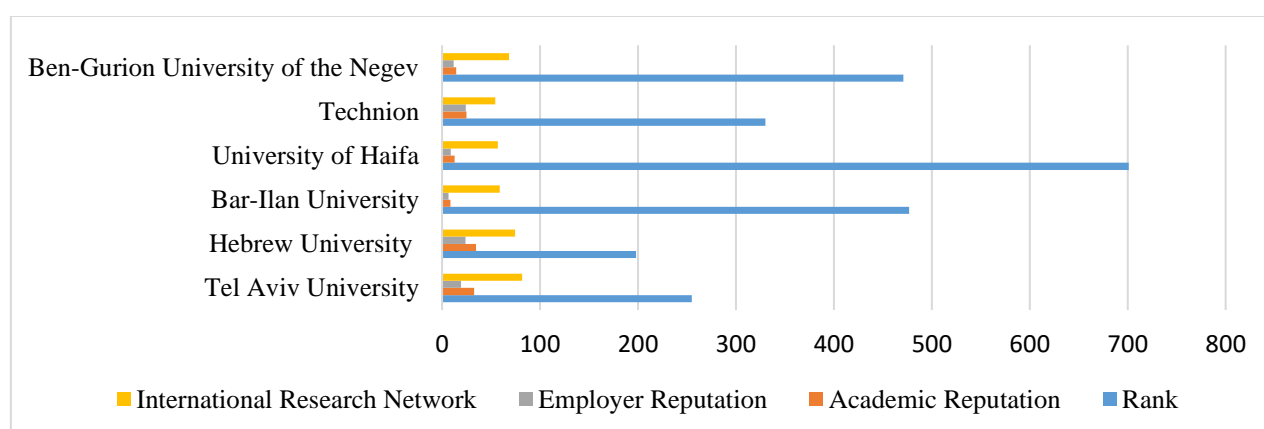


Figure 3.11. Indices of criteria for ranking Israeli universities in the QS ranking in 2022
[developed by the author based on ¹⁸⁸]

The QS rating does not fully characterize the dependence of the university's position in the ranking on the constituent criteria of its research activities. The data presented in the graph show the high rating of Hebrew University (198th place in the ranking) and its research activities (criteria: International Research Network – 74.6, Employer Reputation – 23.8, Academic

¹⁸⁷ *The Times Higher Education World University Rankings*. [accessed 25.01.2022]. Available at: https://www.timeshighereducation.com/world-university-rankings/2020/world-ranking#!/page/0/length/25/locations/IL/sort%20by/scores_research/sort_order/asc/cols/scores.

¹⁸⁸ *QS World University Rankings 2022*. [accessed 11.02.2022]. Available at: <https://www.topuniversities.com/university-rankings/world-university-rankings/2022>

Reputation – 34.8). The opposite situation is with the University of Haifa (701st place in the ranking), but the university has some high criteria: International Research Network – 57, Employer Reputation – 9, Academic Reputation – 12.9. When striving to occupy a higher position in the ranking, it is desirable for universities to monitor the criteria for ranking ratings in research activities.

Israeli universities strive to participate in world rankings, but national rankings and a system of indicators developed in the universities themselves are needed to evaluate research activities¹⁸⁹. The participation of Israeli universities in the ratings of educational organizations indicates their focus on innovation and development.

The strategic importance of the mission of the world ratings under consideration is beyond doubt. However, the application of the methodology used in them to assess the innovation ecosystem at the level of individual universities or groups of universities (for example, in the region), according to the author, is very difficult and inefficient. This is due to the rather low weight of the innovative component of the reviewed ratings, as well as the impossibility of detailing the ratings and identifying indicators of potential UIE development opportunities for specific universities.

To analyze the innovation ecosystem, the author singled out the enlarged structural elements of the university innovation ecosystem: 1) scientific, 2) personnel, 3) organizational and 4) financial and 5) the interaction of the UIE participants.

1) The scientific component of the university innovation ecosystem implies the potential of the university for the development and deepening of fundamental and applied scientific research and the use of their results, as well as the achieved level in using the results of intellectual activity (registration of patents, know-how and licensing agreements) and recognizing the importance of scientific research and innovation activities (participation in grants, support programs at various levels, etc.). Evaluation criteria can be the total number of publications; number of publications indexed in Web of Science and Scopus; the number of citations of publications indexed in Web of Science and Scopus; the number of grants received for the reporting year and others.

From 12/01/2021 to 11/30/2022, publications in the field of Physical Sciences accounted for 39% (515), Life Science 35% (456), Chemistry 19% (257), Earth & Environmental Science 7% (95)¹⁹⁰ (Appendix 23). Unlike in many countries, the vast majority of Israeli publications (about 92%) include university authors. On average, about a quarter of the scientific publications of Israeli

¹⁸⁹ LAPUŞIN, R., ISRAELI, M. *Assessment the rating of innovative activities of higher educational institutions: on the example of Israel*. In: Journal of Research on Trade, Management and Economic Development. Chisinau: UCCM, 2020, Vol. 7, ISSUE 1(13), p.59-70. ISSN 2345-1424.

¹⁹⁰ *Nature Index*. Israeli. [accessed 07.02.2023]. Available at: <https://www.natureindex.com/country-outputs/Israel#research>

researchers are carried out in collaboration with other foreign researchers, and their number has increased slightly¹⁹¹.

To stimulate research activities and develop entrepreneurial skills among students, teachers and researchers, various programs are being introduced at universities. Universities (Technion, Hebrew University, Ben Gurion University, Bar Ilan University, University of Haifa) offer data science programs sponsored by the Planning and Budgeting Committee¹⁹². The author's testing of employees of Israeli universities confirms the presence of various subjects related to entrepreneurship (77.8% of respondents confirmed the teaching of entrepreneurship, 66.7% - innovation management, 55.6% - project management, 11.1% - startup management). In addition, business representatives participate in their teaching (44.4% of respondents confirmed the participation of business representatives in teaching entrepreneurship) (Appendix 24).

Israeli higher education institutions are simultaneously engaged in scientific research and commercialization of developments. Applied research is carried out in research universities and institutions (state, local, university and non-profit), in hospitals, in industry. The use of university research results can be built in several directions (Figure 3.12).

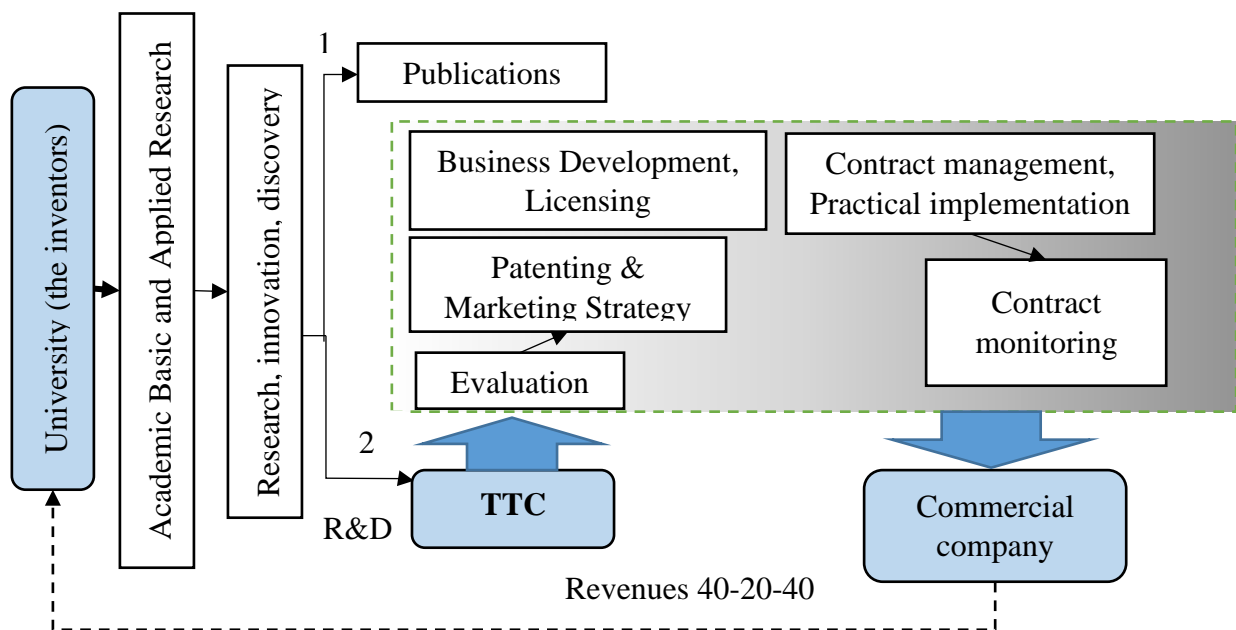


Figure 3.12. Technology transfer process in a research university in Israel [developed by the author based on¹⁹³]

The first direction (1) is the traditional channel through which scientific knowledge is

¹⁹¹ KIRSCH, U. *Universities of Israel - Unique Aspects of the Changing World*. Haifa Israel: Samuel Neaman Institute, 2018. p. 50. (Herber). [accessed 01.09.2020]. Available at: <https://www.neaman.org.il/EN/Israel-Universities-Unique-Aspects-in-a-Changing-World>

¹⁹² *Innovation in Israel overview 2018-19*. Israel Innovation Authority, 2019. [accessed 05.12.2020]. Available at: https://innovationisrael.org.il/en/sites/default/files/2018-19_Innovation_Report.pdf.

¹⁹³ *Technology Transfer in Countries in Transition: Policy and Recommendations*. WIPO, 2012. [accessed 19.11.2020]. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_transition_2_b.pdf.

disseminated through publications available to everyone, including business. The second route (2) is through university-owned technology transfer companies (TTCs). This direction is used by a researcher or a structural unit of the university dealing with commercialization issues.

The promotion of research depends only on the initiative of the researcher and the academic significance of the project. Israel does not have specific legislation governing the transfer of knowledge from the academic sector to the general public and industry. Each university pursues a certain policy in the field of technology transfer in accordance with its goals, objectives and principles. All universities have internal statutes that govern the rights and obligations of university researchers in the context of technology transfer.

Technology transfer is carried out: through scientific publications, scientific exchanges, as a result of formal informal links with industry, including the transfer of technology and intellectual property licenses to third parties.

Some Experts¹⁹⁴ note certain problems of the technology transfer process: commercialization does not always bring positive changes to the research activities of universities due to the desire for applied work to the detriment of fundamental ones; due to patent protection, the dissemination of the results obtained is limited; in view of the need to obtain additional support, the dependence of science on the state is increasing; there is a risk of respect for the freedom of research activities; conflicts of interest and obligations, both institutional and personal, are possible.

All these problems are solved at the universities themselves and at the state level, especially in terms of ensuring the protection of intellectual property rights. According to the author, it is necessary to reduce the pressure of the latter, as well as the market, on the activities of companies involved in technology transfer. It is unlikely that this should be done by law. Most likely, it should be about finding mechanisms that will ensure a balance between the interests of society as a whole and the interests of the participants in the transfer process: business, research university and researcher, both in the short and long term.

2) The personnel component of the university innovation ecosystem is formed by: qualification and competence characteristics of various categories of university staff, which determine readiness for innovation; the potential for attracting and adapting young teachers and scientists as the most promising human resource for the innovative development of the university.

It is universities that are the source of creative, talented personnel that provide the opportunity for innovation. Israel has over 145 scientists for every 10,000 employees, one of the

¹⁹⁴ MESSER-YARON, H., NIV, Y. *Responsible Technology Transfer by Starving Universities*. In: Proceedings of International Conference „Privatization of Higher Education”, 7-8.01.2008. Haifa, 2008, p. 231-232. ISBN 978-965-9011-4-0.

highest rates in the world, according to the Investment Promotion Center¹⁹⁵. Research is carried out by graduate students of various specialties, who make up 32% of all university students¹⁹⁶. This index is very high compared to other developed countries. Natural sciences, mathematics and statistics make up 44% of all doctoral programmers (Appendix 25). This confirms the fact that learning through research in various areas is one of the principles of Israeli universities.

In the strategic plan for the development of higher education, the number of graduates of master's degree and scientific degrees should increase. By 2025, the number of MAs should be 77,951 people and PhDs - 12,580, and by 2028, respectively, 87,053 and 13,154¹⁹⁷.

Research activities are carried out not only by doctoral students, but also by the teaching staff of the university. One of the conditions for becoming a full-time employee is the possession of an academic degree. The share of full-time university employees in recent years has been over 45%. The share of senior lecturers in the total number of teaching staff of universities was 36.2% in the 2021-2022 academic year. The problem with Israeli universities is that in order to get a position as a full-time teacher, you must have experience in any prestigious foreign educational institution. The trend of a low number of senior teachers persists for a long period also due to low salaries compared to foreign academic institutions. Young teachers and scientists make up the potential for innovative development of the university. The share of teaching staff under the age of 40 tends to decrease. If in the 2017-2018 academic year this indicator was 40.5%, then in 2021-2022 it was 39.5% (Appendix 26).

The high level of scientific research in universities is confirmed by the fact that over the past 10 years, 12 Israeli scientists have become Nobel Prize winners¹⁹⁸. Technion alumni include four Nobel Prize winners and heads of global corporations such as Adobe and Yahoo.

Scientific research in Israeli universities is determined by the profile of the higher educational institution, the level of organization of its interaction with enterprises and organizations, the academic and industry sectors of science. Universities combine all areas (humanitarian, technical and scientific). However, there are some educational institutions that focus on certain subjects (for example, the Technion and the Weizmann Institute) (Appendix 27).

3) The organizational function involves, in order to form an innovation ecosystem of universities, the creation of an appropriate infrastructure in them that ensures the development of

¹⁹⁵ *Investment Climate Statements: Israel*. U.S. Department of State. 2021 [accessed 01.07.2022]. Available at: <https://www.state.gov/reports/2021-investment-climate-statements/israel/>

¹⁹⁶ *Higher Education in Israel: Background & Overview*. [accessed 07.04.2022]. Available at: <https://www.jewishvirtuallibrary.org/background-and-overview-of-higher-education-in-israel#2>.

¹⁹⁷ *Israel 2028. Vision and Strategy for Economy and Society in a Global World, 2008*. [accessed 03.09.2020]. Available at: <http://www.usistf.org/wp-content/uploads/2014/03/Israel-2028.pdf>.

¹⁹⁸ *Israel's Twelve Noble Prize Laureates*. In: Israel Journey Masa, 2022. [accessed 16.02.2022]. Available at: <https://aardvarkisrael.com/israels-twelve-noble-prize-laureates/>

the scientific component, as well as a business environment based on cooperation necessary to form new ties with participants in the region's innovation system. This means that the university not only provides conditions for the implementation of research and development by order of entrepreneurs, but also generates innovative business, responding to demand, creating new products, technologies, and markets. The result of the organizational function of the UIE is the creation of start-ups on the basis of the university, technology transfer centers, business incubators and technology parks.

All universities in Israel enter into agreements with subsidiaries (TTC) that commercialize research results. The decision of Israeli universities to create a TTC, rather than university divisions, is explained by the peculiarities of the legal framework in force in Israel, in particular with taxation¹⁹⁹. For example, in 2019, 10 out of 18 TTCs were university-based companies²⁰⁰ (Appendix 28).

TTC specialists (financiers, marketers, lawyers, and others) evaluate the scientific viability and commercial potential of the development (invention) for its commercialization. With a positive assessment, TTC proceeds to register a patent for the invention and begins to form a marketing strategy to attract interested parties. If the search is successful, the university grants the relevant company a license to use the patent on the basis of a contract. Next, TTC specialists develop a business model and a scheme for promoting the product. Under this product, a commercial structure is created with an involved representative of the business community, where the company invests intellectual property (IP), and the business partner invests. A new business enters the market and, if the product is successful, the company pays royalties to the creators.

The proceeds from the commercialization of the invention are distributed between the inventors and the university and are used to fund other basic scientific research. For most universities in Israel, "Revenues 40-20-40" means that 40% of commercialization revenue goes to the inventors, 20% is reinvested to fund research, and 40% is used to cover the costs of the TTC and meet the needs of the university. This system solves several important problems. Developers do not have to think about where to find money and what to do with the invention in the future. In addition, the very possibility of obtaining a significant income from the created technology contributes to an increase in research. In addition, investors save on time and financial costs associated with the difficult process of selecting projects for investment. Thus, at the same time, research work and entrepreneurial activity of participants in various fields of Israeli activity are

¹⁹⁹ *Technology Transfer in Countries in Transition: Policy and Recommendations*. WIPO, 2012. [accessed 05.09.2020]. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_transition_2_b.pdf.

²⁰⁰ *Technology Transfer Offices (TTO)*. [accessed 07.10.2021]. Available at: <https://www.iati.co.il/category/24/technology-transfer-offices-tto>

stimulated. The scheme for the commercialization of Israeli university innovations is universal and may vary somewhat.

TTC universities are part of the Israel Technology Transfer Organization (ITTN), a non-profit organization that provides a platform for cooperation between technology transfer companies in Israel²⁰¹. This company represents the interests of member companies before the Israeli government, helps local companies to participate in the transfer of new technologies, promotes information in society about innovation. The TTC actively promotes patents for inventions by faculty and university staff.

The total number of licensing agreements at Israeli research universities increased significantly in 2021 (853) compared to 2020 (318). The level of use of the results of intellectual activity in the form of applications for intellectual property (IP) is shown in Figure 3.13.

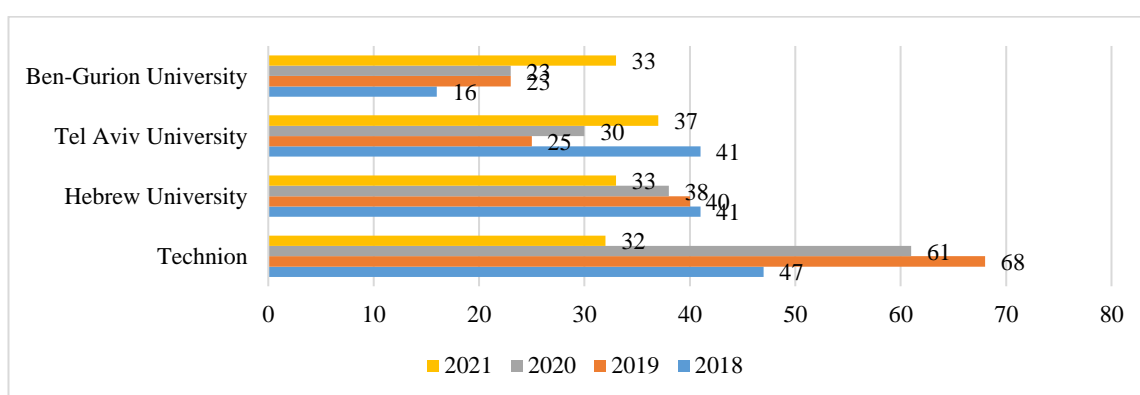


Figure 3.13. Number of IP applications of Israeli universities in 2018-2021 [developed by the author based on ²⁰²]

The data in Figure 3.13 shows that Technion-Israel Institute of Technology (Technion) received the highest number of IT applications in 2018-2021 compared to other universities, but there is a significant decrease in 2021 compared to 2019. Also, at Herber University there is a slight decrease in IP applications in 2020 compared to 2019. In the other two universities, the number of IP applications is increasing annually.

Israeli universities filed about 296 unique patent applications in 2021, up 30 applications from 2020 (497)²⁰³ (Appendix 29). Science Life and Physical Sciences & Engineering research applications accounted for 38% each, the number of applications that received Sciences Life grants

²⁰¹ *Israel Technology Transfer Organization (ITTN)*. [accessed 11.05.2022]. Available at: <https://www.datanyze.com/companies/israel-technology-transfer-organization-ittn/430015292>

²⁰² *Statistical Country Profiles*. WIPO statistics database, 2021. [accessed 07.02.2022]. Available at: https://www.wipo.int/ipstats/en/statistics/country_profile/profile.jsp?code=IL

²⁰³ *Survey of Knowledge Commercialization Companies in Israel 2020-2021*. [accessed 07.03.2023]. Available at: <https://www.cbs.gov.il/en/mediarelease/Pages/2022/Survey-of-Knowledge-Commercialization-Companies-in-Israel-2020-2021.aspx?fbclid=IwAR0aixOHI9KIB-J8FFWoDAHHwyci66IpV82CeMc1HkIxKkcvLbjkTFMOeNg#losExcelos>

(43-45%), significantly higher than Physical Sciences & Engineering (23-29%)²⁰⁴. This shows the priority direction of research for this period.

In Israel, most university TTCs prefer patent license agreements over other methods of commercialization. But a number of researchers believe that in the new economy, university TTCs should pay more attention to the creation of spinoff companies and their active support. The scientist-author of the development (with rare exceptions) does not go to work in a spinoff company, but plays the role of a consultant or “chief scientist” in it, doing this as part of a part-time job in the company. To create a team that devotes most of its time to the development of the project, specialists from outside are involved.

The main feature of a university startup in Israel is that it is actually created without a startup. All participants in the startup company being created are fully transferred intellectual property (IP) rights. If the startup is created by the TTC, then the technology is licensed to the startup in exchange for royalties or a small stake in the startup plus royalties; the right to receive a portion of the proceeds from the sale of the company, IP or shares on the Exit Fee. The number of academic startups in Israel is presented in Appendix 30.

The characteristics of the subjects of the infrastructure of the innovation ecosystem can be considered from the standpoint of the commercialization process: from development to the formation of assets and from assets to a market transaction. At the heart of any model of innovation infrastructure should be two interrelated components, one of which is aimed at providing research and development, and the other is aimed at supporting and stimulating the commercialization of the results of intellectual activity. The second component of the innovation infrastructure takes into account the dynamics of complex relationships that are formed between its participants, whose functional task is to ensure the promotion of innovations, provide access to business acceleration services, organize access to financing from business angels and pre-sowing and seed investment funds. In the structure of the entities that ensure the commercialization of an innovative project, there may also be subjects of financial support (for example, the Applied Research Foundation at Tel Aviv University). Israeli universities have a sufficient number of subjects of innovation infrastructure that provide research and development: scientific and research centers, entrepreneurship centers, university laboratories that ensure the development of the scientific component of the innovation ecosystem of universities (Appendix 31). However, components aimed at supporting and stimulating innovation are sometimes insufficient due to the diversity of innovations and approaches to their implementation.

²⁰⁴ GETZ, D., KLEIN, R., BARZANI, E. *R&D outputs in Israel. Analysis of Scientific Publications 2021*. Israel, Haifa: Samuel Neaman Institute, 2022. [accessed 12.05.2022]. Available at: <https://www.neaman.org.il/EN/R&D-Outputs-in-Israel-Analysis-of-Scientific-Publications-2021>

University Research Centers are an integral part of the Science and Technology Complex (STC) of Israel. They solve not only fundamental problems, but also create applied developments on an ongoing basis. For example, the Institute of Space Technology, the Center of Excellence in Energy and the largest nanotechnology center operate on the basis of the Technion University. University laboratories are used for commercial (industrial) needs of firms from specialized sectors of the economy. This turns out to be a very important help for small technology companies that do not have the opportunity to purchase and operate expensive research equipment on their own. For example, Ben-Gurion University of the Negev has three research centers. The Innovation Centers of the Hebrew University of Jerusalem and Ben Gurion University of the Negev were awarded two of the world's most prestigious awards for entrepreneurship in higher education in 2020.

Entrepreneurial centers will turn campuses into an element of the university innovation ecosystem. Despite the fact that Israel is a state of innovation, for many years the activities of university campuses have been focused mainly on research and teaching. In 2019, the Council for Higher Education launched the New Campus program, which encourages the creation and modernization of entrepreneurship and innovation centers in higher education institutions²⁰⁵. Entrepreneurship and Innovation Centers have been established on campuses where students are trained in entrepreneurship. Students on campus work alongside lecturers, researchers, and professional mentors to advance their projects.

Israel's national digital learning project Campus was established to promote general, academic and vocational education in Israel, as well as a means to reduce social divides and boost the country's economic growth. A division of Campus is IsraelX, a national consortium of higher education institutions in Israel, which includes all Israeli universities. The Council for Higher Education and the Israel National Digital Ministry lead this consortium²⁰⁶. On the basis of Campus, the national online platform Campus-IL was created in 2018²⁰⁷ for digital learning in order to improve educational processes and retraining courses, provide quality content to universities, government agencies and the public.

For inter-university cooperation and pooling of resources in Israel, the Inter-University Center for Digital Information Services MALMAD has been established, which operates as a consortium. Its services include the provision of digital information services to Israeli universities, colleges and research institutes, the licensing and management of these services, the management

²⁰⁵ *Council for Higher Education of Israel*. [accessed 11.07.2022]. Available at: <https://che.org.il/en/>.

²⁰⁶ *IsraelX*. edX. [accessed 07.07.2022]. Available at: <https://www.edx.org/school/israelx>

²⁰⁷ *Campus-IL*. Israel's National On-line Digital Learning Platform. [accessed 10.03.2022]. Available at: <https://oecd-opsi.org/innovations/campus-il-israels-national-on-line-digital-learning-platform/>

of special projects in the field of digital information, the organization of master classes and seminars on current topics.

There is no single model for building an innovative infrastructure in universities. Each Israeli university is developing its own innovation infrastructure. This is explained by the fact that universities have a different profile of training specialists (technical, economic, legal, etc.), their own capabilities and resources.

According to the author, in the innovation infrastructure of universities, along with the components for ensuring scientific research and their commercialization, there should be a functional component aimed at forming a partner organizational culture and the necessary competencies in the field of innovative entrepreneurship, technology marketing, and intellectual property protection. Despite the fact that there is no universal innovation structure and there is no need to create one, it is worth considering partnership as a basic component. Partnership sets the order of interaction, directions and forms the remaining functional components of the innovation infrastructure. Since such a multifaceted concept as partnership is considered as a fundamental functional component, it is necessary to form appropriate competencies that should be fixed both as a mandatory component in the framework of the educational program of higher education for engineering specialties, and through regular professional development of employees and managers of elements of the innovative infrastructure of the university. The interaction of the functional components of the infrastructure of the university's innovation ecosystem should help reduce barriers to the commercialization of innovations associated with the gap in communications between subjects, the lack of marketing research, and the development of a partner organizational culture.

4) The financial component of the innovation ecosystem of universities refers to the funding sources and mechanisms that support the commercialization of research and development, such as seed funding, venture capital, and government grants, as well as the management of intellectual property and licensing agreements to generate revenue. The financial component of the innovation ecosystem of universities should ensure the growth of the quality and volume of funding for scientific research and innovative projects. The success of the development of the UIE is determined by the sufficiency of funding for their research. The majority of universities in the world largely exist due to the financial support of the state²⁰⁸, but in many countries such support is not a priority. Israel spent 5.44% of GDP on R&D in 2020, more than any other country (Figure 3.14).

²⁰⁸ CĂLUGĂREANU, I., ANTOCI, N. *Configurarea managementului proiectelor internaționale în baza parteneriatului public-privat*. In: *Administrarea Publică*, 2022, nr. 1(113), p. 81-94. ISSN 1813-8489.

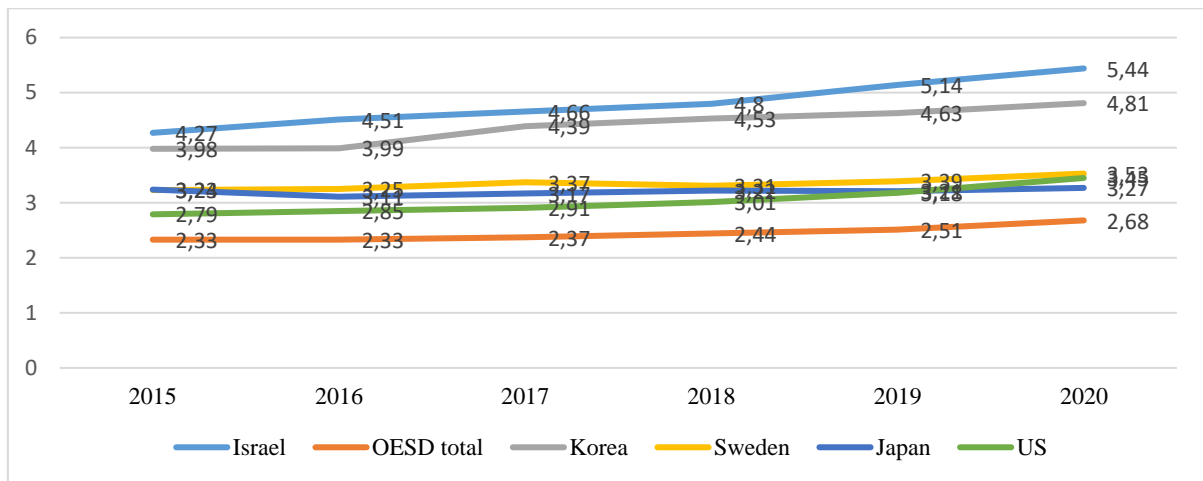


Figure 3.14. Gross domestic expenditure on R&D (GERD) as a percentage of GDP
[developed by the author based on²⁰⁹]

* The OECD Science, Technology and R&D Statistics report for 2021-2022 is not currently available

The share of spending on R&D as a percentage of Israel's GDP exceeds that of the OECD over the past 6 years and has an upward trend, which characterizes the state's special attention to R&D, creation and promotion of innovations to the market.

Research universities in Israel are characterized by a high diversification of R&D funding sources: public (science fund, R&D programs); private (in the form of donations from state or charitable organizations, including from foreign sources with the assistance of diasporas around the world; investors and commercial companies), from Israeli and international funds for competitive research based on interstate agreements. This allows maintaining a high level of academic freedom, conducting research that does not have an immediate commercial return, and retaining talents in national universities.

In recent years, the Israeli Science Foundation (IFS), which is a non-profit autonomous organization, has increased in activity. It is 95% funded by PBC. The IFS awards grants to Israeli scientists on a competitive basis. Its annual budget is about \$60 million. 2/3 of all its funds are used to finance more than 1300 grants per year.

PBC cannot provide all the resources needed to keep research universities up to par with the world's best universities. The Israeli government is considering a significant increase in the research budget, which will allow research universities to advance their R&D.

Figure 3.15 shows the Israel Science Foundation Budget over the past ten years.

²⁰⁹ OECD Science, Technology and R&D Statistics. [accessed 11.02.2022]. Available at: https://www.oecd-ilibrary.org/science-and-technology/data/oecd-science-technology-and-r-d-statistics/main-science-and-technology-indicators_data-00182-en.

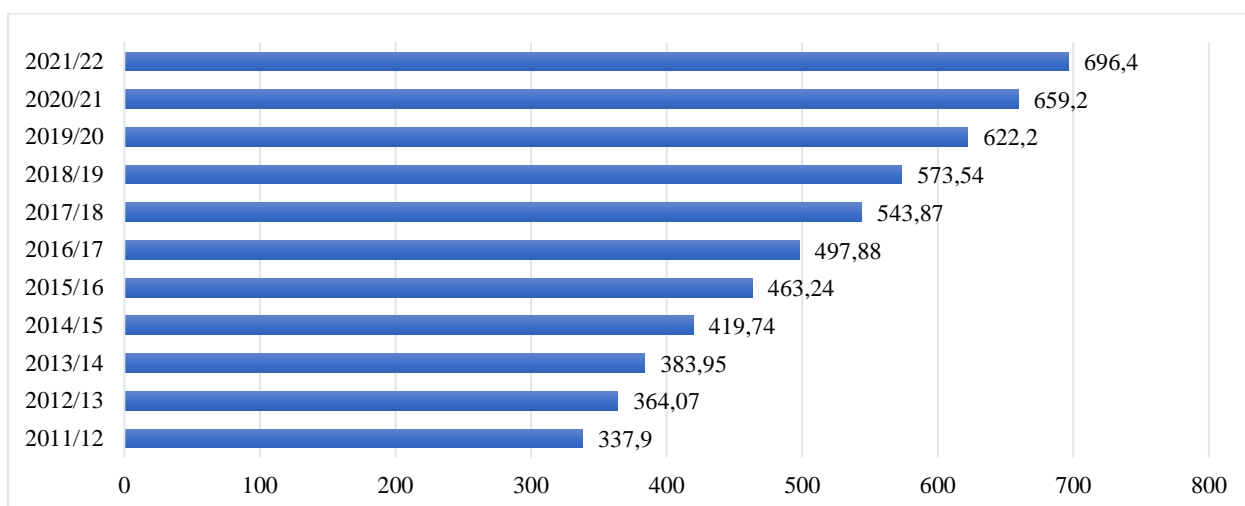


Figure 3.15. The Israel Science Foundation Budget (millions ILS) [developed by the author based on ²¹⁰]

By 2022, the research funds budget will increase to ILS 1.1 billion, which is higher than the 2016 budget (ILS 770 million). The budget for 2022 will increase compared to 2016 by about 300 million shekels. These funds are intended to increase the number or amount of research grants for Israeli researchers, and in some cases for researchers abroad.

PBC has decided to increase the research budget by 40% during 2017-2022. The total investment in the formation and modernization of the research infrastructure for this period is a total of ILS 870 million²¹¹. The allocated funds will be used for scientific research, including: grants for equipment; to hire and use professional human resources; for the management of institutional research infrastructure and others.

5) The study on the evaluation of innovation ecosystems in higher education institutions should focus not only on the performance indicators of the elements (R&D costs, results), but also to consider the effectiveness of the interactions of participants within the framework of the functional component, which will be achieved through the creation of an enabling environment.

The university innovation ecosystem is characterized by a special interaction between its participants, through which certain effects arise that create a favorable environment for the speedy implementation and commercialization of innovative research. Collaboration, mutual learning, including mutual international cooperation, is characteristic of the innovation ecosystem of Israeli universities. Israeli universities work closely with companies in a nationally built ecosystem that includes the state, the army, financial institutions (venture companies, funds), international projects and multinational corporations.

²¹⁰ *Budgeting for Research Foundations*. Council for Higher Education of Israel. [accessed on April 5th, 2020]. Available at: <https://che.org.il/en/research-foundations/budgeting-research-foundations/>.

²¹¹ *The Higher Education System Celebrates the 60th Anniversary of the Council for Higher Education and 70 Years of Academic Excellence*. Council for Higher Education, 2020. [accessed 12.09.2021]. Available at: <https://che.org.il/wp-content/uploads/2018/11/Press-Release-Collection-of-Data-for-Start-of-Year.pdf>.

The main results of cooperation between Israeli companies and universities are joint articles and patent applications. For example, scientists at Tel Aviv University have shown significant growth in collaborative publications through collaboration with industry²¹². Israel shows high results in cooperation between academic institutions and industry (Appendix 33). In the field of joint patent applications with various partners, the Hebrew University is the leader, which has more than 40 applications in 2011-2020, then Tel Aviv University (20), Technion and Bar-Ilan University each with 16 joint applications²¹³.

The Technion-Israel Institute of Technology builds on ongoing support for proposed and existing R&D projects and strengthens collaboration between the various actors in the innovation ecosystem: academia, technology divisions of Israel Defense Forces (IDF), and industry. The Technion has opened a "Knowledge Center for Innovation", which distinguishes three main areas of work: research on innovation in industry, development of a knowledge base about innovation, and activities that promote the support and application of inventions in production. One of the most popular events - "Managing Innovation Forum" - is held specifically for the managers of 40 large and small, high and low-tech Israeli companies. "Moving up" workshop, projects of business and technological innovations in the industry, consultations of experts on innovations for business, support committee for traditional industries - all these events and projects are aimed at connecting traditional industries with the latest technologies. "The Liaison Office" provides collaboration between industry and institute researchers. In Israel, there are also companies based on university research. Examples are Mobileye, OrCam and BriefCam, whose technology was created at the Hebrew University of Jerusalem, and StoreDot, with technology based on nanoscience research at Tel Aviv University.

The existence of dialogue and effective communication channels, building trust and commitment are the most important factors for cooperation, and the quality of cooperation is influenced by the transfer of knowledge and the creation of scientific communities (Appendix 33). The relationship between universities and business should be viewed not as a set of isolated transactions within a limited range of areas of interaction, but as a system of long-term mutually beneficial relationships with a wide range of possible types of cooperation in four blocks: education, research, commercialization of knowledge and technologies, management. The cooperation of universities with various organizations in the innovation ecosystem confirms the

²¹² *Annual Innovation Report State of High-Tech 2022*. Israel Innovation Authority, 2022. 70 p. [accessed 07.02.2022]. Available at: <https://innovationisrael.org.il/en/sites/default/files/Annual%20Innovation%20Report%20-%20State%20of%20High-Tech%202022.pdf>

²¹³ LECK, E., GETZ, D., ZETCOVETSKY, I. *Research and Development Outputs in Israel: 2000-2020 Academy-Industry Cooperation Final Report*. Israel: Samuel Neaman Institute, 2021. 74 p. [accessed 18.05.2022]. Available at: https://www.neaman.org.il/EN/Files/Report_Patent%20report%202021%20Final%20with%20access.pdf

GII ranking on indicators characterizing the collaboration of science and industry (Appendix 33), as well as the results of testing conducted by the author (Appendix 32). In general, the innovation ecosystem of Israeli universities is at various stages of development (formation, functioning, development). The test results showed that 55.6% of respondents consider the stage of formation characteristic of the innovation ecosystem, 22.2% - UIE is formed, 22.2% - UIE is developing. In this regard, the innovation ecosystem requires the interaction of participants from different departments of the university. In the process of searching for ideas, creating technologies or products, their commercialization, various organizational structures are inevitably involved.

The test results showed the participation of representatives of business structures in the management of the UIE. The majority of respondents (55.6%) believe that management in the university innovation ecosystem is carried out only by the university management; business representatives participate in the management of the UIE - 33.3%; the management of the UIE is carried out by a special body created jointly by all ecosystem participants - 11.1% (Appendix 32). The heads of Israeli research universities do not have the primary authority to determine teaching staff and determine pay conditions; promote new academic programs without regulatory approval; build new buildings²¹⁴ and etc. The president (rector) is responsible for creating the physical and operational infrastructure for the system of academic teaching and research activities. The Vice President for Research and Development is appointed by the president of the university and has the authority to manage research and development at the university²¹⁵.

An example of a successful Israeli entrepreneurial/innovation ecosystem is the Technion. The innovation ecosystem of this university meets the criteria of the dynamically developing structure of the UIE (Appendix 34). The Technion's entrepreneurial/innovation ecosystem includes research institutes, interdisciplinary research centers, scientific support departments, laboratories, entrepreneurship training centers and student clubs, technology parks and a business incubator (Appendix 35). According to research authority documents²¹⁶, the main objective of the department is to provide the researcher with the maximum amount of funds and services necessary to conduct his research, within the framework of promoting research activities in the Technion and in accordance with the policy of the institution. The Research Authority's business units are presented in Appendix 36. The creation of an innovatively receptive structure of the Research

²¹⁴ *Israel 2028*. Vision and Strategy for Economy and Society in a Global World, March 2008. [accessed 14.09.2020]. Available at: <http://www.usistf.org/wp-content/uploads/2014/03/Israel-2028.pdf>.

²¹⁵ GETZ, D. KATZ, S., KLEIN, R., TZIPERFAL, S. *Leadership and Academic Management in Institutions of Higher Education – Universities. Literature survey and in-depth interviews with officials*. Haifa Israel: Samuel Neaman Institute, 2021. 168 p. (Hebrew). [accessed 16.03.2022]. Available at: <https://www.neaman.org.il/EN/Leadership-and-Academic-Management-in-Institutions-of-Higher-Education-Universities-Literature-survey-and-in-depth-interviews-with-officials>.

²¹⁶ *Research Authority Technion*. Organizational structure. [accessed 01.03.2022]. Available at: https://www.ra.trdf.co.il/prdFiles/pages/sd_rgeneral_138518_doc_file_heb_1.pdf

Authority provides not only for the management of scientific and innovative activities of the university, but also for the interaction of all participants in the ecosystem. Therefore, the development of strategy, functions and management principles are essential in the formation of the UIE.

When conducting research, it was revealed that there are certain barriers to the scientific component of the UIE: applied research is given more attention compared to fundamental research; the dissemination of scientific results obtained is sometimes limited by the length of patent protection procedures; the dependence of science on the state increases when receiving additional support; conflicts of interest and obligations, both institutional and personal, are possible. But at the state level in Israel, measures are already being taken to overcome these barriers. Universities are granted rights to IP derived from publicly funded research, as well as exclusive rights to commercialize such inventions. TTC is of great importance in promoting innovations. However, this is not enough without the popularization of areas of activity related to the commercialization of innovations. With the help of a set of marketing tools, you can manage the innovation process and promote innovation.

One of the problems of Israeli universities is the "brain drain", because in other countries researchers are offered not only very high salaries, but also allocate many funds, private sponsors who are ready to give huge funds for research work. Young teachers and scientists make up the potential for innovative development of the university, but they cannot always realize it due to low salaries, certain requirements for obtaining a full-time teacher position, the difficulty of obtaining funds for research work and others. The Israeli government actively supports modern research and development, as well as international scientific and economic projects. The development of the university innovation ecosystem creates conditions for young scientists and stimulates their activities.

Science-based industrial parks were established near the universities, which was a huge commercial success. Industrial companies began to "spun off" from universities, which are engaged in the commercial sale of certain products produced on the basis of university research. Often they are created in cooperation with local and foreign corporations. Universities have interdisciplinary research and testing institutes in a wide variety of fields of science and technology vital to the country's industry.

According to the results of the conducted studies, a decrease in the volume of financing of the innovation sphere was noticed; insufficient dynamics of innovative activity; the gap between the formation of an innovation infrastructure and obtaining noticeable results from the functioning of the innovation ecosystem; lack of a common methodology for the formation and development

of innovation ecosystems; availability of statistical data on the innovative activities of ecosystem participants.

Information about research activity (for example, the number of university research centers, laboratories, etc.) is not concentrated on university websites and it is difficult to find this information, since some data is distributed by departments or is completely absent. There is also a significant number of subjective assessments associated with the advertising of the university. According to the author, all information regarding the innovation activities of Israeli universities needs to be systematized on a single site (Council for Higher Education or The Innovation Authority) or on each university site in a unified and structured form. This will enable a more efficient comparative analysis of university innovation ecosystems.

The results of the research have shown the effective use of digital technologies for the interaction of participants in the innovation ecosystem at the national level. The use of digital technologies, in particular digital platforms, contributes to the formation of interactions, but it is necessary to use these technologies to obtain initial information about the participants in the innovation ecosystem (the number of participants, the frequency and quality of their interactions), as well as the speed and time ranges of the stages of innovation commercialization both at the system level higher education and individual universities.

The recommendations for solving these problems and the direction of further research include the need to create unified methodological foundations for the formation and development of university innovation ecosystems; methods of functioning and development of the main elements of the innovation ecosystem by creating, among other things, technological maps for the formation of network structures, commercialization of technological innovations; systematization of data on the innovation activity of universities on a single site or on universities.

Prospects for the development of innovation ecosystems of universities, contributing to the successful commercialization of scientific research, are seen in the implementation of the following areas: a clear formation of priorities for scientific and innovative activities; strengthening the interaction between the various elements of the university ecosystem; development of relationships with venture capital funds and investors; development of interaction with enterprises of the real sector of the economy, including on the basis of active marketing of university resources; active search for projects, teams, competencies; development of partner organizational culture and competencies of innovative entrepreneurship.

3.3. Analysis of the factors of the internal and external environment of the innovation ecosystem of higher educational institutions in Israel

The formation and development of innovative ecosystems based on universities is becoming one of the main trends in the development of higher education in the world. Innovation ecosystems of universities become drivers of the socio-economic development of the region, stimulating their economic viability. Regional development, in turn, supports the educational and research mission of the university.

Ecosystems themselves are dynamic and evolutionary, not a static phenomenon that can be captured by a snapshot at a particular point in time. They are influenced by various factors (conditions) that contribute to the development or destruction of IE. The development conditions necessary for functioning as an innovation ecosystem (in the example of Silicon Valley), the role of the state in the process of its evolution, as well as the reasons for the success of the companies themselves, are presented in Appendix 38. The main conditions include the presence of ecosystem participants, the presence of a venture industry, the presence of a critical mass of talented people, the demand for new products, legislation favorable for the development of entrepreneurship, and others.

A review of current scientific research devoted to the analysis of ecosystems and factors influencing their development showed the lack of attention of the authors to the study of the characteristics of university innovation ecosystems. Since the university is the core of the innovation ecosystem or its participant, for the successful development of the university innovation ecosystem, it is necessary to analyze the most significant factors in the development of the UIE. An example of the influence of factors on the success of the University of Massachusetts is presented in Appendix 39.

The variety of factors and conditions for the development of ecosystems determines the variety of methods for their research. Moreover, for a specific innovation ecosystem, the set of methods can be different, as well as their application at different organizational levels by different participants in the university ecosystem.

The main methods for assessing the factors of development of innovation ecosystems include methods of strategic analysis (Porter's model of competitive forces, PEST analysis, SWOT analysis), survey methods, in-depth interviews, expert assessments, and others.

As you know, the competitiveness of an organization is achieved by creating and maintaining a set of competitive advantages - the special properties of an organization that competitors cannot apply or copy for a long time. Analysis of competitiveness factors is necessary to identify external opportunities and internal reserves of the institution, and also allows you to develop a strategy for the functioning of the university, aimed at maintaining, increasing and

developing its competitive advantages. The purpose of the analysis of the macro environment, which forms the nearest field of external business contacts of Israeli universities in the development of the innovation ecosystem, is to assess their competitiveness.

The dynamic development of innovative innovation ecosystems is significantly changing the existing production value chains, industry structures, principles and mechanisms of doing business. The transformation of the environment for the development of ecosystems creates other conditions for the interaction of market participants in a competitive environment. Ecosystem competition has a complex, multi-level nature. At the internal horizontal level, it manifests itself in the framework of access and the ability to effectively use specific resources (knowledge, information, technologies), at the vertical level, competition is realized in the ability to form and adapt to the institutional environment. At the external level, competition is determined by the ability to create the best business models that combine a variety of customized goods and services, material and digital technologies, the ability to predict and independently create trends. The scheme of interaction of ecosystem competition elements is shown in Figure 3.16.

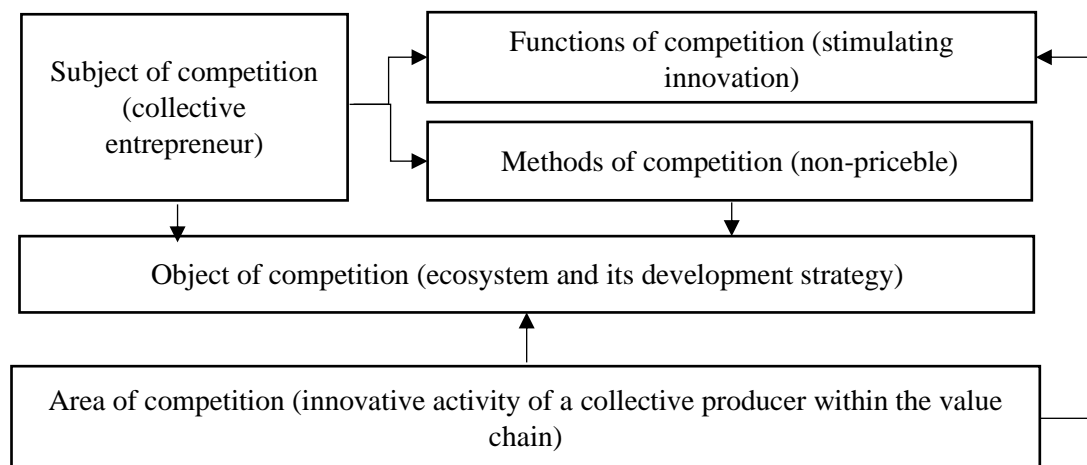


Figure 3.16. Scheme of interaction of ecosystem competition elements [developed by the author based on ²¹⁷]

With the ecosystem approach, the content of competition is the process of evolution of the business network, and its role is manifested in the formation of various forms of network market structures. The subject in the competition is a collective entrepreneur within the framework of deliberative coordination (Appendix 40). Competition is directed at the ecosystem itself and its development strategy. The area of competition extends to the innovative activity of a collective producer within the value chain. The functions of competition are to stimulate innovation by

²¹⁷ PETIT, N., TEECE, D. *Taking Ecosystems Competition Seriously in the Digital Economy: A (Preliminary) Dynamic Competition/Capabilities Perspective*. In: *Capabilities Perspective* (December 9, 2020). [accessed 10.12.2022]. Available at: [https://one.oecd.org/document/DAF/COMP/WD\(2020\)90/en/pdf](https://one.oecd.org/document/DAF/COMP/WD(2020)90/en/pdf)

transforming business models, realizing various forms of combining the digital and physical worlds. All these features must be taken into account when assessing the competitiveness of innovation ecosystems in the process of their development.

According to the author, to assess the competitiveness of an organization, the Five Competitive Forces model by Michael Porter is used. M. Porter's model analyzes the immediate environment of the organization and identifies five competitive forces: the bargaining power of suppliers; bargaining power of consumers; market power of existing competitors; threats of new players; the threat of substitute products²¹⁸. The concept of "market power" for the purposes of this study will be replaced by "influence". In accordance with the approach of M. Porter, the author conducted a study of the external microenvironment of the innovation ecosystem of Israeli universities (Figure 3.17).

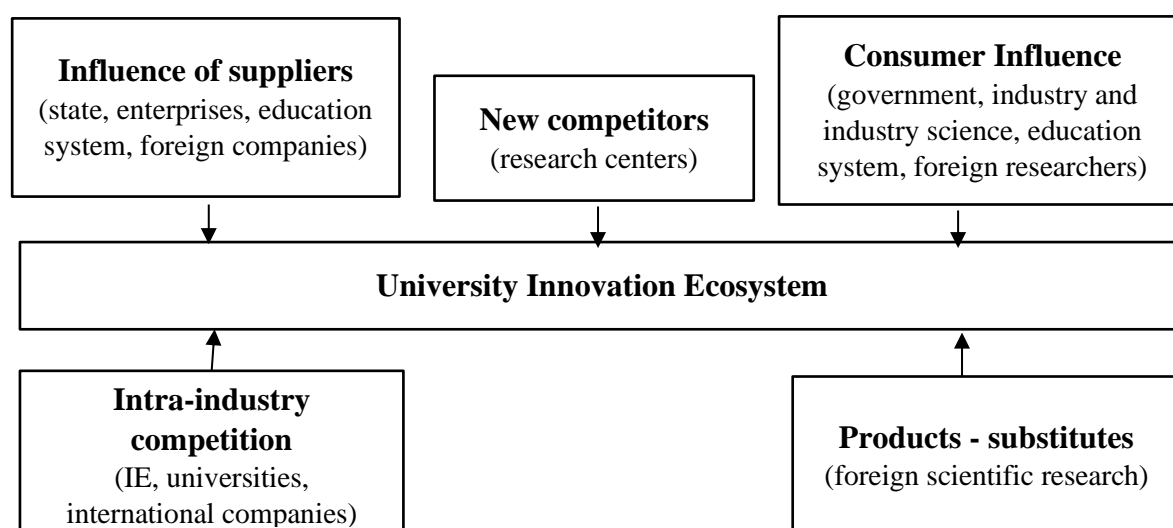


Figure 3.17. M. Porter's Five Forces Model of the university innovation ecosystem
[developed by the author based on²¹⁹]

The analysis of competitive forces is carried out by the author using tables (Tables 3.2-3.6), assigning each parameter a score that reflects a low, medium or high degree of threat to the university's innovation ecosystem. To assess the impact of each driving force from Michael Porter's competition analysis model, one of the three statements in the table must be selected and the corresponding score from 1 to 3 must be entered. The scores given are summarized at the end of each table and a breakdown of their values is provided.

Influence of suppliers. The concept of "supplier" implies an economic entity that supplies the organization with the resources necessary for its work. The author refers to them: the state as

²¹⁸ Porter's Five Forces. Strategic Management Insight, 2021. [accessed 17.08.2022]. Available at: <https://strategicmanagementinsight.com/tools/porters-five-forces/>

²¹⁹ BLAGORAZUMNAYA, O., ISRAELI, M. Analysis of the factors of the external and internal environment of the innovation ecosystem of universities. In: EcoSoEn, 2022, an. 5, nr. 3-4, p. 19-25. ISSN 2587-344X.

the main source of financing of fundamental and applied science and promotion of innovations; the business sector, as the creator of equipment and other fixed assets of science, as well as partly a source of funding; the education system as a supplier of the necessary qualified personnel; foreign companies supplying scientific equipment, partly funding research.

Table 3.2. Influence of suppliers on the development of the university innovation ecosystem
[developed by the author]

Parameter	Parameter assessment	
	2	1
Number of suppliers	Few suppliers	Wide selection of suppliers
	+	
Limited supplier resources	Limited in volume	Unlimited in volumes
	+	
Priority of UIE activities for suppliers	Low priority of UIE business lines for suppliers	High priority for UIE business lines for suppliers
		+
Final score	5 points	
3 points	Low influence of suppliers	
4-5 points	Average level of influence of suppliers	
6 points	High level of supplier influence	

The influence of suppliers on the development of the UIE is medium due to limited resources. However, this impact is neutralized by the high priority given to the development of the innovation ecosystem for all its participants.

The State of Israel and its policy to support innovation and development of creativity is to focus the economy on knowledge-intensive production, increase public funding for fundamental research, develop and implement a program for the development of the scientific sector and business, increase the remuneration of scientists, solve social security problems, stimulate the participation of academic institutions in patenting, stimulating the opening of branches of large international companies and mixed enterprises in the country. The main source of funding for research and development are the government (Israel Science Foundation) and public organizations, which provide financial support for more than half of the work in this area.

The Israeli entrepreneurial sector is characterized by developed ecosystems (military, ICT sector, Startup), venture capital market, close ties between Israeli universities and business. Israeli companies focus on the B2B market. A high level of entrepreneurship and innovation is characteristic mainly of high-tech industries, while traditional industries lag behind their counterparts in other developed countries. This is due to the focus of knowledge-intensive sectors of the economy on globalization, while traditional industries compete with great difficulty in the domestic market. In addition, most high-tech companies with high employee salaries are located near Tel Aviv (the center of Israel), while low-wage enterprises are located in less densely populated areas far from the center.

The education system is called upon to perform the functions of a supplier of qualified personnel necessary for science. Research and development in various fields in Israel is carried out at the country's seven universities, dozens of state and public research institutes and hundreds of civilian and military enterprises²²⁰. The process of "brain drain" from Israel has a negative focus on the staffing of Israeli science; the share of faculty in Israeli universities under the age of 40 tends to decrease; The conduct of scientific research is largely dependent on the provision (for example, laboratories) with modern equipment, funding for projects must be constant, scientific personnel must be professional, so there is an average dependence on suppliers.

A significant role in scientific research is played by foreign companies that act as suppliers and as consumers. They finance innovative developments and start-ups. Programs administered by the Israel Innovation Authority include bilateral funds (joint R&D programs with overseas partners such as China, Canada, the USA, etc.) that are eligible for financial assistance equal to 50% of an Israeli company's R&D costs.

Influence of consumers. The consumers of the results of the UIE activities include: the state, the spheres of branch science and high-tech production, the education system, as well as foreign researchers.

Table 3.3. Influence of consumers on the development of the university innovation ecosystem [developed by the author]

Evaluation parameter	Parameter Estimation		
	3	2	1
Share of consumers of UIE results	Over 80% of results come from multiple consumers	50% of consumers use UIE results	All UIE outputs are consumed by all consumers
			+
The uniqueness of the UIE results	UIE results are not unique	The results of the UIE are partly unique	The results of the UIE are completely unique
		+	
Satisfaction with the quality of UIE performance	Dissatisfaction with key results of the UIE	Dissatisfaction with UIE related results	Complete satisfaction with the quality of UIE performance
		+	
Final score	5 points		
4 points	Low level of customer exit risk		
5-8 points	Average level of customer exit risk		
9-12 points	High Threat of Client Exit		

The influence of consumers is rated at 5 points, which means the average level of threat. This is explained by the fact that the results of the UIE activities (conducting R&D and their

²²⁰ ROSHKA, P.I., BLAGORAZUMNAYA, O.N, DREIHER, D., ISRAELI, M. *Innovation as an element of the development of healthcare and education in Israel*. In: Modern engineering and innovative technologies, Nr.24, 2022, p. 39-47. ISSN 2567-5273.

commercialization) are partially unique, there are incriminating characteristics that are important for consumers of the results of this activity. However, consumers will switch to another UIE due to the rapidly growing diversified needs for consumer innovation. Since the number of consumers for scientific research of universities and the results of the UIE activities is large and they act largely independently of each other, they buy a certain number of products (technologies or services), thus they do not have the opportunity to strongly influence prices, quality and other conditions for the provision of services.

The state is an important consumer of scientific achievements in terms of a source of information in the formation of policy in the field of education and innovation. To obtain high results in fundamental and applied research, the state allocates grants from the ISF on a competitive basis, which are provided to about a thousand scientists. The Israel Innovation Authority provides practical assistance to various researchers in the form of developing a plan for the implementation of their ideas, innovation incentive programs aimed at meeting the changing needs of local and international innovation systems. State regulation and incentives for entrepreneurial activity contribute to the creation of unique and high-quality results of the UIE activities.

The spheres of sectoral science and high-tech production require highly qualified specialists trained in the country's universities. The large number of patents obtained by Israeli universities is one of the indicators of the effectiveness of cooperation between scientific institutions and industry. Thanks to the relationship between university science and business, unique and high-quality products (technologies, services) are created. These relationships are influenced by various factors: the existence of effective dialogue and communication channels, the coordination of expectations and the definition of common goals, the creation of trust and commitment between consortium members, the transfer of knowledge from academia to industry, and others (Appendix 41).

The education system as a consumer is interested in conducting scientific research at universities. Over 80 percent of all published research in Israel, almost all development in the field of basic sciences and basic research training are conducted at universities. Universities have interdisciplinary research and testing institutes in various fields of science and technology (in chemistry and computer science, in the field of natural and technical sciences, agriculture and medicine), which attract practitioners.

The Office of Innovation aims to expand the reach of multinational companies, both in terms of the areas of employment they offer and the technology areas in which they operate and research.

The influence of existing competitors. The author considers the existing innovation ecosystems and the industry environment as existing competitors.

Table 3.4. The influence of existing competitors on the development of the university's innovation ecosystem [developed by the author]

Evaluation parameter	Parameter Estimation		
	3	2	1
Number of innovation ecosystems	High level of market saturation	Average level of market saturation	A small amount of IE
			+
Innovation market growth rate	Market stagnation or decline	Slowing but growing market	High
			+
Growth rate of the educational market	Market stagnation or decline	Slowing but growing market	High
		+	
Level of differentiation in UIE performance	UIE results are no different	UIE results differ in key areas	The results of the UIE are significantly different
		+	
Final score	6 points		
4 points	Low level of intra-industry competition		
5-8 points	Average level of intra-industry competition		
9-12 points	High level of intra-industry competition		

An analysis of intra-industry competition shows that there are a small number of licensed educational research universities in the educational services market, so competition is driven by slowing but growing growth rates. The UIE's closest competitors are educational research universities, existing innovation ecosystems and international companies. It cannot be said that the listed organizations are direct competitors due to the differentiation of educational programs conducted by R&D, the interests of ecosystem participants. Intra-industry competition is characterized by a low level of IE and a high growth rate of high-tech companies (including international ones), which rapidly develop innovations in various areas due to highly qualified specialists and modern equipment. The threat of existing competitors in the market is medium.

The presence of Israel's Silicon Valley (Appendix 42) can be conditionally considered as a competitor to the development of the UIE, since some university scientists are participants in this ecosystem. Members of the Israeli Silicon Valley (more than one million people from national and international companies and organizations) develop new technologies and innovations, conduct research and development in the field of IT technologies, pharmaceuticals, etc., create start-ups.

The threat of new competitors. Such threats include the presence of independent scientific centers outside universities.

Table 3.5. The impact of new competitors on the development of the university's innovation ecosystem [developed by the author]

Evaluation parameter	Parameter Estimation		
	3	2	1
Growth rate of innovation creation	High and growing	Decelerating	Decrease
	+		
Level of investment in innovation	High	Average	Low
	+		
Government policy	No government restrictions	The government intervenes in the industry, but at a low level	The government fully regulates the industry and sets limits
		+	
Final score	8 points		
3 points	Low level of intra-industry competition		
4-8 points	Average level of intra-industry competition		
9 points	High level of intra-industry competition		

The threat of new competitors entering the market is moderate. The level of investment in innovation characterizes the dynamics of the Global Innovation Index, which tends to grow for Israel.

In order to assess the threat of the emergence of new competitors, it is necessary to take into account the complexity and ease of entry not only into the educational services market, but also into the innovation market. A high-level scientific environment is formed on the basis of the long-term formation and interaction of scientific schools. Attracting world-class foreign researchers (similar to Silicon Valley in the USA) to research centers outside universities for scientific research, in the author's opinion, will not be particularly competitive. But the high growth rates of the high-tech sector and the level of investment in R&D in it contribute to the creation of their own research institutes and development centers.

The threat of substitute products. Substitute products for the results of the activities of the innovation ecosystem of universities, also known as the achievements of university science, may include new products, services, and technologies that have been developed through research and development, as well as patents, publications, and other forms of intellectual property. These achievements can have significant economic, social, and environmental impacts, driving innovation and growth in a wide range of industries and sectors.

When substitute products appear, there is a threat to the performance of the innovation ecosystem of universities as it may reduce the market demand for the university's innovations and impact its revenue streams. Additionally, the emergence of substitute products may increase competition, which can result in a reduction in the value and profitability of the university's intellectual property, potentially hindering its ability to attract funding and investment.

Furthermore, the university may lose its competitive advantage in the market, leading to a decline in its reputation and influence in the innovation ecosystem.

Table 3.6. The impact of substitute products on the development of the university's innovation ecosystem [developed by the author]

Evaluation parameter	Parameter Estimation		
	3	2	1
Similar results of UIE activity in the international market of innovations	Exist and hold a high share of the international innovation market	Exist, but only entered the international innovation market	Does not exist
	+		
Similar results for the UIE in the domestic innovation market	Exist and occupy a high share of the domestic innovation market	Exist, but only entered the domestic innovation market	Does not exist
		+	
Final score	5		
2 points	Low level of intra-industry competition		
3-5 points	Average level of intra-industry competition		
6 points	High level of intra-industry competition		

The strength of the influence of substitute products is average due to the fact that there are many of them on the international market and most Israeli startups are bought by international companies.

The last stage of the analysis is the summary of the results presented in Table 3.7.

Table 3.7. The results of the analysis of threats to the development of the university innovation ecosystem according to the model of M. Porter [developed by the author]

Parameter	Value	Level	Direction of work
Vendor Threats	5	Average	Increasing state support for universities; narrowing the gap between industries and regions; reducing brain drain; expansion of research cooperation with foreign UIE
Consumer Threats	5	Average	Formation of new competencies of teachers and students, ensuring effective cooperation with business and integration into the global scientific and educational space
Threats from existing competitors	6	Average	Improving the technical level of equipment of the UIE infrastructure
Threats from new competitors	8	Average	Finding a balance between education and R&D
The threat from substitute products	5	Average	Changes in the marketing system

"The threat of new competitors" and "the influence of existing competitors" are the most significant environmental factors that affect the UIE operations, while "suppliers", "consumers", and "substitute products" are relatively insignificant factors.

Based on the results of the analysis of the five competitive forces according to the model of M. Porter, we can conclude that the strategic development of the university's innovation ecosystem for the coming years can be based on:

- 1) increase by the state of funds to increase the remuneration of scientific workers; closing the gap between high-tech industries and Israel's traditional, geographic regions; encourage young researchers to work in the country; expansion of research and teaching cooperation with foreign UIE;
- 2) the formation of new competencies of teachers and students through networking with business structures (mutual consulting, modernization of existing and joint development of new educational programs, joint research projects, exchange of experience, etc.); ensuring effective integration into the global scientific and educational space through the creation of joint projects with foreign organizations, participation in foreign conferences, international scientific congresses, exchange programs for scientists,
- 3) increasing the technical level of equipment of the UIE infrastructure through the joint efforts of ecosystem participants;
- 4) changing the structure of educational services towards a balance between education and research based on their close interaction; finding additional funding for R&D joint projects;
- 5) changes in the marketing system to promote the results of the UIE.

To assess the development of the university innovation ecosystem and its competitiveness, this is a PEST-analysis, which is designed to identify the Political, Economic, Social and Technological aspects of the external environment. PEST analysis is presented in Table 3.8.

Table 3.8. External factors influencing the development of the university innovation ecosystem [developed by the author based on ²²¹]

Political	Economic
1. Changes in legislation in the field of education and research 2. State and municipal regulation and control of activities 3. Introduction of standards for the development of innovation ecosystems 4. Social policy of few resource groups (including those in the field of university R&D)	1. The state of the economy of the industry directly related to the profile of the university, and trends 2. Average salary in education 3. Inflation rate 4. Demand for university graduates and trends
Social	Technological
1. Demographic situation (including migration situation) 2. Sociocultural values of the population 3. Level of social mobility 4. Opinion and attitude of consumers / employers towards private educational institutions 5. The demand for basic educational programs by applicants	1. Development of educational technologies in Israel and in the world 2. Funding for research and development 3. Status and development trends in educational methods and research 4. Technological literacy of consumers

²²¹ BLAGORAZUMNAYA, O., ISRAELI, M. *Analysis of the factors of the external and internal environment of the innovation ecosystem of universities*. In: EcoSoEn, 2022, an. 5, nr. 3-4, p. 19-25. ISSN 2587-344X.

The major political factors that impact the development of the university innovation ecosystem are alterations in Israeli education-related laws, and state and local regulation and supervision of activities. Among the economic aspects of the PEST-analysis, one should single out the average salary level in the educational sphere, the inflation rate, the need for university graduates, and trends of change. The crucial social factors include the demographic condition and the applicants' demand for fundamental educational programs. Technological aspects (the development of new technologies) have the strongest influence on the development of the UIE, as they provide an innovative process, status and trends.

An integrated approach to assessing the competitive position of the university's innovation ecosystem requires an analysis of its internal context, an effective tool for strategic planning of which is SWOT analysis. The purpose of the SWOT analysis is to form a field of strategic alternatives and evaluate each of them based on the concept of competitiveness, i.e. the ability of the UIE to compete for a long time, while achieving the strategic goals and objectives of development and satisfying the interests of its participants. To determine the possibilities for achieving this goal, it is necessary to divide the factors and phenomena into four categories: Strengths, Weaknesses, Opportunities and Threats. By developing a proper strategy, an organization can highlight its strengths and minimize its weaknesses, allowing it to seize opportunities and avoid dangers. The results of our SWOT analysis of the development of the UIE are shown in Table 3.9.

Table 3.9. SWOT analysis of the development of the innovation ecosystem of universities
[developed by the author based on ²²²]

Strengths 1. Educational system 2. Partnerships 3. Human capital 4. Infrastructure and programs 5. Entrepreneurial culture	Opportunities 1. Management 2. Connections 3. Potential 4. Orientation 5. Financing
Weaknesses 1. Concept and strategy 2. Systematic and organizational flexibility 3. Access to resources 4. Database	Threats 1. "Brain drain" (migration situation) 2. Motivation for starting a business 3. National security 4. Information portal for innovation

Strengths. The strong educational system of Israel, especially in the training of technical and engineering personnel, is confirmed by international ratings. Scientific research aimed at performing across the entire spectrum of exact, natural, humanitarian and social sciences is

²²² KON, F. et al. *A panorama of the Israeli software startup ecosystem*. In: SSRN Electronic Journal, 2014. ISSN: 1556-5068. [accessed 10.12.2022]. Available at: https://www.researchgate.net/publication/262726131_A_Panorama_of_the_Israeli_Software_Startup_Ecosystem_W_P

recognized by the world scientific community in some scientific fields. Each university has its own characteristics of the organization of scientific research, due to the profile of the higher educational institution, the level of organization of its interaction with enterprises and organizations, academic and industry sectors of science²²³. The presence of the Technology Transfer Company for the commercialization of university innovations contributes to the emergence of start-ups, incl. student. The close geographic location of universities and resources for the ecosystem contribute to the development of a network of scientific organizations that are located throughout the country with the presence of specialists.

The mutual influence of participants in the ecosystem is carried out through communication processes using communication channels and communication in a network society. Many leading ecosystem actors are focused on changing their internal processes to become more responsive and adapt to ecosystem dynamics and emerging opportunities.

The diversity of participants and their role in the UIE is determined by a network of partnerships with enterprises in the real sector of the economy, as well as technology platforms, clusters and other associations in the field of innovation. The innovation ecosystem will function successfully only if the diversity of its subjects with the necessary resources, competencies and goals is ensured; involvement in the process of technology transfer of representatives of business communities as mentors and experts, the use of technology and social networks as a portfolio to document the development process of the UIE.

In the new paradigm of universities, one of the main roles is given to their human capital, which includes the knowledge, skills, creative abilities of teachers and researchers, university management, support staff, doctoral students, graduate students, and partly students. At Israeli universities, at all stages of professional and intellectual growth of students, they develop educational programs, hold competitions for the best business idea, provide an opportunity for internships in laboratories, and motivate them to participate both financially and in terms of prestige. The presence of infrastructure for research (technology hubs, innovation laboratories, R&D centers, own venture funds in some universities (TAU)) contribute to the functioning and development of the UIE. The Israel Innovation Authority through training and grants aims to increase the number of workers in the high-tech sector by creating academic and non-academic training programs that will re-train highly skilled professionals in line with ever-changing job needs. The development of an entrepreneurial culture in universities also contributes to the development of the UIE.

²²³ DREIHER, D., ISRAELI, M. *Innovation as the key to improvement in healthcare and education*. In: Economic Series. House of România de Măine Foundation Bucharest, 2022, Vol. 13(22), Issue 4, 2022, p.309-318. ISSN 2393-1795.

Weaknesses. In the absence of a unified vision, it is difficult to involve stakeholders in the development of innovations, since they must have a common understanding of the opportunities and challenges for the growth of the ecosystem. The focus on innovative dynamics and the progressive development of the ecosystem depends on a common vision of the UIE participants, a permanent discussion of interaction issues, debugging communications in the ecosystem, changes in the management structure and the formation of a development strategy. The development strategy lays down the target settings of the university, taking into account the provisions of the state policy in the field of education. An analysis of strategic documents (strategies or strategic plans) for the development of world universities showed that their target models are largely determined by the guidelines for the development of national higher education systems (Appendix 43). Depending on the content of the strategic goals formulated in the documents, all analyzed universities were conditionally divided into two large groups: 1) universities aimed at increasing their influence at the global level (mainly leading European, American and almost all Asian universities). Their innovative activities are focused on the development of innovative start-ups in innovative areas that can change the world; implementation of breakthrough scientific research at the global level; building mutually beneficial partnerships and networks at the global level. 2) Universities aimed at leading positions at the national and regional level (mainly British, some North American universities). Their priority goals are to promote the spirit of entrepreneurship, commercialization and technology transfer; increasing research and publication activity; strengthening of regional partnerships; and development of international relations. An analysis of the development strategies of the leading universities in Israel showed that the leading universities are more oriented towards global development (Appendix 44). In general, the main guideline for them is the training of globally competitive specialists, the implementation of world-class innovative scientific projects using the latest technologies and on the basis of broad integration. Insufficient understanding of the vision, mission and values of the ecosystem in these strategic plans, the short duration of the goals set to improve the efficiency of universities (the desire to obtain significant results in 2-3 years of program implementation), the lack of operational planning and organization of ongoing work to develop the capabilities of each participant adversely affect UIE development.

The principle of systematic existence of an ecosystem is that the sustainability of an innovation ecosystem is ensured by the presence of systemic relations between its elements. The lack of consistency in the UIE hinders the coherence and implementation of the ideas of its participants, which is manifested in the search for new opportunities, managerial attention to the description of the procedures for joint work (a tendency to traditional forms and methods) of all participants in the ecosystem, managing a portfolio of innovative projects and maintaining a

balance between projects in it, aimed at long-term development, and those aimed at improving the current performance of the ecosystem. Many stakeholders are working in silos due to a lack of trust. Their organizational structures and processes hinder productive collaboration that would create the conditions for innovation. As such, strategies and actions are needed to realize opportunities within an organization or within the wider ecosystem. Organizational collaboration strategies and the capacity for execution determine success in an ecosystem. Forming organizations will also require a change in stakeholder thinking. If organizations and the stakeholders that work for them can adopt agile approaches, they are more likely to become competitive and achieve sustainable growth. In addition, ecosystem participants must be able to update their processes based on best practices (management practices in strategy development, accounting, marketing and organizational development) to achieve results.

As resources in the innovation ecosystem, personnel, financial resources from all available sources, information, premises, equipment, software, and various communications are used. Resources can be divided into two types - resources on the supply side and resources on the demand side. Supply-side resources refers to money from specific sources such as funds, grants, seed money funds, and research funding funds. These resources may also include all monetary assets (received in the form of investments, loans or income), as well as tangible and secured assets or those that will soon become so. The source of origin of assets is mainly banks, venture investors, private investment companies, business angels and other financial donors. Access to such financial resources is critical to enabling innovators to make basic purchases, pay salaries, and purchase products and services. This is the most flexible source as it is equivalent to money. Demand-side resources that are not directly monetized include contacts, partnerships, access to certain services and value chains of partners (e.g. distributors, suppliers, customers), branding, access to infrastructure (e.g. research centers, innovation hubs), knowledge and intellectual property, etc. These demand-side resources are part of the overall ecosystem resources, but are not necessarily owned by the organizations or stakeholders using them. They are required by ecosystem participants when implementing a strategy that involves achieving goals without the involvement of external resources, as well as other organizations within the framework of the open innovation ecosystem strategy.

Insufficient formation of research databases is reflected in the analysis of the functioning of the UIE (conversion of data into information), the collection and preliminary analysis of innovative ideas, the formation of optimal access to national and international research and development, the search for potential customers, customers of innovative products and solutions, analysis ecosystem innovation opportunities.

Opportunities. Based on the analysis of UIE development factors, four key opportunities can be identified that must be used in any ecosystem to ensure its competitiveness: management; communications; potential and orientation. These capabilities allow the ecosystem to be dynamic and competitive.

The main focus of the innovation ecosystem should be on collaboration: stakeholders should share resources in order to achieve a result. The governance model of the UIE must be flexible, able to quickly respond to change, and comprehensively meet the needs of the community. Without it, many ecosystems don't work as the dominant actors kill off the smaller, more innovative ones, regardless of their geographic location. Public policy should support the development of innovation and encourage the development of creativity, which is characteristic of Israel. The state must ensure that their policies are credible and attractive to the local workforce. Otherwise, once innovators have reached the limit of their growth potential, they will migrate to neighboring or even distant ecosystems in order to be able to grow.

A successful ecosystem can both create incentives for innovation and be a source of competitive advantage. There must be strong links within ecosystems that provide the right business environment, a willingness to innovate, and entrepreneurs to develop appropriate technology solutions. In order to accelerate the development of an entrepreneurial ecosystem that includes large firms, universities, government agencies and start-ups, not only the functions of these structures, but also the interaction between them, is of paramount importance. The expansion of cooperation between universities and other UIE participants can be carried out in the field of training; joint projects; seeking additional financing (venture funds, crowdfunding, investments by foreign corporations). Building ecosystem links is contextual, requiring flexibility in the design of policies and programs that support the dynamism of innovation and entrepreneurship. The development of innovation ecosystems is characterized by a focus directly on the interaction of participants in the innovation process and the creation of favorable conditions for this process. A dynamic innovation environment requires a coherent regulatory framework that can guide, encourage and promote an innovation culture, mindset, projects and programs. Appendix 45 presents the activities of the Israel Innovation Authority to promote innovation dynamics in the country.

An important factor that should be widely disseminated is being in an environment that encourages innovation, that is, an environment that provides both inspiration and support. This environment encourages people to work together to solve problems and share knowledge, creating a collaborative and forward-thinking work environment that combines talent, opportunity and resources. To create the innovative potential of ecosystems, a formal or informal innovation infrastructure is needed, which is usually concentrated around higher education institutions:

innovation centers, technology parks, laboratory programs and other similar mechanisms. The key to their success is communication, collaboration between stakeholders, and a problem-solving orientation. Universities play a key role in the development of technological innovation, as they can offer various mechanisms to support ideas in the marketplace and to adapt curricula. To accelerate their transformation into leading innovation centers, it is necessary to create new and update existing global partnerships.

Ecosystem orientation is essential to improve competitiveness and will enable innovative businesses to succeed at scaling in both the public and private sectors. Israel is characterized by a developed Startup ecosystem, an entrepreneurial B2B system, digital platforms and social networks to promote innovation, the participation of the Israeli military industry in the development of local start-up ecosystems, a favorable business environment for innovation and technology companies operating in the global market, as well as the assistance of the Jewish diaspora in establishing economic ties with other states. To ensure the competitiveness of critical sectors, universities must work in partnership with stakeholders involved in corporate and high-risk investments; global corporations should cooperate with universities and government structures; government structures should form partnerships with universities and corporate stakeholders; representatives of the business community should cooperate with government structures and the industry.

A key factor in the functioning and development of the UIE is the presence of investment in R&D. Seed Funding and Research Funding are supported by Seed Funds and Research Funding Funds.

Threats. At present, the Israeli economic model is built in such a way that at its center are the institutions of the knowledge economy, which requires a significant amount of labor force of the appropriate skill level. At the same time, today there is a fairly significant emigration (“brain drain”) from Israel of specialists and young scientists, mainly to the United States. Among the reasons for this situation, one can single out the increase in the tax burden for the most educated residents of Israel (they pay 2/3 of the total income tax and national insurance contributions); slowdown in labor productivity growth compared to the developed countries of the world; an increase in the cost of living compared to other developed countries. Despite the existing demand for highly qualified personnel in Israel, there is a low supply of professional personnel in certain areas (programming, IT, servers). In the field of science, there is a decrease in social support for scientists and the status of a research worker, as well as an age disproportion in the staff of scientific research leaders. At the moment, many of the Israeli companies have research and development centers outside of Israel, as it is easier to hire them here. In addition, the start-up development model in Israel needs to be improved. It looks like this: a startup is created; funds are

raised for its development; having reached a certain stage of growth, a startup is listed on the stock exchange and sold to large companies (mainly from the USA). However, such a system may soon reduce the competitiveness of the Israeli economy, as many opportunities for creating large corporations in the country are missed. Foreign TNCs withdraw capital and intellectual property from the country. The author believes that Israel needs its own companies that can create products, conduct R&D and invest in national start-up projects.

Motivation for starting a business. In Israeli society, it motivates entrepreneurship by choice, elevates the social status of the entrepreneur, promotes interorganizational entrepreneurship, a culture of improvisation and initiative. Although the culture of entrepreneurship in the country²²⁴ is aimed at striving for knowledge, survival in the face of an external military threat, transferring the experience of start-up entrepreneurs, etc., there is still a fear of failure when starting a new business (Appendix 46). According to the GEM international research program, Israel ranked 30th in the opportunity index (measures the level of motivation for entrepreneurship by choice) among 49 countries in 2018/2019²²⁵. According to the GEM report, self-assessment of entrepreneurial skills and abilities among the non-entrepreneurial population in Israel was 41.5 percent in 2018/2019 (including 38.5 percent among immigrants), which is significantly lower than the same indicator among the non-entrepreneurial population of other developed countries. countries (Appendix 47). However, Israel ranks third among developed countries in terms of the number of active entrepreneurs (56 percent of the population knows many examples of successful entrepreneurs). The demand for and receptivity of innovation in both the entrepreneurial and research sectors of universities contribute to the motivation of staff to engage in entrepreneurial activities, participate in the creation of start-ups and opening their own business.

National security in the context of permanent military and political confrontation contributes to the creation of innovations. A country without generous reserves of natural resources is faced with constant threat, economic boycott, and is forced to constantly change in order to survive. Israel's military spending has become a source of innovation, as military service allows young scientists to combine military art with the development of dual-use technologies, the creation of start-ups.

The absence of an information portal (website) on the innovation activities of universities and enterprises by industry (sector) of the economy hinders analytical work and obtaining timely information for decision-making on the development of the innovation ecosystem.

²²⁴ BLAGORAZUMNAYA O., ISRAELI M. *Innovative culture as one of the directions of innovative activity of the university*. In: EcoSoEn, 2019, an. 2, nr. 3-4, p. 45-54. ISSN 2587-344X.

²²⁵ MENIPAZ, E., AVRAHAMI, Y. *Entrepreneurship Report, Israel, GEM 2018/2019*. Beer Sheva: Ben Gurion University, 2019. 50 p.

Based on the SWOT analysis, it can be argued that the innovation ecosystem of universities has the potential for development and improvement. Possible strategic actions could include the following:

1. To increase the level of organization of interaction between all participants in the ecosystem, taking into account the focus and characteristics of scientific research; to carry out organizational changes in internal processes, adapting to the dynamics of the ecosystem; agree on the strategy of the university, taking into account the concepts and vision of the participants, state policy in the field of innovation and education; increase the level of knowledge, skills, creativity of innovators, attract local human resources based on the promotion of an entrepreneurial culture.
2. Provide access to knowledge, infrastructure through contracts and partnerships within the open innovation ecosystem strategy and ensure the continuity of financial resources; change the attitude of Israelis to the opening of a new business; attract talented young scientists to the ecosystem, taking into account the migration situation, taxation, and an increase in the cost of living.
3. Develop a unified concept of the UIE and harmonize it with the mechanism of institutional and legal regulation of innovation activities; discuss issues of interaction and procedures for working together in a changing environment; debug communications in the changed management structure in the ecosystem; promote creativity, encourage and promote an innovative culture; create new and update existing global partnerships.
4. Create an information portal (website) with indicators of innovative activities of universities, a database of innovative ideas, national and international research and development.

Based on the results of the study, the following conclusions can be drawn:

The development of the university innovation ecosystem directly depends on the development of the external environment (state policy, public and private grants, integration of economic sectors with science, infrastructure and development programs, etc.) and etc.). In order to properly navigate in a changing environment, UIE participants must analyze environmental factors (customer interests, technological capabilities, regulatory changes, and others), the needs of society and constantly respond to them through the implementation of appropriate programs and policies.

For the functioning and development of the innovation ecosystem, Israeli universities have created conditions to stimulate the entrepreneurial activity of scientists and students, including such tools as technology transfer centers, student project competitions, incubators and accelerators, seed funds, technology parks, etc. Universities develop programs and projects, conduct events to

create partnerships with UIE participants, introduce investors to projects, select them and invest in them at an early stage. The study showed the influence of internal factors that negatively affect the dynamics of the innovation ecosystem of universities: the lack of a unified UIE concept and strategy, organizational flexibility, access to resources and a database of innovations. To ensure the development of the university's innovation ecosystem, the UIE must establish appropriate policies, initiatives, and specific support programs that enable it to constantly adapt to a changing environment, evolve, and attract talent, resources, and opportunities.

3.4. Conclusions for chapter 3

1. The national innovation system of Israel is a complex system of closely interrelated participants (state, business, universities, etc.), which is presented by the author in the form of a simplified model of the national innovation system of the country. The small size of the country facilitates cooperation and communication between all participants in the system within the country, as well as with the innovation systems of the leading countries. Highly developed networking in the innovation sphere is manifested in the high diversification of sources of funding for scientific research (public, private and foreign investments, grants, various donations) and political support of the state.

2. In the course of the study, the role of the State of Israel in the formation of the national innovation system is revealed. This role is to implement policies conducive to research and development, creating universities and research institutes, as well as fostering a culture of entrepreneurship and willingness to take risks. In Israel, the mechanism of action of innovation processes was launched and this made it possible to form a class of innovative entrepreneurs.

3. The study demonstrates the rapid growth of the Israeli high-tech sector due to the processes of globalization over the past two decades, as well as the important place of startup companies in the Israeli economy, as they contribute to job creation, technological innovation and economic growth and have made Israel a global center for entrepreneurship and innovation. The entrepreneurial sector of Israel's innovative economy includes small and large Israeli companies; representative offices of TNCs in Israel; relevant financial, legal, analytical and consulting companies.

4. The author's research showed the systematic nature of the organization of fundamental, applied research and technology transfer in Israel based on cooperation between state and private organizations. Through programs, grants and allocated financial means, the state supports the development of innovations in the most promising areas of the economy (information and communication technologies; medicine and pharmaceuticals; agriculture and biotechnology; natural resources and energy; defense and aerospace industry). In addition to attracting foreign

investments, large companies in Israel are interested in creating their own research centers. They can function thanks to the country's developed innovation ecosystem, including the presence of leading research universities, a highly qualified workforce and an entrepreneurial culture.

5. The results of the analysis confirmed a relatively high level of scientific research in the universities of Israel; noticeable increase in the prestige of work in the scientific sphere; unique human capital from the point of view of experience, workability and combinations of various cultures; A strong connection and interaction between the academic environment and industry through university technology transfer centers. Participating in the international rankings of Israeli universities and concentrating the efforts of all their structures on increasing the ranking can lead to significant successes in science and innovation.

6. The research revealed a strong connection and interaction between the academic environment and industry through Technology Transfer Centers, which carry out the commercialization of university research (estimation of the commercial potential of the future product, development of a business plan for its promotion to the market, search for an investor, etc.). Knowledge transformation is embodied in the joint cooperation (consortium) of commercial enterprises and universities within the framework of a number of government programs, as well as the transfer of human capital to companies through university graduates.

7. Despite the positive sides of the entrepreneurial environment in Israel, identified factors that hinder the development of the innovative ecosystem of universities: the absence of a single concept and vision; the disconnection of interests and the inconsistency of the goals of the participants of the innovation ecosystem; insufficient attention to the development of the development strategy and a management mechanism for the university innovation ecosystem ; limited access to resources and infrastructure; insufficient formation of scientific research base and others. The listed factors prevent productive communication, coordination, realization of ideas of the participants of the university innovation ecosystem , effective cooperation for the development of innovations and more effective functioning of the innovation ecosystem of universities.

4. IMPROVEMENT OF THE MECHANISM FOR MANAGEMENT AND EVALUATION OF THE DEVELOPMENT OF THE INNOVATIVE ECOSYSTEM OF HIGHER EDUCATION INSTITUTIONS

4.1. Improving the mechanism for managing the innovation ecosystem of higher education institutions

In any successful university (hereinafter, this term will be used, since R&D is not carried out in every university), scientific research is carried out, which requires the attraction of talents, ideas and turning this research into results and their commercialization. This systematic activity is impossible without effective management. A sustainable management system is able to respond flexibly to all emerging changes in the external and internal environment, as well as “softly” influence creative people, the main creators of new knowledge.

Higher education institutions that apply the ecosystem approach and organize entrepreneurial processes produce new personnel who are innovatively active with a high level of entrepreneurial ambitions and the risk associated with them. Universities, sometimes in conjunction with research institutes and other idea generation structures, are the basis of innovation ecosystems. The innovation ecosystem at these universities is based on the following elements: science; venture investments; tangible and intangible infrastructure; innovative demand; involvement of external participants; flexible and adaptive; innovatively active structure. Self-organization and decentralization are becoming the most important principles of the work of a highly organized association of research and entrepreneurial systems, new models of thinking are being formed in formal and informal associations, existing and potential innovators within the framework of the innovative environment being created.

The formation and development of the university innovation ecosystem is largely predetermined by the diversity of its constituent participants, processes, forms and types of their interaction, which are under the constant influence of external and internal environmental factors, respectively, there is a need to develop new management mechanisms. This will allow you to systematically and quickly go all the way from ideas, inventions and discoveries to their commercial result, create innovative opportunities for the joint development of products, interactions between companies and industries, while simultaneously developing the economy of the region and the country.

The concept of a mechanism is an obligatory attribute of the dynamics of any system, a tool for ensuring the purposefulness of its activities. The mechanism is also widely used in management practice. It is considered from different points of view: as a system, an internal structure that determines the procedure for the implementation of a particular type of activity; a set of rules, laws and procedures that ensure the proper functioning of the system, as well as the interaction of its

participants; a set of procedures for making managerial decisions; a set of management decisions to achieve the set goals.

In innovation management, there are also several approaches to solving the problems of introducing innovative solutions, carrying out targeted and irreversible changes of an innovative nature through the construction and use of mechanisms for innovative development, innovative development management, innovation management, strategic management of innovative activities, etc.

The integration processes of the university, when establishing its relationship with the elements of the innovation ecosystem, can be internal and external, so they must be taken into account when forming and developing the UIE. According to the author, in the formation and development of the UIE, it is necessary to consider in two directions:

1) taking into account the influence of external processes, which are determined by the policy in the field of higher education and the business environment;

2) improving the internal structures of universities for their innovative development.

The first direction reflects the management of universities, which must be flexible and entrepreneurial, necessary to build relationships between academia, industry and governments²²⁶. The university environment and political initiatives can contribute to the relationship between the university and other UIE members. The university environment in the form of international cooperation contributes to the development of innovation in a university with different academic, political and cultural traditions. International students play an important role in shaping university spin-offs²²⁷. The mobility of students and scientists contributed to the development of local (regional) entrepreneurial ecosystems through the Bologna process. The goal of the innovation policy is to improve the system of higher education and their socio-economic impact on a progressive society through the effective management of universities, the promotion of research, innovation and entrepreneurship.

The second direction corresponds to the point of view of the following content: unlike enterprises that create innovations mainly to increase profits, universities have complex tasks with many goals in educational, research, entrepreneurial activities and reflect the internal patterns of their development. The content of these areas is presented in Table 4.1.

²²⁶ HEATON, S., SIEGEL, D. S., TEECE, D. J. *Universities and innovation ecosystems: a dynamic capabilities perspective*. In: Industrial and Corporate Change, 2019, p. 1–19. ISSN 1464-3650.

²²⁷ HUNADY, J., ORVISKA, M., PISAR, P. *What matters: the formation of university spin-offs in Europe*. In: Business Systems Research: International journal of the Society for Advancing Innovation and Research in Economy, 2019, nr. 10(1), p. 138-152. ISSN 1847-9375.

Table 4.1. Organizational and managerial aspects of the innovative activity of the university by type of activity [developed by the author based on ²⁴⁸]

Scientific research activity	Educational activities	Entrepreneurial activity
<ul style="list-style-type: none"> - carrying out R&D; -cooperation in the field of R&D with other organizations; -examination of innovative projects; -ensuring the protection of intellectual property objects; -creation of innovative goods and services. 	<ul style="list-style-type: none"> - teaching entrepreneurship on the basis of new educational programs; - innovative teaching methods (learning methods); -formation of students' skills and habits of independent research activity, scientific thinking; -participation of teachers, graduate students and university students in grant competitions and programs; -Assist in the preparation of applications and the implementation of grant projects. 	<ul style="list-style-type: none"> -partnership in research and technology commercialization through: formal methods of technology transfer (patenting, licensing, creation of start-ups); partnership in production; through informal channels (personnel exchange, joint publications, conferences, etc.).

The organization of training for solving innovative problems includes training in entrepreneurship; digitalization; way of learning, including young researchers; formation of skills and competencies for graduates to create their own business, work in industry or science. Important aspects of managing the university's research activities are R&D, cooperation with other organizations in the field of research and the creation of intellectual property. The university innovation ecosystem is built around the commercialization of innovations, which has the result in the form of bringing products to the market²²⁸ and the university is interested in getting the maximum benefit from the commercialization of its own developments (including technologies). In the process of commercialization, the main goal of the university and the relevant technology transfer centers is to promote partnerships and the implementation of various projects (from scientific developments and ideas to the creation of an enterprise). At the same time, it is important not only to achieve a high level of technology transfer, but also to develop student entrepreneurship. The UIE aims to create conditions for the self-realization of all participants in the scientific and educational process and the production of economic and social benefits in priority areas for the region and the country.

Universities must find an appropriate balance between teaching, basic and applied research, and entrepreneurship, rather than favoring commercial and entrepreneurial values over research and teaching. They should be an addition, not a replacement. According to the author, within the university it is necessary to build its own system of relationships between educational, research and entrepreneurial activities, built in the process of managing the innovation ecosystem.

²²⁸ SHWETZER, C., MARITZ, A., NGUYEN, Q. *Entrepreneurial ecosystems: A holistic and dynamic approach*. In: Journal of Industry-University Collaboration, 2019, nr. 1(2), p. 79-95. ISSN 2631-357X.

The university innovation ecosystem has certain properties, and from the point of view of UIE management, the following can be distinguished: uniqueness (consists in the impossibility of applying the standard management procedure); the absence of a formalized purpose of existence (there is no unequivocal answer to the question of their purpose); lack of optimality (inadmissibility of constructing an objective control criterion); dynamism (change of structure in time); incompleteness of the description (the complexity of the object does not allow to characterize it from all sides equally correctly and accurately); the presence of freedom of action (the impossibility of predicting the actions of control subjects). The listed properties were taken into account by the author when improving / developing the mechanism for managing the formation and development of the UIE.

For the university innovation ecosystem and the possibility of harmonizing the interests of all its participants, their well-coordinated work, it is necessary to develop a mechanism for managing the UIE. The author understands the university innovation ecosystem management mechanism as a set of processes, principles and methods that ensure the achievement of certain goals, the necessary dynamics of increasing funding, resources and connections in the process of interaction between its participants and their communities regarding the creation and commercialization of innovations.

The author has developed a diagram of the mechanism for managing the university's innovation ecosystem, which is shown in Figure 4.1.

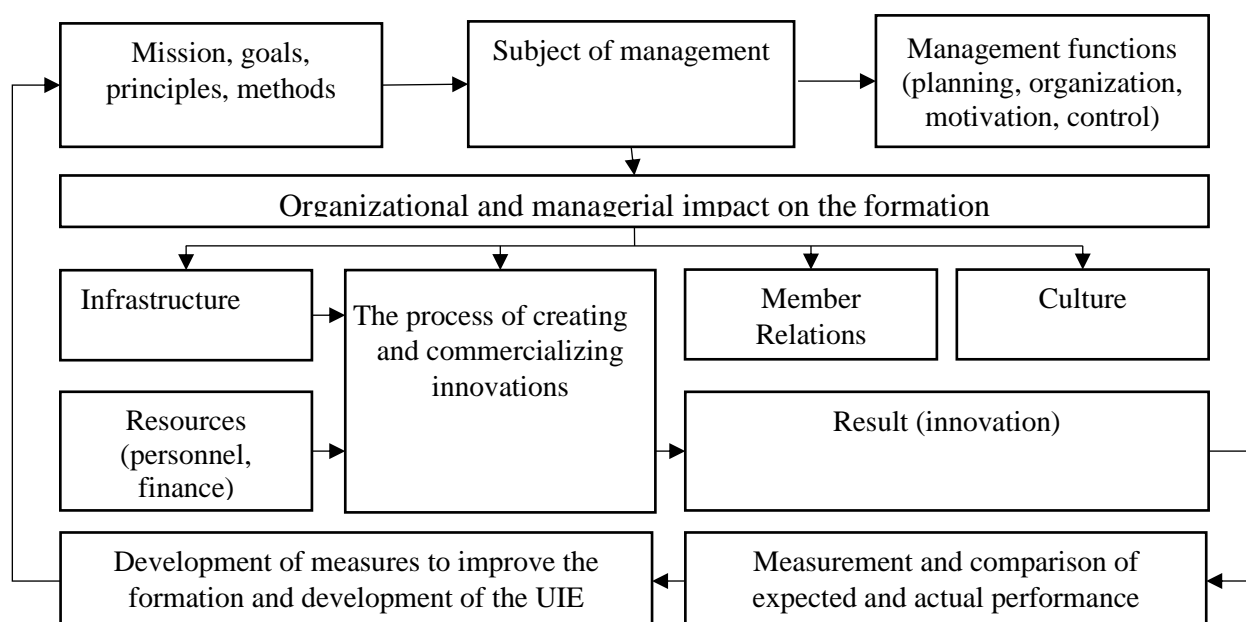


Figure 4.1. Scheme of the mechanism for managing the university innovation ecosystem
[developed by the author ²²⁹]

²²⁹ ISRAELI, M. *The mechanism for management the innovative ecosystem of the university*. In: EcoSoEn, 2022, an. 5, nr. 1-2, p. 54-59. ISSN 2587-344X.

The subject of management is the internal and external participants of the UIE, which directly or contribute to the implementation of innovative processes. The subject of management exerts a control influence on the objects of the UIE: resources, processes and results of development, the environment. In order to exercise control, it is necessary first of all to realize its goals and objectives, to choose a control method in accordance with the nature of the problem being solved and the type of control object, and then develop a control action from the subject to the object. The interconnection of the elements presented in the diagram is an approach to harmonizing the relationship between them, which will contribute to the improvement of the UIE management mechanism. Table 4.2 reveals the composition of the main elements of the university's innovation ecosystem management mechanism.

Table 4.2. The composition of the elements of the management mechanism of the university innovation ecosystem [developed by the author]

Mechanism element	Characteristic
Goal and tasks	Goal: Formation and development of the UIE for the commercialization of scientific research. Tasks: creation of conditions for the formation of the UIE; increasing the level of integration of the university in the IE region or country; efficiency of innovative activity of the university.
Management principles	Flexibility, openness, autonomy, balance of interests of participants in the innovation ecosystem, consistency, efficiency.
Subject	Innovator, research scientists and academic entrepreneurs, scientific laboratories, technology commercialization institutes, entrepreneurial structures at the university.
An object	Innovative activities of the university in the generation and commercialization of new knowledge; formation and development of the university innovation ecosystem .
Coordinating center	Management or structural unit of the university; external coordinator for the interaction of elements of the national innovation system
Conditions and factors functioning mechanism	1) ensuring the legal regulation of the UIE (including internal regulations for management); 2) innovation infrastructure; 3) level of culture (entrepreneurship); 4) organizational structure of the university, etc.
Methods, methods interactions elements	study of market demands; promotion of information on the supply market; formation of a procedure for agreeing contracts and resolving conflict situations with the customer; creation of integrative platforms for interaction and organization of open events (fairs, competitions, tenders, etc.); formation of temporary working groups, etc.
Tools managers impacts	organizational structure for the management of the UIE; internal document flow, including projects, contracts, budgeting; regulations and algorithms for managing the UIE; formation of key indicators of the formation and development of the UIE, etc.
Work results mechanism	increasing the innovative activity of the university, increasing the level of income from innovative activities, increasing the competitiveness of the university, increasing the number of interactions with external subjects of the UIE, etc.

In the UIE management mechanism, in partnership with all participants, it is necessary to develop such an instrumental set of methods that will coordinate and regulate the flows of innovations and results of innovative activities, information and cash flows, competencies and projects, and promote the promotion of scientific results to the market. These methods need to be regularly adjusted, improved, coordinated with the interests of other IE participants.

The choice of elements and forms of their interaction within the innovation ecosystem must comply with a number of principles:

consistency - the innovative potential of UIE participants must correspond to the goals and objectives set;

balance of interests of participants in the innovation ecosystem - UIE participants should be receptive to innovation, but also be ready for innovation risk, its redistribution between them, joint and several responsibility for the results of innovation;

openness - information about ongoing projects should be available and open to all participants in the innovation ecosystem;

flexibility - legal conditions must be provided for the implementation of scientific and innovative activities, respect for the interests of ecosystem participants and the concentration of innovative potential in the most significant areas;

autonomy - a certain independence of the participants in matters of self-management by the life of the UIE;

efficiency - the results of management activities should pay off all costs for the development and operation of the UIE.

These principles are the basis for the UIE legal regulation, within which certain structures are specified depending on the complexity and complexity of the tasks to be solved.

The UIE management mechanism is implemented within the framework of the main management functions (planning, organization, motivation, control). Purposeful management of the formation of the UIE requires a strategic approach, which is seen as a function of planning, a way to achieve long-term goals and strategic alignment. Strategic Alignment promotes and facilitates academic entrepreneurship, technology transfer and innovation and includes publications in basic research, R&D collaboration, incentives for individual researchers, creation of spin-off companies, patent or licensing activities that are supported by university structures²³⁰. With the help of planning tools, a strategy for the formation and development of the university's innovation ecosystem should be developed, which will provide a solution to unique problems and

²³⁰ LEHMANN, E.E., MEOLI, M., PALEARI, S., STOCKINGER, S.A. *The role of higher education for the development of entrepreneurial ecosystems*. In: European Journal of Higher Education, 2020, nr. 10(1), p. 1-9. ISSN 2156-8235.

non-standard tasks.

Organization as a management function finds its manifestations through organizational structures, processes (functioning, development), laws, culture. The use of methods and means of motivation helps to harmonize the interests of UIE participants in order to increase innovation activity. With the help of control, a continuous process of movement of resource and information flows is created, which makes it possible to control a purposeful management process.

Having considered the elements of the UIE management mechanism, the author proposes a set of measures for the management mechanism, taking into account the specifics of the formation and development of the UIE, which is presented in Table 4.3.

Table 4.3. Activities for developing a management mechanism for the formation and development of the university's innovation ecosystem [developed by the author]

Measures to develop a management mechanism for the formation of the UIE	Activities for the development of the UIE development management mechanism
identification of innovative participants, functional and infrastructure elements that make up the UIE	analysis of the factors of the innovation environment and identification of strategic problems and limitations of the development of the UIE in the context of their constant change
definition of goals, principles, methods and necessary resources for the formation of the UIE	formation of a system of goals, objectives, development strategies of the UIE and analysis of their feasibility based on management methods
identification of relationships and interdependencies within the elements of the UIE, as well as with the external environment	targeting internal and external tools that regulate the interaction of UIE participants and their communities with each other and with the external environment
setting the scope of power and limits of responsibility of the UIE participants	definition of principles and technologies, formulation and implementation of general and specific functions and methods of managing the development of the UIE
formation of corporate culture values and determination of procedures for resolving conflicts, conflicts of their interests	formation and development of the necessary culture of change, culture of acceptance of failures and entrepreneurial risks
creation of an effective management team (Coordination Center) and provision of conditions for its functioning and the formation of a knowledge base	promoting connectivity and sharing the knowledge base and the network
development and implementation of integrated support systems for innovative entrepreneurship and innovators	
information and legal support of the process of managing the formation and development of the UIE	
formation of performance indicators and periodic assessment of the level of maturity of the UIE	formation of evaluation indicators of the level of maturity and potential of the UIE, the effectiveness of the management of the development of the UIE
establishment of feedback for adjustment and adaptation of the mechanism in the mode of self-organization in changing conditions	

To effectively manage the innovation ecosystem, it is necessary to consistently form a set of knowledge about it, understand the peculiarities of the organization of the innovation ecosystem at the university, and, guided by the methods of the UIE formation and development management

mechanism (Appendix 48) develop appropriate activities. This set of measures will complement and improve the existing theoretical and practical approaches to the development of a mechanism for managing the formation and development of the UIE. The UIE is not focused on economic gain, but on the creation and sharing of knowledge to create innovation. Therefore, managing the mobility of the knowledge base is an important activity of the university.

When forming the UIE, it is necessary to be able to determine the innovation cycle, at each stage to analyze the current situation (positive or negative provisions). The generation and commercialization of innovations are not the main activities of the university, so distribution and implementation on the market is one of the roles of the organizer of the university innovation ecosystem. Gaining feedback on innovation dissemination will allow the university to identify the next set of client needs and drive innovation. It is also necessary to have an innovative strategy for the university, innovative leaders in project teams and open interaction in the external innovation market.

The ecosystem management of the university, according to the author, includes the structural and managerial aspects. The structural side should provide flexible and efficient support for the development of R&D, intellectual property and infrastructure. The managerial side includes the selection of UIE participants and the management of network relationships between them, elements of leadership (including the level of hierarchy, leadership and personal characteristics of leaders), incentives and control mechanisms.

The structural side of the UIE, according to the author, is a structure of interdependent elements (divisions and organizations) and links between them, providing participants with additional opportunities (resources, competencies) to achieve their goals. The organizational structure of the university should provide a link between teaching, research, entrepreneurial and managerial activities to stimulate entrepreneurial behavior²³¹. Most universities have a vertical, hierarchical organizational structure. But academic entrepreneurship requires interdepartmental and interdisciplinary collaboration; horizontal cooperation²³².

The ecosystem approach differs from the traditional approach in that the initiative to create the results of intellectual activity belongs to the university, and does not come from the governing bodies and relevant policy documents. As a result, the university is forced to adapt to the environment and create an appropriate structure that helps to implement these processes.

²³¹ MORAES, G. H. S. M. D., FISCHER, B. B., CAMPOS, M. L., SCHAEFFER, P. R. *University ecosystems and the commitment of faculty members to support entrepreneurial activity*. In: BAR-Brazilian Administration Review, 2020, nr. 17(2). [accessed 07.02.2022]. Available at: https://www.researchgate.net/publication/341251155_University_Ecosystems_and_the_Commitment_of_Faculty_Members_to_Support_Entrepreneurial_Activity

²³² HEATON, S., LEWIN, D., TEECE, D. J. *Managing campus entrepreneurship: Dynamic capabilities and university leadership*. In: Managerial and Decision Economics, 2020, nr. 41(6), p. 1126-1140. ISSN 10991468.

Management should be built on a combination of the traditional vertical structure of the university and horizontal links between university departments (scientific and educational centers, project office, temporary creative teams, etc.), thus developing and supporting the creative initiatives of university employees. Therefore, the structure of the university needs to be reorganized in such a way that it can provide the results of scientific research, technology transfer, cooperation with business and other participants in the ecosystem.

The departments of the university that perform specialized functions for the implementation and provision of innovative activities include departments in the field of training, conducting and supporting research, organizing and managing innovative activities and innovative infrastructure.

The unit responsible for the educational process should provide scientific and educational programs in innovative areas, promotion of educational services, information exchange in the field of knowledge.

The project office, as a specialized structural unit of the university, initiates, manages, monitors R&D projects (including interdisciplinary ones), compiles a register of projects and analyzes them. The main task of this structural unit is precisely to help creative teams in the implementation of innovative activities, implemented through the implementation of a certain set of projects in a given sequence. The essence of management is to combine the efforts of various creative teams without destroying vertical ties to achieve the goal set in the project. Projects need to implement teamwork with the involvement of experienced mentors from the venture environment. Project management should be guided by the observance of the fundamental principles: the coordination of the requirements of stakeholders and the definition of measurable project goals; creation of a project team, appointment of a project leader (manager); time constraints and allocated budget. The project portfolio management system is implemented through a set of tools, methods, methodologies, resources and procedures.

According to the author, it is necessary to build a coordinating center - a unit for managing innovative activities - into the agreed management structure of the university. The specified division will coordinate the work of all departments of the university related to the formation of the university's innovation ecosystem; coordinate the goals and objectives of the UIE participants and university departments; determine the areas of joint action based on the analysis of cause-and-effect relationships between the participants, carry out certain activities to develop and implement innovation policies for productive changes in the ecosystem; develop criteria for evaluating the activities of university departments and link them with the motivation of their employees.

The author proposed the creation of a coordination center for improving and structuring management processes, distributing tasks between participants and improving interactions between them. The structure of the elements of the UIE Management Focal Point is shown in

Figure 4.2.

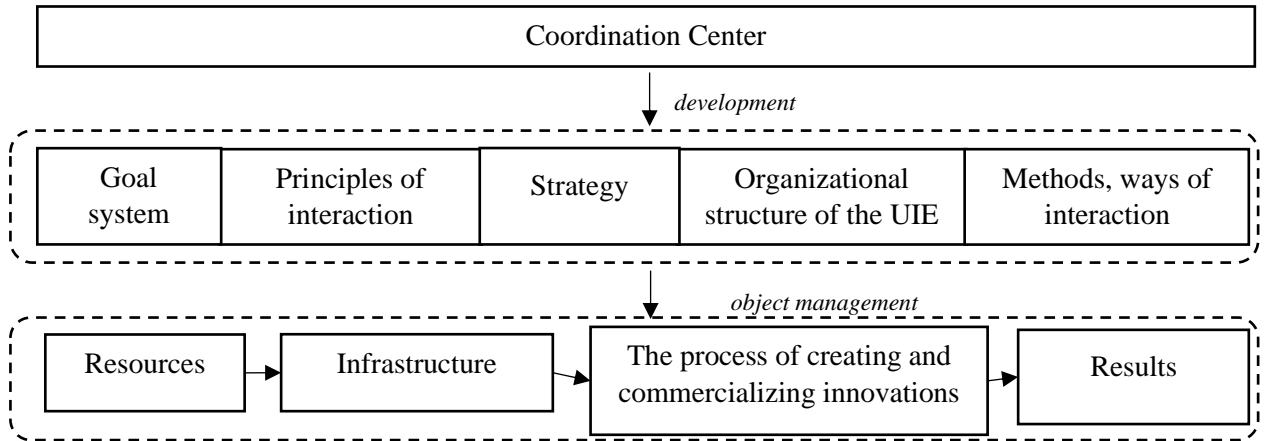


Figure 4.2. The structure of the elements of the coordinating center for managing the university innovation ecosystem [developed by the author]

The main task of the coordinating center for the management of the UIE is to set a system of goals for the formation or development of the UIE, the formulation of principles, methods and methods of interaction between participants and other stakeholders, the development and implementation of a strategy for the formation or development of the UIE, and the construction of the organizational structure of the UIE.

The activities of the focal point should be aimed at managing the provision of resources for the process of creating and commercializing innovations in order to obtain results. Thus, the coordination center exercises a control influence on the objects of management (resources, the process of creating and commercializing innovations, infrastructure, results).

Resources should be understood as financial, labor and others, the receipt of which is coordinated and controlled for redistribution between the structural divisions of the UIE. The innovation infrastructure involves the creation around the UIE of a wide network of interactions with partner organizations (business structures, business support centers, offices for technology transfer and commercialization of innovation results). The coordinating center should have a unit that will manage the innovation infrastructure, provide its financing, provide researchers with scientific and production facilities (student business incubator, technology park, laboratories, etc.), logistical, financial, informational, personnel, consulting and other services, as well as provide an environment for the functioning and interaction of departments.

The process of creating and commercializing innovations implies an interorganizational transfer of technologies, which will make it possible to manage this complex and multi-stage process more efficiently, to form a number of situations for the adoption and implementation of managerial decisions. This, in turn, will lead to certain results (the degree of implementation of a scientific idea in the form of a product, service or technology).

The organization of the work of the coordination center is impossible without a flexible, hybrid structure. The organizational structure of the focal point is shown in Figure 4.3.

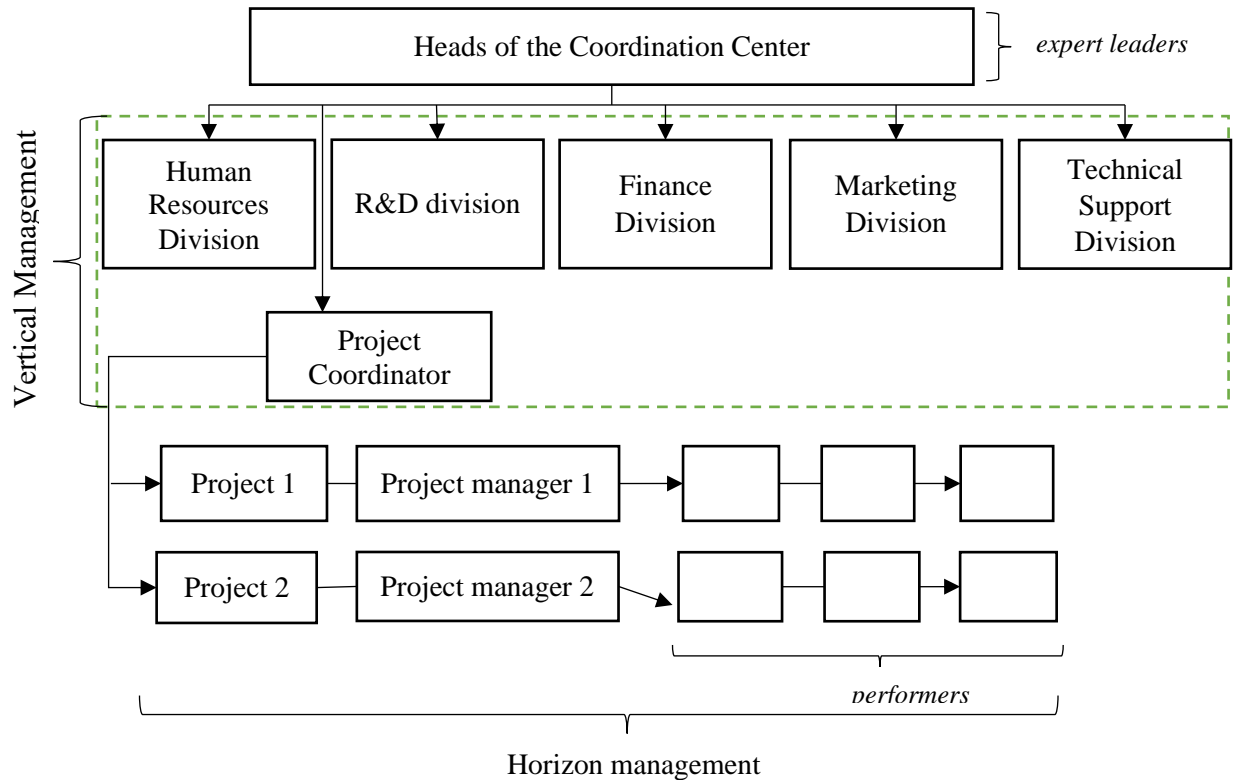


Figure 4.3. Organizational structure of the management of the coordinating center of the innovation ecosystem of a higher educational institution [developed by the author]

The leadership of the UIE focal point can be a team, which will include: managers or representatives of enterprises; head (rector) of the university and heads of departments related to R&D; local government leaders. They will make decisions on a variety of development issues affecting a variety of aspects of the UIE 's activities. The structural subdivisions of the coordination center will include managers, specialists and executors of various subdivisions of the participating organizations (including, if necessary, the introduction of contracts and third-party specialists) who will participate in joint projects.

Management side. The choice of participants is a component of the managerial side of the ecosystem management of the university. The author divides all UIE participants into two groups: external (state and regional bodies, business partners, research organizations and others) and internal (scientific staff, students involved in research work; administration and employees of structural divisions). The joint efforts of key stakeholders are aimed at the development and implementation of new products and services. The individuals and organizations involved in these collaborative efforts represent different sets of skills and priorities, and their roles are often fluid. The ecosystem approach in the organization of university research is constantly transforming, but the high level of cooperation and self-organization remains unchanged in order to commercialize

innovative developments.

One of the management aspects is the management of relations between UIE members. The literature describes various approaches for managing stakeholder relationships in an ecosystem.²³³: community governance²³⁴, adaptive management²³⁵, generative leadership²³⁶ and etc. They describe processes for managing stakeholder relationships and actions to better understand the dynamics of the innovation ecosystem.

In modern conditions of digitalization and transition to remote methods of work, some aspects of interaction within the ecosystem can also be carried out remotely. In this regard, the innovation ecosystem acquires new features: virtuality, multidimensionality, interdisciplinarity, openness and flexibility. To the university innovation ecosystem, one should apply such a characteristic as a system-forming character, that is, the ascending formation of elements and their further integration into a network, into an appropriate innovation system.

The joint activity of participants in innovative interaction will be most productive within the framework of their behavior patterns: autonomy, partnership, consensus and division of functions (Appendix 49).

Relationship management between UIE members should take into account the differences between the scientific community and business in choosing the form of technology transfer, their different interests, discuss and build these relationships on the basis of partnership, as presented in Table 4.4.

Table 4.4. Comparative characteristics of the interests of the scientific community and the industry [developed by the author]

Science community	Technology transfer	Business
Social responsibility	Professional work on the commercialization of innovations	Responsibility to shareholders
Basic Research		Applied Research
Creation of new knowledge		Development of new products
Research motivated by pure curiosity		Specific goals focused on the product
Publications and joint projects		Property rights and privacy
Sharing research materials with the business environment		Control over research materials
Science orientation		Product Orientation

²³³ AUTIO, E., LEVIE, J. *Management of entrepreneurial ecosystems*. In: The Wiley handbook of entrepreneurship, 2017, nr.43, p. 423-449.

https://www.researchgate.net/publication/318601925_Management_of_Entrepreneurial_Ecosystems

²³⁴ BOWLES, S., GINTIS, H. *Social capital and community governance*. In: The Economic Journal, 2002, nr.112, p. 419-436. ISSN 1468-0297.

²³⁵ STRINGER, L. C. et al. *Unpacking "participation" in the adaptive management of social-ecological systems: A critical review*. In: Ecology and Society, 2006, nr.11, p. 1-22. ISSN 1708-3087.

²³⁶ LICHTENSTEIN, B. *Generative emergence: A new discipline of organizational, entrepreneurial, and social innovation*. Oxford: Oxford University Press, 2014. 480 p. ISBN 978-0199933594.

Building effective relationships between universities and industry (the concept of an ecosystem of university and business cooperation²³⁷) is often quite a difficult management task. When managing university-business cooperation, it is necessary to take into account the maximum development of all possible types of cooperation between universities and commercial companies within four areas - education (knowledge transfer, entrepreneurship training), research (research support, joint research, technology transfer.²³⁸), commercialization and management (resource sharing). At the same time, it is necessary to develop innovative areas, support the most promising research at universities, discuss the provision of additional sources of funding, develop mechanisms for working between UIE participants, taking into account their behavior, the specifics of management and the level of development in the ecosystems in which they also participate.

The transfer of knowledge and cooperation between universities and other participants takes place through such types of cooperation as: joint research, contract research and technology consulting, partnership programs, staff mobility between firms and state scientific institutions, cooperation in the training of graduate students, internships to gain practical experience for students, professional training of workers, use of intellectual property rights by public scientific organizations, spin-offs, informal contacts and personal networks.

The most successful tools for working with corporations and industrial enterprises are: joint funds to finance development at an early stage; work in consortiums, etc. Universities can influence local ecosystems. This requires a concerted effort to develop relationships with local partners and communities. Cooperation can be in various areas: in developing a city development strategy, financing local initiatives, creating innovative business centers, etc.

One of the main management goals is to form new and maintain established ties between the university and business representatives, eliminate institutional barriers, and involve stakeholders. Network relationship management consists in developing a variety of activities that involve representatives of various organizations in the interaction; in database development, network analysis and mapping; participation of the university in network structures and projects (national, international).

When building mechanisms for future relationships between universities and business, it is necessary to conduct a detailed analysis of the availability of key resources (temporary, human, financial, physical, informational), types of joint activities, planned results, supporting

²³⁷ GALAN-MUROS, V., DAVEY, T. *The UBC ecosystem: putting together a comprehensive framework for university-business cooperation*. In: *The Journal of Technology Transfer*, 2019, nr. 44(4), p. 1311-1346. ISSN 1573-7047.

²³⁸ SANTORO, M.D., CHAKRABARTI, A.K. *Firm size and technology centrality in industry-university interactions*. In: *Research Policy*, 2002, nr. 31, p. 1163- 1180. ISSN 0048-7333.

mechanisms (policy, strategy, structural and operational mechanisms), external environment (near and far environment).

The scientific specialization of university research does not necessarily determine the future direction of entrepreneurial activity, as entrepreneurship often involves the application of knowledge across different fields and industries, and may arise from unexpected discoveries or innovations that were not the original focus of the research. In this process, the policy of the university plays an important role, which contributes to the identification of promising areas of research and the maximum reduction of the "incubation" period necessary to obtain results that can later be applied in practice. First of all, this is the correct distribution of intellectual property rights between the university and the direct executors of projects and an effective financing system that allows concentrating limited financial resources on the most promising areas.

The concept of leadership provides for the interaction of universities with regional (local) governance structures to shape the path of future economic development²³⁹. The main firm (if the university is the usual actor) or the university (if the university is the originator) plays a central role in the orchestration²⁴⁰ IE activities. Therefore, for the management of IE, it is important to identify the main participants and their strategic initiatives, since the opportunities for influencing the ecosystem of other actors are unevenly distributed. Successful adaptation of the university to the innovation ecosystem at the local or national level can be realized through "co-management", focused on the participation of all internal and external participants in the ecosystem.

Leadership elements characterize the managerial side within a higher education institution and include aspects such as the level of hierarchy, leadership, personal characteristics of leaders, mechanisms for delegating authority and stimulating participants in the innovation process, the ability to respond to and manage changes. Innovation ecosystems are structured around different roles and functions²⁴¹. For entities at the top level of the UIE hierarchy, it is important to clearly set strategic goals that stimulate scientific, innovative and entrepreneurial activity, as well as promote cooperation and partnership. Collaboration in management means that industry and the university cooperate at the level of management. University innovation councils often include

²³⁹ THOMAS, E., FACCIN, K., ASHEIM, B. T. *Universities as orchestrators of the development of regional innovation ecosystems in emerging economies*. In: Growth and Change, 2020, nr. 52(4). ISSN 1468-2257. [accessed 01.12. 2021]. Available at: <https://onlinelibrary.wiley.com/doi/pdf/10.1111/grow.12442>.

²⁴⁰ RUSH, N. M., HOFFMAN, K., GRAY, B. *Innovation management, innovation ecosystems and humanitarian innovation*. In: Literature Review for the Humanitarian Innovation Ecosystem Research Project, 2014, p. 1-42. [accessed 05.03. 2021]. Available at: <https://cris.brighton.ac.uk/ws/portalfiles/portal/331782/Rush+2014+Humanitarian-Innovation-Ecosystem-research-litrev+%281%29.pdf>.

²⁴¹ Idem. RUSH, N. M., HOFFMAN, K., GRAY, B. *Innovation management, innovation ecosystems and humanitarian innovation*. In: Literature Review for the Humanitarian Innovation Ecosystem Research Project, 2014, p. 1-42. [accessed 10.11. 2020]. Available at: <https://cris.brighton.ac.uk/ws/portalfiles/portal/331782/Rush+2014+Humanitarian-Innovation-Ecosystem-research-litrev+%281%29.pdf>.

business professionals²⁴² or consultants for international projects. Some universities create a board of external directors, where only the rector is an internal member. These examples characterize the transition to an open management system, which turns the university into a communication center for business, society and the state.

The role of the university leadership is to provide the necessary support, stimulate the promotion of innovation, restructure research units, allocate resources to address emerging needs and opportunities. Successful leadership of the university also lies in the organization of teamwork. The management of partner (cross-functional) teams is of paramount importance for the UIE and will provide clear lines of responsibility, flexibility of the entire organizational structure. The leadership establishes rules and regulations for coordinating and motivating innovation activities in the UIE, and should guarantee a set of interrelated processes for the commercialization of university research. University presidents must actively manage not only their universities, but also their innovation ecosystems. To do this, they must: be able to analyze environmental factors to identify their impact on the change and development of the UIE; support innovation and be the initiators of change; think strategically; champion new values and an entrepreneurial culture.

The results of an innovation ecosystem depend not only on the activities of its participants, their interest and motivation, but also on incentives. Imbalance of incentives can lead to adverse consequences²⁴³, for example, under-investment by business participants. In Israel, universities hold 70% of intellectual property - a very strong incentive to advance technology.

The implementation of new approaches to stimulate scientific developments in the field of innovation, the formation of a mechanism to stimulate the entrepreneurial activity of employees and students, patent and infrastructure support for the commercialization of innovative developments will allow higher education institutions to develop successfully.

The most successful universities use the following various mechanisms to stimulate the innovative potential of their employees and the development of entrepreneurship: positioning entrepreneurship for scientific development; the development of scientists' qualities of an academic entrepreneur along with their innovative ideas; transfer of intellectual property (IP) to the university; financial incentives for researchers (one-time payments, interest on future income, funding for research groups and laboratories, salary bonuses, etc.); non-material incentives (a system for recording success in determining the annual salary in the form of grades for articles, attracted grants, etc.); an opportunity to create a student and entrepreneurial community, etc.

Inside the university, according to the author, it is necessary to develop a certain program,

²⁴² SEPPO M., LILLES A. *Indicators Measuring University-Industry Cooperation*. In: Estonian Economic Policy, 2012, Vol. 20, Issue 1, p. 204-225. [accessed 09.10. 2021]. Available at: <https://doi.org/10.1515/tpep.v20i1.782>

²⁴³ COLOMBO, M. G., DAGNINO, G. B., LEHMANN, E. E., SALMADOR, M. *The governance of entrepreneurial ecosystems*. In: Small Business Economics, 2019, nr. 52(2), p. 419-428. ISSN 1573-0913.

with the help of which the university will involve its teachers, students, and graduate students in certain processes of creating innovations. It is very important to build such a program into a curriculum that will promote various elements of innovation, entrepreneurship, that is, those elements that students, graduate students, etc. receive. within, for example, incubators. To stimulate the entrepreneurial activity of scientists and students, it is necessary to create such tools as assistance in technology licensing, participation in obtaining public and private grants, holding student project competitions, and others. The balance between research and teaching can be changed by changing the salary structure and incentives for teachers, since incentive payments to the inventor and opportunities for additional income stimulate entrepreneurial behavior. A certain percentage of the time (for example, 10-15% of the teachers' working day) can be scheduled for participation in research projects, for generating new ideas and for conducting experiments. But since idea generators do not always have the skills to defend their ideas, managers working with an idea generator can help, encourage and support a person.

The management of innovation activities of the university provides for the implementation of the control function, which is designed to facilitate the management of the UIE from the information-analytical, methodological and instrumental side. Control contributes to the achievement of the goals of the innovative development of the university, allows you to monitor the implementation of individual stages and work of the innovation process, coordinates and synchronizes the efforts of participants, reveals conflicting trends and contradictions in their activities.

In an innovative environment that generates projects for the implementation of new ideas, it is necessary to form a new worldview, introduce the foundations of a new organizational culture. The coincidence of the values of the employee with the values of the university, which characterizes its corporate culture, guarantees the dedication and loyalty of employees to the educational institution for a long time. To do this, it is necessary to form a new worldview, new values, and improve the entrepreneurial, legal and economic culture not only of managers at all levels of management, but also of ordinary employees. Corporate culture can be transformed to reduce resistance to change, but this requires significant time and effort. It is necessary to actively work not only with employees, but also with talented youth, so that innovation can become one of the main components of the university's corporate culture. The team should have a clear understanding of the very idea of the formation and development of the university innovation ecosystem .

The author believes that when forming the UIE, it is necessary to: 1) determine the scientific directions of the university, which should include research into new promising markets based on high-tech solutions; 2) to reform the organizational structure of the university with a focus on the

commercialization of research; 3) to build an effective mechanism for managing the interaction of IE participants, which will allow for the search, selection and support for the commercialization of innovative projects.

When developing the UIE, it is important to consider: 1) to diagnose the functioning of the UIE; 2) improve UIE development management approaches; 3) evaluate the results of managerial impact on the maturity level of the UIE.

The author proposed a number of measures and developments aimed at improving the UIE management mechanism. First of all, in order to fully understand the essence of the concept of the UIE management mechanism, the author's definition was formulated: a set of processes, principles and methods that ensure the achievement of certain goals, the necessary dynamics of increasing funding, resources and connections in the process of interactions of its participants, their communities regarding the creation and commercialization innovation. However, the understanding of the mechanism would be incomplete without reflecting the composition of its elements. The author structured the elements, ranging from goals and objectives, principles, subject and object to the results of the mechanism. Each element contains its own task and is necessary for the harmonization of management.

The author's understanding of improving the mechanism for managing the university innovation ecosystem consists of a number of proposals that reflect the two sides of ecosystem management - structural and managerial. As part of the structural side, the author proposes the creation of a coordination center based on the university with its own structure of elements interaction for the implementation of appropriate management and regulation of the management process in the formation and development of the UIE. The key task of the center will be to set a system of goals for the formation or development of the UIE, formulate the principles, methods and methods of interaction between participants and other stakeholders, develop and implement a strategy for the formation and development of the UIE, and build the organizational structure of the UIE. In the context of the managerial side, the processes of managing relations between UIE participants are considered, which, taking into account the interaction, will be the most productive within the framework of their behavior models: autonomy, partnership, consensus and division of functions. The classical functions of management (planning, organization, motivation, control), the role of management, organizational leadership, culture were also considered and the features of their manifestation during the formation and development of the UIE were highlighted.

The UIE governance mechanism cannot and should not become a static process. It should be based on an evolving network that goes beyond individual organizations and institutions and is determined by the goals and values of the participants, their potential, resources, the quality of interaction and the effect achieved. At the same time, it is important to use the resources and self-

development energy of the university's innovation ecosystem core.

4.2. Development of a strategy for the formation and development of the university innovation ecosystem

It is impossible to form a management system for the innovation ecosystem in a short time, simply reproducing the relevant infrastructure facilities and institutions. However, according to the author, purposeful management of the formation and development of innovation ecosystems is justified and necessary. This goal requires a strategic approach, namely the development of a strategy aimed at developing the innovation ecosystem itself. The author has developed and proposes for implementation in universities an algorithm for creating a strategy for the formation and development of the university innovation ecosystem (hereinafter referred to as the "strategy"). In economic theory, modern approaches to creating an innovation management system and instrumental support for the commercialization of innovative products have already been formed. Among them, an important place is occupied by the strategic approach, which demonstrates its relevance and flexible adaptability.

The implementation of a strategic approach to the development of the strategy is expedient within the framework of three consecutive stages: conducting theoretical and practical research; creation of an algorithm for forming a strategy; development of a substantive component of the strategic scenarios discussed below.

Stage 1: theoretical and practical research. Strategy development traditionally begins with a study of the current situation and the factors influencing it in higher education. The development of this author's strategy is based on the process of conducting a theoretical and empirical study of the higher education system at the global and country levels. The object of the study was the system of higher education at the global level and within Israel, as well as the process of embedding the innovation ecosystem of universities into it. Also, the author in the third chapter of this scientific work studied a range of issues limited to the thematic direction of the study (assessment and management of the innovation ecosystem in universities). The structural scheme of the study is presented in Figure 4.4.

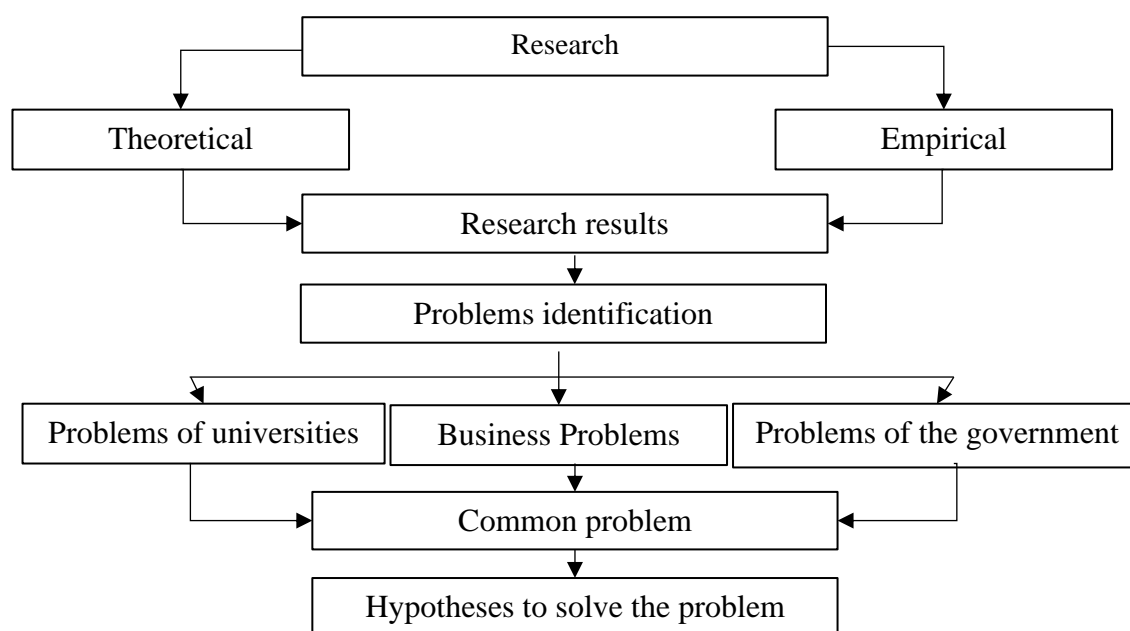


Figure 4.4. Research basis for the formation of a strategy for the formation and development of the university's innovation ecosystem [developed by the author]

Detection of the problems of the main participants (university, business, state) will determine the possibilities for the development of the innovation ecosystem, so it should be systematic and accompanied by the search for the most optimal options for changing the current situation and solving the detected problems. In addition to identifying problems, in the course of the study, the author identified the potential for the development of innovation ecosystems is the innovative potential, which shows the ability of the system to achieve the goals of innovation activities of the university and ultimately contributes to the development of socio-economic development of the region and / or country. Within the framework of various approaches, conceptually innovative potential is defined in three meanings: as a resource (a set of different potentials), as a process of creating innovations and as the final result of this process. Within the framework of the university, an effectively organized innovation process (research of opportunities, generation of ideas, promotion of ideas, commercialization), strengthening the interaction of university scientists with business representatives and authorities, entrepreneurial culture, as well as a developed research and venture infrastructure contribute to the development of the university's innovation ecosystem.

The results of the study showed that by itself, increasing the level of innovative potential of the university cannot take place effectively and naturally within the university and in the system of higher education as a whole without strategic measures aimed at this. In this case, the barriers are three groups of problems at the level of universities, business and the state. At the level of universities, the author identified problems: insufficient attention is paid to the vision, mission and values of the innovation ecosystem in the strategic plans of universities; lack of consistency in joint work with all UIE participants; the decline in the human potential of Israeli universities,

accompanied by a decrease in the share of young teachers and scientists and their entrepreneurial activity; insufficient formation of research databases. At the business level, problems were identified: lack of personnel in the field of high technologies from university graduates; weak industry competition due to the gap between the tech sector and the rest of the economy. At the state level, it is necessary to solve the problems of attracting talented young scientists to the ecosystem on the basis of migration policy; insufficient number of innovative assistance programs to expand research collaboration between manufacturing companies and academic institutions; weak motivational policy of opening your own business through an entrepreneurial culture.

These obstacles in the formation and development of the innovation ecosystem form a complex problem that needs to be solved: the presence of a certain number of already established elements of the innovation ecosystem and the relationship between them demonstrates the need for integrated strategic development with the active cooperation of all UIE participants and taking into account their interests, improving the process of exchanging information, financial and labor resources to increase the influence of the university as a leader in scientific research and commercialization of innovations on the economy and social life.

In theory, there is the concept of working research hypotheses. The author applied this method to find possible ways to solve the problem. Hypothetical assumptions were made regarding the solution of the problem associated with the development of a strategy for the formation and development of the university's innovation ecosystem:

- formation and development of IE as a conceptual system is possible in the form of a mechanism for managing the strategic development of IE;
- the formation and development of IE, as well as further improvement is possible only at the level of individual universities that have the prerequisites for the development of innovations;
- the formation and development of IE is a strategic process, therefore, in order to increase the effectiveness of this, an appropriate strategy with the classical structural elements inherent in any management strategy is necessary.

As solutions are developed in the context of the strategic approach to the formation and development of IE, the author will confirm or refute the hypotheses presented.

Stage 2: creation of an algorithm for developing an IE formation and development strategy. The second stage of strategy development is to create an algorithm, which is schematically presented in Figure 4.5.

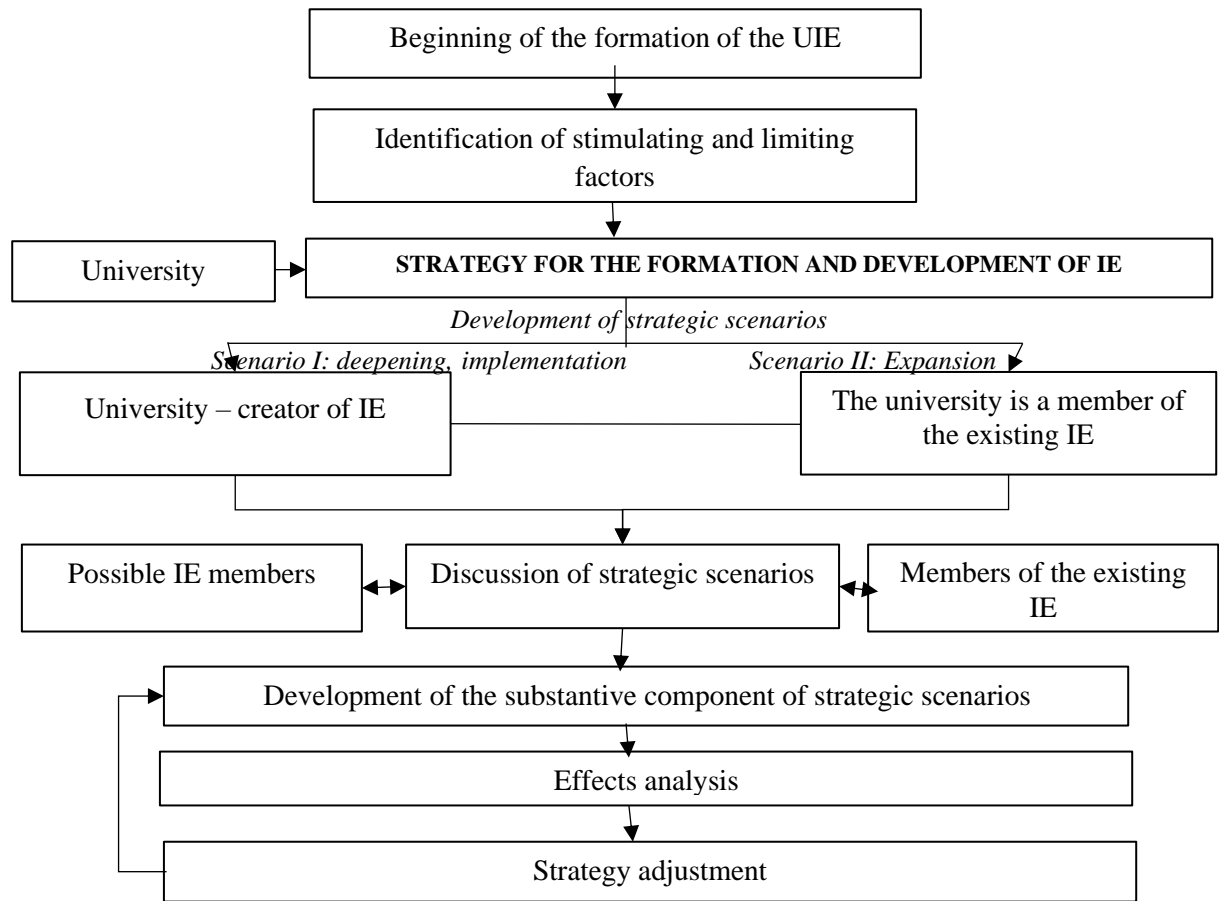


Figure 4.5. Algorithm for developing a strategy for the formation and development of the university's innovation ecosystem [developed by the author]

In the presented algorithm, the formation of the strategy begins with the analysis of the influence factors, as well as the identification of limiting factors that act as research boundaries. Based on the methods of strategic analysis (Porter's model of competitive forces, PEST-analysis, SWOT-analysis), the survey method, expert assessments, the author identifies the limiting (limiting, constraining) factors for the development of innovation ecosystems of the university. These include the insufficient level of compliance of subjects with the requirements of innovative development of the university and the region / country. This means that there is no single concept for the development of the UIE; lack of common understanding by ecosystem participants of the opportunities and challenges of ensuring the growth of the ecosystem; low organizational flexibility in the productive cooperation of UIE participants; insufficient formation of research databases is reflected in the analysis of the process of functioning of the UIE. Also, the limiting factors include territorial, temporal and resource aspects.

The strategy for the formation and development of the innovation ecosystem should be interrelated with the main goal of the university and be formed directly when developing the overall development strategy of the university. The strategy of the university (development

strategy) involves the advanced development of research activities as the basis for personnel training. The development strategy of the university determines and orients the strategy for managing its innovative activities, i.e. sets the foundations of its formation and essence. In turn, the strategy of innovation in dynamic communication deepens, clarifies and contributes to ensuring the strategy of the university. They make up an integrated whole.

Transformation of the ecosystem approach in the development of a strategy for the formation and development of the university's innovation ecosystem involves:

- 1) creation of an innovative and receptive management structure not only for scientific and innovative activities, but also for the entire university as a whole;
- 2) organization of research, development and marketing management subsystems; development of strategy, functions and principles of management of innovation activities of the university;
- 3) development of a motivation system, involvement of relevant scientific and educational organizations and enterprises on the basis of the organization of effective interaction within the framework of the created innovative alliances, consortia;
- 4) creation of a favorable environment for the exchange of information and knowledge between the participants of the innovation ecosystem, including the development of specialized platforms, the creation of platforms for strategic cooperation;
- 5) development and stabilization of interaction between existing and potential participants of the innovation ecosystem;
- 6) development of mechanisms for expanding the financing of innovative cooperation;
- 7) providing conditions for the creation of viable results of intellectual activity and their subsequent implementation.

There are two possible scenarios for the formation and development of the UIE:

1. Universities are active creators of innovation ecosystems, forming networks that physically and virtually connect people with different knowledge from different industries and other fields of activity, both in physical and virtual settings. The development of the innovation ecosystem is a complex and multi-stage process. At the same time, attention must be paid to every aspect of the ecosystem.

2. The university is included as a member of one or more IE (region, country, industry, etc.). The participation of universities in the ecosystem is diverse and aimed at accelerating the development of innovation and technology transfer, namely: they conduct basic research that stimulates long-term innovation; help its employees, students and graduates to develop and test new ideas by providing technical tools, entrepreneurship programs, creating accelerators and even venture funds. In other words, the university must meet the needs and capabilities of the innovation

ecosystem in which it belongs. According to the author, it is explained by the fact that fundamental research serves as building blocks for long-term innovation. It creates the knowledge and tools needed to solve complex problems. By investing in fundamental research, scientists and innovators can gain insight into new phenomena and develop new theories and models. Furthermore, to create new technologies that can have a transformative impact on society.

In accordance with the above scenarios, the strategy of the university can be of two types: the strategy for the formation and development of IE on the basis of the university; strategy for integrating the university into the existing IE. Each of the strategies has its own goals, objectives, principles of formation and development. The complexity of the formation of the strategy is due to the fact that, on the one hand, it should determine the general vector of development of the ecosystem, on the other hand, to ensure the coordination of actions and the balance of values and interests of its participants. In addition, it should provide for the effective dynamics of the process of innovative activity of universities and reproduction at the enterprises of the region in terms of qualitative characteristics (foresight of changes in the subject area of innovation) and the development of solutions to ensure sustainable development. Appendix 50 outlines the possible main elements of the university's management strategy (mission, vision, goal and strategic directions) for the two scenarios of the formation and development of the UIE.

When developing a strategy for the formation and development of the UIE for both scenarios, the following principles of its formation must be observed:

- 1) the strategy should not contradict the general strategy of the university, the strategy of regional development and the strategy of the IE member enterprises;
- 2) the strategy should be developed taking into account the leadership and interest of all participants in the development of innovations and the relationships between them;
- 3) the strategy should correspond to the resource and potential capabilities of the university and other participants;
- 4) the strategy should be based on research potential, information security, consulting, expertise.

When developing a strategy, university management may encounter many alternatives, which are based on typical strategies and their numerous modifications. The strategy should be based on certain factors and tasks that the university sets itself in order to achieve a reliable advantage among competitors, taking into account real opportunities and infrastructure. At the same time, it should take into account the specifics of managing strategic (i.e. large-scale and long-term) changes in the university, organizations and business ecosystem that are part of the innovation ecosystem.

Discussion of strategic scenarios should be held with future participants of the UIE: representatives of the region or the innovation ecosystem where the university integrates. According to the first scenario, the creation of an innovation ecosystem will contribute to the transition of relations between the university and the regions to a qualitatively different level. Regional authorities, seeking to ensure the economic growth of their territories, understand that the most competitive resource today is knowledge turned into innovations. The university itself should become an institutional environment for innovative ideas and a new type of relationship with government and business. According to the second scenario, the participants of the existing innovation ecosystem expect new ideas and developments, new start-ups and innovative activity from universities. The success of the developed UIE strategy and the effectiveness of the planned activities should be assessed in terms of the extent to which the activities of higher education institutions meet the expectations and needs of society and individual stakeholders. Therefore, the strategy should take into account as many success factors as possible in the implementation of the strategy and its creation is a complex, multi-stage and iterative process.

In order to maintain a consistent description of the strategy development algorithm (Figure 4.5), the stage of the content component of strategic scenarios as its element will be considered by the author below.

The algorithm for developing a strategy is completed by analyzing the effects. For this purpose, the Balanced Scorecard (BSC) methodology discussed by the author in paragraph 4.3 may be used. The BSC will allow the top management of the university to focus on achieving the strategic goal in the field of innovation, to monitor on an ongoing basis, to analyze and evaluate the activities of the UIE taking into account market requirements. This methodology allowed the author to develop a list of indicators for assessing the development of the university's innovation ecosystem by its functional components, the integral development index UIE. The algorithm developed by the author to assess the development of the innovation ecosystem will improve the process of managing and controlling the development of the university's innovation ecosystem. The effectiveness of managing the development of the university's innovation ecosystem depends on the relevant choice and adequate application by the performers of a variety of methodological tools for managing processes at each specific place at a certain time. The key effects in the use of the ecosystem approach in higher education are expressed by increasing the level of research and innovation activities, increasing the number of joint projects and the compliance of the educational process with new trends. All this becomes possible thanks to the involvement of experts from organizations acting as representatives of the external environment in the educational, research, innovation and entrepreneurial processes of the university.

Adjustment of the parameters of the strategy is made depending on the factors of the macro-

meso-, microenvironment.

Stage 3: development of the substantive component of strategic scenarios.

For both scenarios of creation and development of UIE, the author identifies the following criteria for determining the role of the university in the innovation ecosystem: the socio-economic context of the implementation of the strategy, incentives for the transformation of the university, the central organization in the ecosystem, the role of the main participants in the ecosystem.

Consider the substantive components of the first strategic scenario - the university as the creator of the innovation ecosystem. An innovation ecosystem can be created within the framework of the university in order to reveal its innovative potential and consolidate potential participants in innovation processes into a single ecosystem. The creation of an innovation ecosystem is a complex and integrated activity that creates conditions and prerequisites for improving the quality of life of the population in the region.

Table 4.5. Characteristics of the university's strategy as the creator of the innovation ecosystem [developed by the author]

Criteria	Content
Socio-economic context	Regions are weak economically and politically
Incentives for transformation	Transformation of the university in order to promote innovations for the socio-economic development of the region
Central organization	University
Roles of key stakeholders	The university is the leader, the rest of the participants are members of the ecosystem

The strategy of the first scenario is a pre-planned reaction of the university to the change in the external environment, the line of its behavior chosen to achieve the desired result in the context of innovative development. This strategy is formed in the conditions of economically and politically weak regions, so the university takes a politically neutral position. The University has accumulated knowledge, experience in research activities, broad and long-term connections in the local community. Under these conditions, the university becomes an orchestrator (central organization) and builds a regional innovation ecosystem around it self through the use of its unique resources. At the same time, close interactions with business and local communities are established. The strategy should be formed around the main activities of the university and its attitude to innovation, aligning interests in order to maximize the strengths of each partner.

The goal of the university's strategy is to become a leader in entrepreneurship and innovative development of the region, to develop and manage the innovative network community, to influence the activation of local innovation ecosystems. Objectives: to develop entrepreneurship and innovation in the region; to unite potential participants in innovation processes into a single

ecosystem in order to jointly create innovations; to develop innovative potential for the socio-economic development of the region.

Strategic measures: development of professional training programs; selection, attraction and training of creative people to create their own business and start-ups; creation of an entrepreneurial environment and entrepreneurial culture at the university to create entrepreneurial competencies and support and encourage initiatives; development of innovative potential both at the university level and at the regional level, contributing to the promotion and implementation of regional developments; focusing the university's R&D in a specific area and becoming a partner for other universities and high-tech business; attraction of technology companies to the territory of the university and creation of favorable conditions for their activities.

To ensure the viability of the ecosystem, the university helps to unite the efforts of other ecosystem participants, spending its capital on it: intellectual, reputational and financial. This has a beneficial effect, in particular, on job creation, overcoming the employment crisis, activating the socio-economic growth of the region, etc.

The second scenario in the development of the strategy considers the university as a participant in the existing innovation ecosystem. Integration of universities into the innovation ecosystem is possible in several main areas:

- 1) production of new knowledge through research activities and the use of the potential of new technologies;
- 2) transfer of knowledge through education and development of human resources;
- 3) contribution to the social and cultural development of cities, regions and the country as a whole;
- 4) promoting the development of innovations at the regional and national levels.

Analysis of the actions of universities in different countries seeking to transform their roles in the innovation ecosystem allowed the author to identify four strategies for the university's behavior as a participant in the existing innovation ecosystem. According to the author, the strategy dictates the behavior of the university when entering the existing innovation ecosystem. Options for university behavior strategies that are integrated into the existing innovation ecosystem at different levels (city/region/country) are presented in Figure 4.6.

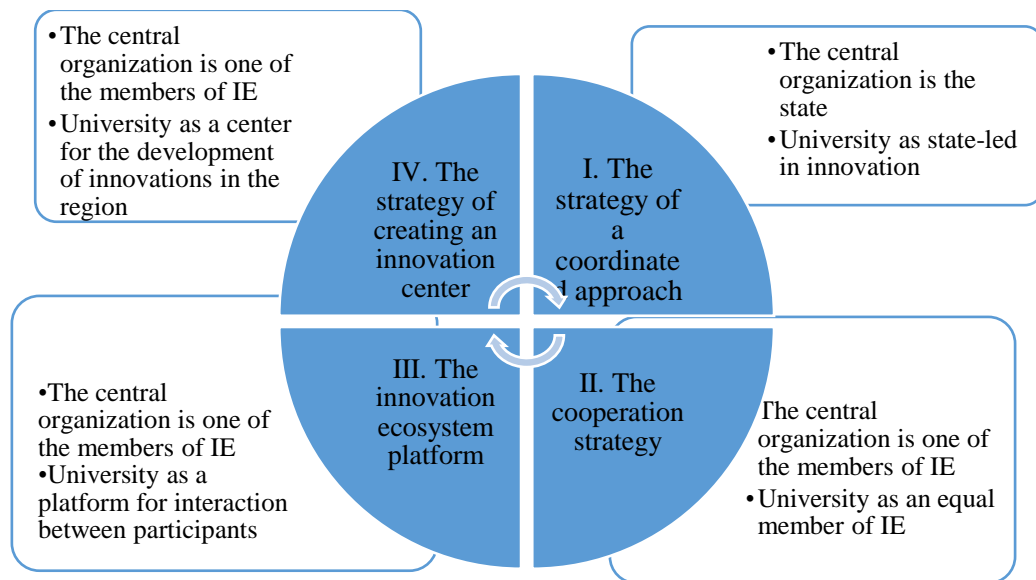


Figure 4.6. Strategies of the university's behavior as a participant in the existing innovation ecosystem [developed by the author]

The strategies presented in the diagram characterize the sequence of manifestation of the university's activity as a participant in the ecosystem (ascending from the conditionally passive role of the university to the active one). Under the innovative activity of the university, the author understands the effectiveness of interaction between the subjects of the UIE. The author considers the university's behavioral strategies when entering the existing innovation ecosystem.

I. A strategy of a coordinated approach is possible in the context of a significant role of the state, capable of determining the innovation policy and development of territories and implementing all this in practice. The government is creating a dense network of centers of university-industrial cooperation, relying on those universities that are deeply integrated into regional innovation structures. As a result, universities act as a tool for implementing the economic policy of the state. The characteristics of the strategy of the coordinated approach of the university on the basis of the selected criteria are presented in Table 4.6.

Table 4.6. Characteristics of the strategy of the coordinated approach of the university [developed by the author]

Criteria	Content
Socio-economic context	A strong state that determines innovation policy and territorial development
Incentives for transformation	Additional funding (public and private) for R&D
Central organization	Government
Roles of key stakeholders	The state initiates the creation of regional innovation ecosystems; participants (including the university) are guided by state interests and plans in the field of innovation

The state plays an important role in the formation of IE, since it is on it that the dynamics of the development of the national IE depends. Thanks to the developed national IE, IE of lower

levels will develop. Regional ecosystems are the basis of national ecosystems and should ensure the implementation of state innovation policy at the regional level. At the same time, the state creates appropriate conditions and acts as a guarantor of stable interaction between the scientific and educational complex, which generates new knowledge and technologies, and business that produces new products. To conduct research, the university receives funding mainly from the state, but is also looking for additional sources. With the support of the state, universities can form scientific communities, which will include not only scientists and managers, but also investors.

The purpose of the strategy of the coordinated approach is the integration of the university into regional innovative structures created by the state for the development and improvement of the effectiveness of scientific research and innovative developments.

Objectives: to develop a mechanism for generating knowledge and tools for implementing innovations in the region; to develop a concept for integrating strategic management and knowledge management based on the mechanisms of interaction of participants in the ecosystem; become a member of the network of centers of university-industrial cooperation.

Strategic measures: increasing the value of knowledge as a key factor in the competitiveness of the university; the transformation of entrepreneurship into an academic science; the development of a comprehensive entrepreneurial culture; building closer and longer-term relationships with business with the assistance of the state (reducing unnecessary bureaucratic barriers, creating additional incentives); making a contribution to the development of the region, as well as the integration of education, science and production, creating conditions for the emergence of high-tech technologies.

II. The cooperation strategy provides for a model of the university's behavior as a participant in the already established regional innovation ecosystem. At the moment, universities are perceived as a source of talent and entrepreneurship, and are also key actors that stimulate regional development. The characteristics of the university's cooperation strategy are presented in Table 4.7.

Table 4.7. Characteristics of the cooperation strategy [developed by the author]

Criteria	Content
Socio-economic context	The region has an established ecosystem, an economically developed environment demands innovations, and is able to
Incentives for transformation	Cooperation between universities and business is the key to successful innovative activity of the region
Central organization	One of the ecosystem participants
Roles of key stakeholders	All participants of the ecosystem have equal opportunities to create and implement innovations in the region

This strategy can be developed and implemented in an economically developed and politically stable environment in which there is a demand for innovations and the possibility of

their implementation in the business environment and society. The innovation ecosystem is actively developing and contributes to improving the quality of life and well-being of the region. The university first needs to enter the already established ecosystem as a useful actor and gain recognition of its actions by local communities. After a certain time, the boundaries between universities and industries, science and technology, private and public institutions are blurred, giving rise to a system of multiple intersecting connections.

The purpose of the cooperation strategy is to develop new forms of cooperation and to take the leading role of the university in creating innovations.

Objectives: to formulate a strategic vision that will determine the impact of the university on the innovation ecosystem of the region through education, research, academic entrepreneurship; adapt the innovation management system of the university to solve various problems of the ecosystem based on project technologies and the design and network approach; Promote innovation at the regional and national levels.

Strategic measures: increasing innovation activity based on the joint work of the university with business in the region; providing access to university differentiated knowledge as a source of new ideas; creation of joint projects of sectoral and intersectoral level, joint scientific and technological parks; transfer of knowledge through education, research and human resource development; joint R&D and commercialization; the use of modern information technologies in the implementation of research projects; consulting activities of universities to solve certain problems of IE member companies; exchange of information between ecosystem participants and discuss intermediate and final results of scientific research even before their publication in scientific journals; participation of the university in management activities (membership of university representatives in the boards of directors of enterprises, and vice versa - membership of business representatives in academic councils of universities); participation of the university in the development and implementation of regional programs for the socio-economic development of the region on the basis of cooperation with regional authorities.

III. The innovation ecosystem platform strategy provides an opportunity for other ecosystem participants to develop their innovative products and services. The platform becomes a place of interaction and exchange of breakthrough ideas between various departments of the university, high-tech companies and other interested actors.

Table 4.8. Characteristics of the platform strategy [developed by the author]

Criteria	Content
Socio-economic context	Developed knowledge-intensive regions
Incentives for transformation	Transformation of the university in order to create the most favorable space for joint work of a wide range of participants

Criteria	Content
Central organization	A university or one of the participants who has the resources to create a platform
Roles of key stakeholders	The university organizes the process of coordination of open innovation activities, and each participant of the platform as a user brings additional value to it, contributing to the emergence of a

The University creates a platform in developed science-intensive regions, becoming a place of interaction for a wide range of ecosystem participants, a place for generating innovative projects in demand by the high-tech sector of the economy, an institute of scientific and methodological support for innovative projects implemented by the enterprises themselves. Such a platform allows initiating innovative projects both in educational activities (for the training of innovative personnel) and in the sphere directly related to the innovative development of the region's economy, to develop and implement innovative products, promotes the exchange of information, knowledge and other resources. Users of the platform are responsible for the creation of products, and consumers (platform entities) are its other participants. Based on the platform strategy, university employees have additional tools and motivation for the commercialization of innovative ideas, and the university has the opportunity to develop commercial activities (for example, the creation of subsidiaries on its basis).

The purpose of the strategy of creating ecosystem platforms on the basis of the university is to attract various participants and create favorable conditions for their interaction, contributing to the intensification of innovation activities and the implementation of innovations.

Objectives: to develop a mechanism for coordinating open innovation activities and joint production of innovations on the basis of the university; create conditions for joint work of representatives of universities, business and government agencies; increase the investment attractiveness of the research and development sector through the creation of an entrepreneurial platform.

Strategic measures: creation of the most favorable collaborative environment (spaces for joint work, special scientific and technological centers, project offices, technopark, scientific buildings, international laboratories, business incubators, etc.); providing additional services to users in order to develop partnerships between universities and business; embedding the university's strategy in the context of the "knowledge triangle"; development of a program for the formation of competencies necessary for the implementation of open innovations, and assessment of the level of these competencies; involvement of a wide range of participants; strengthening user orientation in order to realize the market potential of new products and services; organization of an open format of innovation processes using new forms and methods of value creation; integration of diverse knowledge bases, participants and technologies through remote (online) and direct

contacts, commercialization of results; development of open innovation and co-production; development of effective collaboration of the university with companies and the public to implement the innovative experience of teachers, mentors (mentors), representatives of business, industry and state innovation policy in the field of ensuring the personnel component of the introduction of innovations; creation of additional opportunities to stimulate scientific and educational activities, innovation processes, development of partnership between producers and consumers on the basis of knowledge; development of tools for assessing (measuring) the results obtained (including intangible effects of flow and investment in the production of new knowledge), service specifications and the formation of integrated service offerings adapted to the needs of target groups in relevant regional innovation ecosystems.

IV. The strategy of creating an innovation center is based on the positioning of the university as the core of IE at the regional level, since it is the source of personnel and ideas in a rapidly changing technological environment. Innovation centers in the region are often entrepreneurial universities, which differ in structure, stimulation of entrepreneurial activity, diversification of funding sources, research and teaching practice, expansion of ties with communities and organizations outside the university, corporate culture (focus on innovation, creativity, interdisciplinary problem solving).

Table 4.9. Characteristics of the strategy of creating an innovation center [developed by the author]

Criteria	Content
Socio-economic context	Relatively prosperous socio-economic and political conditions, society is aimed at the development of entrepreneurship
Incentives for transformation	Transformation of the university in order to meet the modern needs of society
Central organization	One of the ecosystem participants
Roles of key stakeholders	The university is one of the important elements of the entrepreneurial ecosystem, and the consumers of the results of its activities are other participants in the ecosystem (state, industry and civil society)

To implement this strategy, a relatively prosperous socio-economic and political environment is needed, in which society actively supports the development of innovation and entrepreneurial activity in the region. As part of the strategy, the university acts as an important element of the entrepreneurial/innovation ecosystem and plays a strategic role in shaping competitiveness in the local market. Its strategy is an integral part of the region's broader economic development strategy. The state, industry, civil society as participants in the ecosystem are consumers of the results of the activities of the entrepreneurial university.

The goal of the innovation center strategy is to become a center for the development of entrepreneurship and innovation in the region for mentoring and commercialization of research

through the implementation of relevant educational programs (including entrepreneurship), the development of research activities and the strengthening of regional innovation ecosystems.

Objectives: to form entrepreneurial and innovative thinking and behavior in future specialists; establish joint research groups with industries and companies to participate in joint projects; develop partnerships and build network interactions for the transfer of knowledge and technology.

Strategic measures: introduction of various tangible and intangible initiatives to encourage entrepreneurship; use of modern educational and managerial practices and technologies, subsequent transfer of knowledge and technologies through cooperation with business; involving students in projects that create opportunities for entrepreneurial activity; development of measures to achieve the degree of unity of values of ecosystem participants and clarity of understanding of their key factors (development trajectory, understanding of competitive advantages, methods of achieving goals, ways to assess results, priorities of activities, the presence of joint values, etc.); providing an opportunity to incubate ideas, connect researchers with industry, and create mentoring between participants and universities or industry leaders; implementation of joint research activities regardless of the source of funding; increasing the level of commercialization of university innovations and creating spin-of-startups; mobility of personnel for the implementation of various projects (within the framework of the mobility program, business specialists are involved in research activities at universities, and university employees have the opportunity to work for several years in the real sector (work in a company as part of a sabbatical or official secondment); academic and student entrepreneurship (creation of spin-off companies by teachers or students of the university); joint use of resources (infrastructure, personnel); support with parties of enterprises (donations, sponsorship, scholarship programs for teachers and students).

Based on the analysis of the university's behavior strategies for any scenario (the university as the creator of the IE and the university as a participant in the existing IE), the author believes that the strategy of the university's innovation ecosystem forms the main directions of its development to achieve its goals. The main strategic vectors for the development of the university innovation ecosystem should be active innovative activity within the university and at the level of the region / country, the creation of comfortable conditions for the developers of ideas in the implementation of their scientific activities, the involvement of representatives of the business environment in the educational and research process, the introduction of a new system of practices and internships for students in partner companies; implementation of design and research work on the orders of enterprises; The solution of these problems requires serious transformations within

the university itself, including the following aspects: product, resource, managerial and organizational.

The formation of the strategy should be based on the formation of a goal-setting system and growth points (strategic projects), the definition of challenges and mechanisms for implementing the innovation strategy of both the university and the region. This will allow you to introduce innovations in real time, taking into account any specifics of the university and the territory on which it is located.

Regardless of the chosen scenario for the formation and development of UIE, the university is turning into an active participant in the economic development of the territory, a center of attraction for talents and an expert platform for the business community of the region. At the same time, he acquires additional opportunities for his own development. Different performers can take part in the development of the strategy.

The strategy for the formation and development of the innovation ecosystem according to the first scenario is developed at the university level. A structure should be formed, which will include various participants (representatives of business, state, etc.). The UIE governance mechanism is implemented within this framework in two ways (sequential stages):

- 1) improvement of the existing organizational structure of the department of innovative development of the university;

- 2) development of the department structure into a separate infrastructure unit (specialized unit) in the overall organizational structure of the university.

These ways are recommended by the author to implement consistently, to start with the modernization of the existing structure, and as needs arise, opportunities grow and areas of innovation develop, create an autonomous unit in the overall organizational structure of the university.

Organizational mechanisms to support a university's innovation ecosystem may include different departments (research units, technology transfer support units, business development units and companies, and others) or centers. Their responsibilities may include: registration of scientific and technological, innovative and educational priorities, development of university partnerships; providing prognostic support for the scientific and technological development of the university; coordination of foresight and development of forecasts by the inter-university community; support of the university-wide project management system; development and promotion of innovative ideas and new enterprises, assisting them at the earliest stages of their emergence through training and providing information, consulting, legal and other services.

The strategy for the development of the innovation ecosystem according to the second scenario (integration of the university into the existing IE) can be developed by an orchestrator,

manager or a key company. Ecosystem leaders work with the university to align academic expertise and strategic priorities with the region's long-term goals. Therefore, when developing a strategy, it is important to have a consensus of IE participants in order to maintain the essence of the common goals and strengthen strong relationships throughout the partnership. The strategy coordinates knowledge flows, taking into account the problems (risks of initiative, interdependence and integration) inherent in joint networks, and reflects the strategic directions of ecosystem development. The university, together with a key company, is focused on the generation of knowledge, since IE includes interrelated heterogeneous and knowledge-intensive companies. Strategic alignment contributes to the processes of commercialization of research, the development of academic entrepreneurship, the transfer of technologies and innovations, the creation of start-ups. The development of entrepreneurial culture is becoming one of the strategic directions of academic entrepreneurship at the university.

As you know, IE from a strategic point of view is something that tends to lose relevance, modernity, despite the presence of innovations. Therefore, the process of forming a management strategy and evaluating the effectiveness of IE's work has a final point. The author proposes to solve this problem through strategy remodeling. The idea is to give the development process of IE a cyclical character, similar to the life cycle of a product. Hence the concept of cyclical development of the university innovation ecosystem , since it is associated with the process of knowledge generation, its dissemination and use (Figure 4.7).

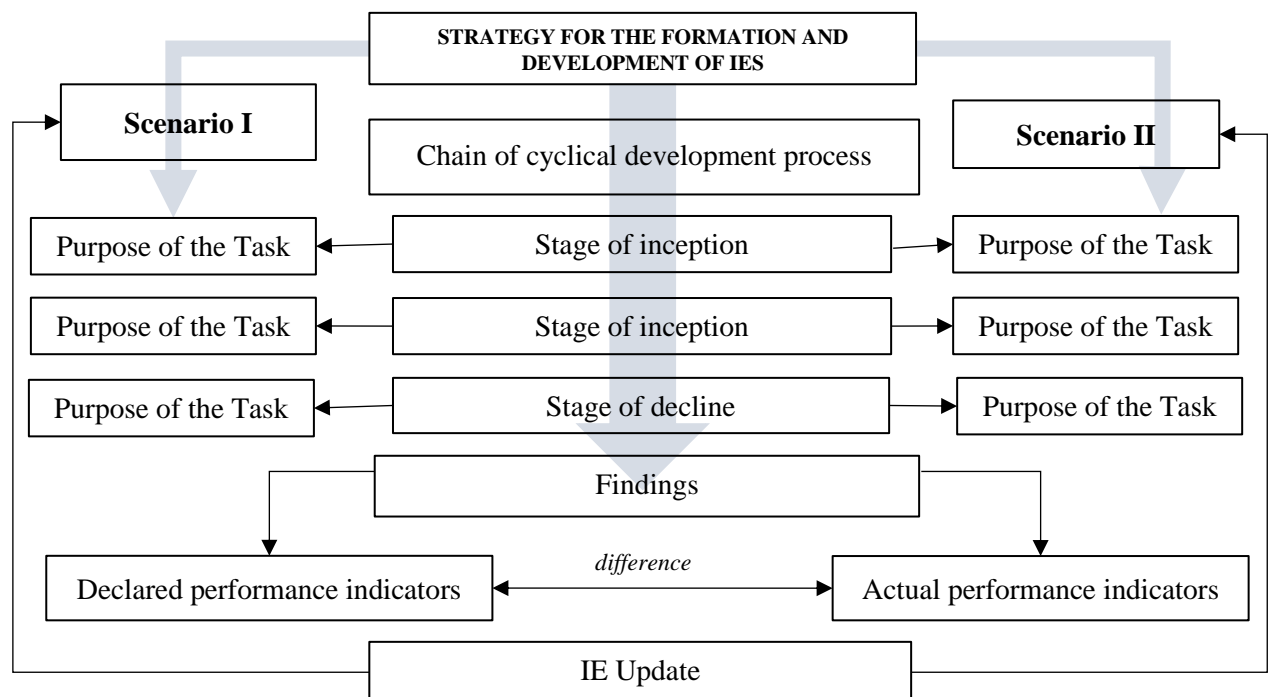


Figure 4.7. Scheme of scenarios for the formation and development of the innovation ecosystem at the stages of the life cycle [developed by the author]

Among researchers, there are different approaches to life cycle definitions. The paper considers the most common three stages of the ecosystem life cycle: nucleation (formation), development and decline. The interaction between the university and its environment is co-evolutionary: the role of the university changes depending on the stage of the life cycle of the innovation ecosystem. The strategies developed by the author of two possible scenarios for the formation and development of IE have different goals, objectives and strategic activities of the university at different stages of the ecosystem life cycle.

The process of forming an innovation ecosystem is a dynamic process that begins from the stage of inception and ends with the stage of decline, but due to transformation, the innovation ecosystem can move into a new configuration through renewal. At the same time, the innovation ecosystem as a self-regulating system has its own development mechanisms that ensure the dynamism and continuity of the innovation process. The management cycle of the ecosystem should be focused on achieving a balance of preferences of the participants in the interaction. The intensity and duration of the relationships between ecosystem participants depends on the ability to build partnerships, since the development of each organization is determined by the results of the functioning of the others.

The outline of the goals and objectives of the university's strategy as the creator of the innovation ecosystem (the first scenario) and the university's strategy as a participant in the existing innovation ecosystem (the second scenario), taking into account its life cycle, are given in Appendix 51, 52.

At the stage of the birth of the ecosystem, it is important for the university to increase resources and concentrate them for certain areas of innovation. Various contradictions may arise between the university and other IE participants, so when developing a strategy, it is necessary to take into account the interests of each participant in the ecosystem. The beginning of the formation of the network community is also characterized by the formation of contractual relations between the participants of the IE. The management cycle of the ecosystem at this stage should be focused on achieving a balance of preferences of the participants in the interaction. The intensity and duration of the relationships between ecosystem participants depends on the ability to build partnerships, since the development of each organization is determined by the results of the functioning of the others.

At the development stage, many participants seek to join the interactions, which is reflected in the growth of the number of connections in the ecosystem. If there are no restraining (limiting) factors, then the growth of participants occurs in a shorter time. At the same time, there may be a slowdown in the growth of the number of activities, which indicates the maturity of the ecosystem. The institutional mechanism of interaction of participants at this stage includes: building a strategic

profile and determining the resource capabilities of the ecosystem; development of a strategy based on the principles of communicative planning; selection of the required forms of integration of participants and diversification of management tools; transition from competition to stakeholder partnership; reorientation of labor in the region – increasing the overall level of education and qualification of human resources.

At the stage of ecosystem decline, there is a breakdown of connections and the exit of participants. The reasons may be the growth of internal conflicts between the subjects of IE, the limitation of the potential of the region, a decrease in confidence in the successful innovative development of the territory. Innovative activity of participants grows more slowly than the amount of resources spent.

Under the influence of internal and external factors, the ecosystem changes. The renewal of the ecosystem is characterized by the degree of its ability to adapt. A successful update requires: an interest in innovation and the interconnection of UIE participants; demand for innovation; opportunities for the implementation and development of UIE functional areas; resource and information security, support, consulting, expertise; institutional conditions (level of technology, level of specialists of a certain qualification and specialization, financing, legislative system, geographical location).

The progressive development of the innovation ecosystem is ensured by the presence of a positive trend in innovative activity. Since the composition of the UIE is not constant, it is therefore advisable to judge the effectiveness of the system by the magnitude of the innovative activity of the university as a permanent and central element of the system. The magnitude of innovation activity is an indicator of the effectiveness of the interaction of system participants (if there is a positive trend, then the system's activity is recognized as successful, and vice versa). Increasing the innovative activity of the university ensures an increase in the efficiency of using the resources of the participants in the innovation ecosystem and helps to strengthen ties between its participants.

The activity of universities in the development of the innovation ecosystem, according to the author, changes at various stages of its life cycle. The innovative activity of the university, which affects the strategy of the university, varies from minimum to maximum. The strategies discussed above can be arranged on a scale that goes from the conditionally passive role of the university to the active one (Figure 4.8).

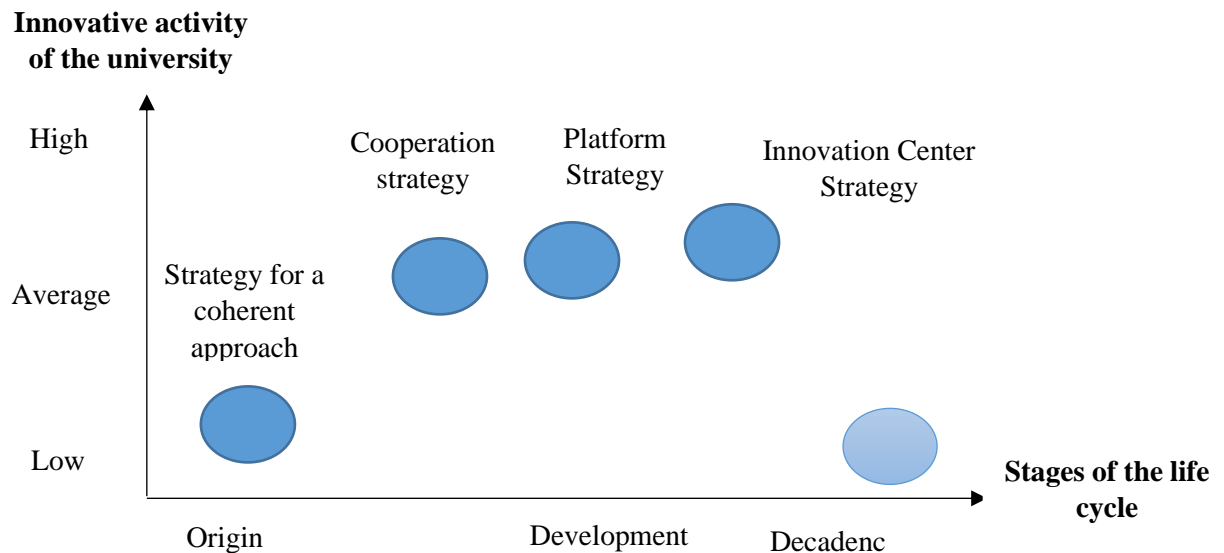


Figure 4.8. Activity of the university at the stages of the life cycle of the innovation ecosystem within the framework of development strategies [developed by the author]

The magnitude of the innovative activity of the university as part of the existing ecosystem at the initial stage of integration of the university into the existing ecosystem is insignificant. According to the strategy of the coordinated approach, the university needs to adapt to the conditions of the IE and the general rules of interaction in it, establish partnerships and be guided by the innovation policy of the state.

Innovative activity of the university increases at the stage of development of IE. Each subject of the UIE fulfills its role, the methods of work are established, the magnitude of communications is almost maximum. The university actively promotes university innovations, has the amount of resources sufficient to perform a large amount of knowledge and innovations of various scientific orientations. It becomes a leader in innovation activity in the region, so it determines the strategic directions for the development of not only the UIE, but the economy in this territory. Strategies for cooperation, creation of platforms and innovation centers are determined by the degree of involvement of universities in the innovation processes of the region, internal and external environments, as well as the goals and objectives facing the educational institution.

Currently, universities are undergoing a profound transformation of strategic orientation, recognizing the need to adapt and more effectively use knowledge in the field of innovation for the market and society. Entrepreneurial universities act strategically as creators and disseminators of new knowledge, organizers of interdisciplinary and extraordinary actions for the application of knowledge, as well as intermediaries in establishing links between universities and industries. They develop a strategy for the formation and development of the ecosystem, depending on the chosen scenario (the university as the creator of the UIE or as a participant in the existing IE) in order to promote the dissemination, application and use of knowledge and technologies. In this

regard, the author offers all stakeholders in the field of innovation ecosystems the passage of successive stages (conducting theoretical and practical research; creating an algorithm for forming a strategy; developing a meaningful component of strategic scenarios) creating a strategy for the formation and development of the university's innovation ecosystem.

A special role in the formation of the UIE is played by the algorithm proposed by the author to create a strategy for the formation and development of the university's innovation ecosystem. The algorithm includes certain elements: identification and analysis of the limiting factors of the study, strategic goal-setting, formation and discussion of strategic scenarios for the formation and development of the UIE, analysis of effects and adjustment of strategy. Scenarios are considered in the context of goals, objectives and strategic activities. The first scenario (the university as the creator of the innovation ecosystem) is a pre-planned reaction of the university to the change in the external environment, the line of its behavior chosen to achieve the desired result in the context of innovative development. The second scenario (the university as a participant in the existing innovation ecosystem) includes the university's behavior strategies developed by the author, reflecting varying degrees of innovation activity. Innovative activity consists in effective interaction between the subjects of the UIE in order to implement strategic measures aimed at fulfilling the goals and objectives of the strategy. The activity of the university is manifested at the stages of the innovation ecosystem life cycle (origin, development of decline) within the framework of a certain strategy. In addition, the author proposes practical strategic measures that require practical implementation during the passage of the stages of the life cycle.

4.3. Assessment of the development of the innovation ecosystem of higher education institutions

To assess the development of the UIE, a measurement tool is needed. The goal of assessing the development of the university ecosystem determines its methodology, a set of indicators, and the selected procedures. By assessing the state of the UIE, it is possible to outline further ways for its improvement and development. Actions involve significant changes in the structure of the university, its staff, curricula, teaching system, as well as research activities.

The research profile of universities is unique, complex and multidimensional. The objects for evaluating the development of ecosystems are their various components: R&D, participants, network interactions, finance, infrastructure, human capital, support system, sociocultural context, various conditions, etc. indicators that are not always directly measurable. The system of indicators of the innovation ecosystem can show the research potential of each specific university in the commercialization of science and technology transfer, strengthening their entrepreneurial activity, as well as integrating their academic and entrepreneurial components into the national and global

innovation ecosystem. Developing a system of indicators for the university's innovation ecosystem is important as it allows for monitoring and evaluating the effectiveness of the ecosystem in fostering innovation and driving economic growth.

The system of evaluation indicators of the innovation ecosystem of universities should take into account both social and economic benefits. However, at present, various scientists have proposed indicators for assessing the development of entrepreneurial ecosystems.²⁴⁴, but in the field of higher education, there is quite a bit of research²⁴⁵. The existing works present models of systems for assessing the entrepreneurial ecosystem with several levels of indicators.

According to the author, the Balanced Scorecard (BSC) method can be used as one of the management methods of strategic management of UIE development evaluation.²⁴⁶. The Balanced Scorecard translates the mission and overall strategy of a commercial organization into a system of clearly defined goals and objectives, as well as indicators that determine the degree to which they have been achieved. The main structural idea of BSC is to balance the scorecard in the form of four components of the organization's activities: "Finance", "Clients", "Internal business processes" and "Learning and development", which are located in a certain hierarchical order, as shown in Figure 4.9.

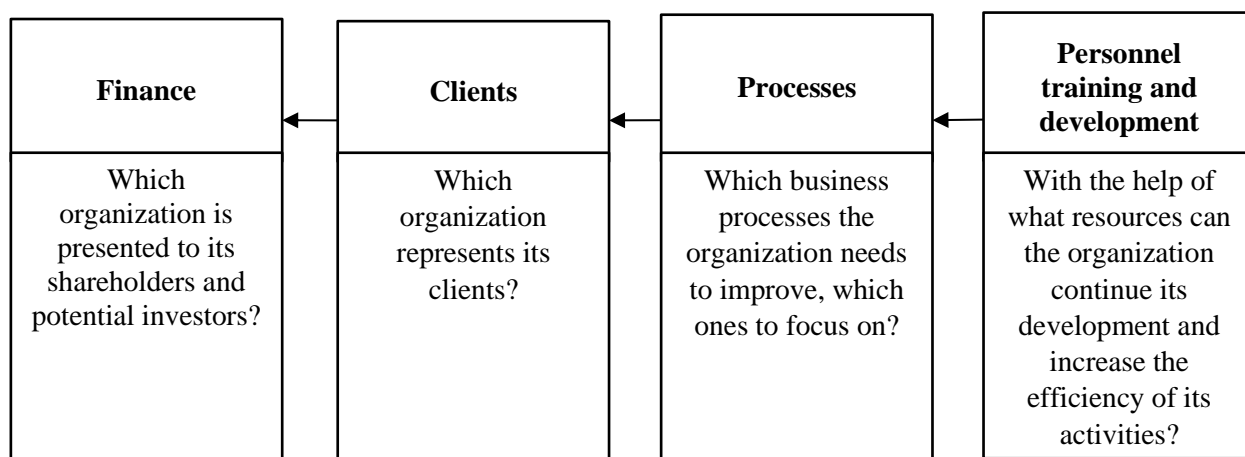


Figure 4.9. Logic of the interconnection system indicators of Balanced Scorecard
[developed by the author]

The Balanced Scorecard combines the financial and non-financial components of a business, reflecting the relationship between levels of management, results and aspects of the organization's activities. BSC is being implemented on the already developed strategy of the company. This is a

²⁴⁴ STAM, E. *Measuring entrepreneurial ecosystems*. In: Entrepreneurial ecosystems. New York: Springer, 2018, p. 173-197. ISBN 978-3-319-45654-6.

²⁴⁵ XIE, Y., ZHANG, W. *Construction and Measurement of University-based Entrepreneurial Ecosystem Evaluation Index System: A Case Study of Zhejiang University in China*. In: ASEE American Society for Engineering Education, 2019. ISSN 2153-5868. [accessed 02.06.2020]. Available at: <https://peer.asee.org/32541>

²⁴⁶ KAPLAN, R. S., NORTON, D. P. *Balanced scorecard*. In: Das Summa Summarum des Management, 2007, p. 137-148. ISBN 978-3-8349-0519-2.

management tool, control over the implementation of strategic goals, an assistant for top managers.

The advantage of the Balanced Scorecard method is that it provides a comprehensive view of an organization's performance by incorporating financial and non-financial metrics and aligning them with the organization's strategy.

Various authors suggest using the BSC to assess the performance of universities²⁴⁷, budgeting mechanism and target agreements²⁴⁸, performance measurements based on financial indicators²⁴⁹, alignment of organizational strategy with performance evaluation²⁵⁰, university sustainability assessments²⁵¹ and others.

Taking into account the existing scientific ideas about the structure and dynamics of the functioning of the innovation ecosystem and the characteristics of universities, the author proposes to apply the methodology for assessing the development of the university's innovation ecosystem based on the BSC. The choice of BSC was due to the fact that it allows you to simultaneously:

- 1) link strategic goals with operational actions to implement the strategy;
- 2) take into account non-financial indicators (along with financial ones), which is necessary to assess the activities of the university related to intangible assets and information;
- 3) respond in a timely manner to inconsistent changes in processes by distinguishing between indicators that measure the results achieved and indicators that reflect the processes to achieve these results.

The application of BSC is possible if the university has an objective understanding of its strengths and weaknesses, the current market situation. On this basis, the mission and strategic development priorities of the UIE should be developed. The university innovation ecosystem consists of functional components (enlarged structural elements) that are necessary for the future assessment of the development of the UIE. The semantic purpose and content are given in Table 4.10.

²⁴⁷ FIJALKOWSKA, J., OLIVEIRA, C. *Balanced scorecard in universities*. In: Journal of Intercultural Management, 2018, nr. 10(4), p. 57-83. ISSN 2080-0150.

²⁴⁸ KÜPER, H. U. *A specific accounting approach for public universities*. In: Journal of Business Economics, 2013, nr. 83(7), p. 805–829. ISSN 442372.

²⁴⁹ PIETRZAK, M., PALISZKIEWICZ, J., KLEPACKI, B. *The application of the balanced scorecard (BSC) in the higher education setting of a Polish university*. In: Online Journal of Applied Knowledge Management, 2015, nr. 3(1), p. 151–164. ISSN 2325-4688.

²⁵⁰ TAPIONS, E., DYSON, R. G., MEADOWS, M. *The impact of the performance measurement systems in setting the 'direction' in the University of Warwick*. In: Production Planning and Control, 2005, nr. 16(2), p. 189–198. ISSN 1366-5871.

²⁵¹ LIN, M-H., HU, J., TSENG, M-L., CHIU, A., LIN, C. *Sustainable development in technological and vocational higher education: balanced scorecard measures with uncertainty*. In: Journal of Cleaner Production, 2016, nr. 120 (2016), p. 1–12. ISSN 1366-5871.

Table 4.10. Characterization of the functional components of the university innovation ecosystem to assess its development [developed by the author on the basis of ²⁵²]

Functional components	The semantic purpose of the functional component	Strategic aspects of the functional component
1. Academic research and entrepreneurship (ARE)	Shows the results of scientific research and development of academic entrepreneurship of the university, as well as their contribution to the economy of the region.	<ul style="list-style-type: none"> - development of an innovative product/service; -contribution of the university to the innovative development of the region; -recognition of university achievements; -accumulation and exchange of knowledge; -financial performance indicators of the UIE.
2. Interactions and Networks (IN)	Shows the productivity of the UIE, the development of interactions and practices of co-evolution and collaboration, the presence of an innovative culture, social capital.	<ul style="list-style-type: none"> -integration of UIE participants into regional and/or national IE; -interaction of the university with local authorities; - interaction of the university with business structures in the field of research; -interaction of the university with business structures in the field of entrepreneurship; -interaction of the university with graduates; -interaction of UIE participants within the university; -entrepreneurial/innovative culture; - university technology transfer network.
3. Processes (P)	Shows the starting conditions for the formation of the UIE, the circle of potential participants and the processes in the development of the UIE.	<ul style="list-style-type: none"> -providing UIE participants with a platform for joint work; -creation of an effective UIE management system; -development of information and analytical system.
4. Resources (R)	Shows the availability of resources for the development of the UIE.	<ul style="list-style-type: none"> -ensuring the availability of funding for new knowledge and research; -reducing the cost of new knowledge and research; -providing the UIE with human resources; -development of production and technical systems for the process of commercialization of scientific research.

The proposed functional components and their strategic aspects (Appendix 53), according to the author, sufficiently characterize the conditions for the effective development of innovation activity formed at the university, and their systematic application gives an adequate assessment of the university's innovation ecosystem.

When comparing the application of the BSC methodology for commercial organizations and

²⁵² ISRAELI, M. *Methodology for assessing the innovative ecosystem of the university*. In: Материалы международной научной интернет-конференции “Тенденции и перспективы развития науки и образования в условиях глобализации” (Вып. 78), 23 декабря 2021. Переяслав-Хмельницкий: Государственный Педагогический Университет им. Г. С. Сковороды, 2021, p. 47-49.

universities for each component, its meaning and evaluation criteria change (Appendix 54). The author proposes to replace the most significant component of the BSC "Finance" with "Academic Research and Entrepreneurship". The remaining components change as follows: "Clients" to "Interactions and Networks"; "Processes" leave the same name; "Personnel training and development" on "Resources".

Further, the author considers the characteristics of each functional component and their strategic aspects.

1. "Academic research and entrepreneurship" characterizes the contribution of academic entrepreneurship to the economic development of a region or country, as well as the creation and development of new firms (spin-offs and start-ups), in contrast to business, where the result is profit, profitability, company capitalization. The development goals of "Academic Research and Entrepreneurship" are subordinate to the goals of other components of the considered system of balanced scorecards, since they are connected by cause-and-effect relationships with the achievement of the goals of academic research.

The results of developing indicators for the functional component "Academic Research and Entrepreneurship" are presented in Appendix 55. Universities perform a dual function: they interact and collaborate with existing enterprises and create new ones. New enterprises are most often created in the UIE with the strongest positions. The creation of spin-off companies reflects the economic role of universities in the development of innovation ecosystems. Patents are another indicator. The value of the per capita indicator of patent activity depends precisely on universities and research companies-spinoffs, which are located on the territory of universities. Patent applications from regional companies usually heavily cite scientific publications by scientists from universities located in the same area. The indicator reflects both the results of research and development and the potential for innovation in the respective territory. But the number of granted patents is a confirmation of the innovative result of the researcher, and not the number of applications for their issuance.

In the economic literature, the Inputs and Outputs indicators are used to measure and evaluate the contribution of the university to the innovative development of the region. Indicators Inputs characterize the necessary input resources, and Outputs - the results of the functioning of the innovation sphere of the region. Both groups of indicators, depending on the purpose of the study, are grouped into blocks: education, science, innovation infrastructure, human resources, innovation financing, regional interaction, and others. In the countries of the European Union, the European Regional Innovation Scoreboard (RIS) is calculated. It takes into account two parameters: the percentage of innovative companies that collaborate with other organizations, and

the number of public and private joint publications.²⁵³ The exchange of knowledge between European universities and public research organizations is assessed with indicators of effective relations between enterprises and science: the number of contracts and joint research, cooperation in innovative projects, the mobility of researchers, continuing professional education, etc.

2. The second functional component "Interactions and networks" characterizes the work of the university with business partners, in contrast to commercial organizations, for which the results of working with clients contribute to the achievement of financial goals. Working with partners means not just the presence of large companies (consumers of innovations), but the presence of the practice of joint development (co-evolution, collaboration), the necessary level of business and social ties, contacts, interest and trust of IE participants, the presence of "soft" variables of the innovation ecosystem (social capital, cultural values). The emergence of successful new firms (spin-offs) depends on this component. If the goals of this component are not achieved or no attention is paid to them at all, the formal creation of a "hard" innovation infrastructure and the allocation of resources will have little effect on the development of academic entrepreneurship. However, the creation of institutions and resource provision are also necessary conditions for the emergence and development of an innovative university ecosystem.

The results of the development of indicators in the direction of "Interaction and Ecosystem Networks" are presented in Appendix 56. Interaction with UIE participants is disclosed using indicators that reflect the university's cooperation with business structures, authorities, alumni and university staff. The indicators of this direction reflect the nature of network interactions between structural elements within the ecosystem. Comparing the values obtained in this ecosystem with the values obtained in past periods, we can conclude that the ecosystem is developing or degrading.

The level of interaction between institutions differs in different countries, and they determine the amount of knowledge creation, the speed of knowledge dissemination, its transformation into innovation and the dissemination of innovation²⁵⁴. Universities need to strive to intensify contacts with partners. As key indicators of the success of these relationships, one can consider the number of joint projects, activities for interaction with business and government. To attract business partners to work together, measures are needed to increase confidence (image) in a higher educational institution. The basis of the good reputation of the university is the quality of education and research, as well as the social responsibility of the university and its contribution to society as a whole.

Universities need to carry out purposeful work to change culture in favor of values that are

²⁵³ DIACONU, M., DUTU, A. *The role of the modern university in supporting the entrepreneurial ecosystem*. In: European Journal of Interdisciplinary Studies, 2015, nr. 7(1), p.11-24. ISSN 2411-958X.

²⁵⁴ MERCAN, B., GOKTAS, D. *Components of innovation ecosystems: a cross-country study*. In: International research journal of finance and economics, 2011, nr. 76(16), p. 102-112. ISSN 1450-2887.

relevant to the ecosystem. It seems appropriate to identify specific innovative and entrepreneurial values that are relevant not only for the university, but also for its partners in the ecosystem, and provide for measures for their implementation and promotion.

3. The third functional component "Processes" contains goals and indicators that characterize the processes that are most important for solving the problems identified in the previous two directions. To do this, you need to know the needs of customers and the interests of partners, ways to meet them. The algorithm for achieving the goals of this component begins with the process of developing innovations at the university and consistently moves into the process of commercialization. The creation of innovations is becoming increasingly important, as unconventional customer satisfaction, generation of new consumer values and long-term performance depend on it. In this component, it is necessary to take into account the methods of supporting innovation through innovation policy at various levels of management, the availability of resource providers, etc.).

The results of the development of indicators of the functional component "Processes" are presented in Appendix 57. The most important for new enterprises (spin-offs) are organizations that contribute to the development of innovation, the creation and rapid growth of a startup, namely: innovation centers, institution centers, business incubators, business accelerators, venture funds, innovation exchanges. In modern conditions, many of these structures operate on the basis of the Internet (for example, Internet exchanges of innovations, platforms for presenting projects, crowdsourcing platforms). Special information systems (various search databases, repositories of scientific and technical information, etc.) are being intensively developed. In world practice, special platforms for cooperation are emerging, including those based on the open innovation model.

For the strategic aspect of creating an effective UIE management system, it is necessary to develop a system for evaluating the organizational activities of the university (management decision-making, etc.) by monitoring the balanced scorecard and improving the efficiency of organizational activities through qualitative transformations.

The information ecosystem of the university should be aimed at meeting the information needs of all participants in the scientific, educational, and innovative activities of universities, and therefore it should become a full-fledged communication tool. The digitalization of innovation processes contributes to improving the quality of managerial decision-making to support and develop innovation ecosystems of territories at various levels - global, national, regional, the integration of statistical data and expert assessments in various areas of production and application of innovations, the formation of information and analytical support for the UIE, etc. It is necessary to carry out systematic work on the introduction of information technology in all aspects of the

university's activities so that the integrated system provides easy access to the necessary information and automatically performs primary data analysis.

4. The fourth functional component "Resources" characterizes the result of the activity of the innovation ecosystem in terms of providing academic entrepreneurs with the necessary resources (financial and human capital), ensuring the process of commercialization of scientific research with production and technical systems. BSC focuses on the need and importance of investing in the training and development of university staff, in informing them and, accordingly, in the development of information infrastructure. BSC is also focused on scientific research and ensuring the process of creating innovations. This component reflects the necessary variables of the university innovation ecosystem, but they are not sufficient success factors.

The results of the development of indicators for the functional component "Resources" are presented in Appendix 58. Funding and institutional policies should adapt, recognize and promote a multi-stakeholder approach to research and innovation. Access to finance is critical to investing in long and medium term innovation projects. The sources of financing for innovative developments are the private and public sectors. To finance innovative projects, most IE companies use their own funds, and at the launch stage, the key financial source of business development is the funds of institutional investors. Since university funding comes primarily from private sources, co-financing the cost of innovation projects between universities and businesses helps spread and minimize risk. The financial performance of the UIE is considered in two groups. One of them is aimed at increasing income, the second is aimed at reducing the cost of new knowledge and research.

The most important element of an effective innovation ecosystem is the presence of a diverse and skilled workforce. Human resources indicators characterize the level of readiness of the university for the formation and development of an innovation ecosystem. Some indicators in this area are directly related to the growth of start-ups (for example, venture investments), while others are indicators that are necessary for capacity building (for example, attracting talent and spending on education)²⁵⁵. Competition in the labor market is not just for human resources, but for talents. Talented employees in the innovation ecosystem must have certain competencies, including a high professional level, creative abilities, specific socio-psychological qualities, etc. In this regard, companies attach particular importance to addressing issues of investment in human capital, and especially investment in talent.

To build a full-fledged innovation commercialization process, the UIE innovation

²⁵⁵ TAICH, C., PIAZZA, M., CARTER, K., WILCOX, A. *Measuring entrepreneurial ecosystems*. Cleveland State University, 2016. [accessed 11.03.2022]. Available at: https://engagedscholarship.csuohio.edu/cgi/viewcontent.cgi?article=2457&context=urban_facpub

infrastructure is required, which is associated with scientific and educational activities (laboratories, research centers, etc.), scientific and production activities (shared centers, training and production complexes, etc.), support for spin-offs (departments of innovative development, marketing centers, etc.).

The use of the indicators presented in Appendices 55-58 is intended to specify the system of goals of the university's innovation ecosystem developed in the course of strategic planning and to make the developed goals measurable. The proposed functional components and their indicators, according to the author, sufficiently characterize the conditions for the effective development of innovation activity formed at the university, and their systematic application will give an adequate assessment of the innovation ecosystem development. The proposed indicators can be supplemented with qualitative indicators based on a survey of ecosystem participants and various experts. This will make it possible to evaluate not only the effectiveness of the interaction of all participants in the innovation ecosystem, but also to determine the list of evaluation criteria, the possibilities of using the evaluation results.

The basis of the BSC methodology is the improvement of indicators for the functional components of the UIE. Based on the developed system of complex indicators for assessing the development of the university innovation ecosystem, the author proposes the construction of an integral index of the innovation ecosystem development, as well as private indices (sub-indices) of functional components. Sub-indices are calculated based on the system of indicators for each functional component, which were described above.

The calculation of the integral index of innovation ecosystem development can be applied both for an individual university and for a group of universities (comparison of various universities with rankings). This will make it possible to characterize both the general level of UIE in more detail and in detail, as well as to evaluate the contribution of individual components, to identify the relationship between indicators and to give their totality a systemic character.

The calculation of the integral index of development of the university innovation ecosystem is carried out on a conditional example. For this, some indicators were selected from each functional component (Appendix 59). However, the choice of indicators (absolute and/or relative) depends on the objectives of the assessment and the availability of information about them. Calculation of the integral index of development of the university innovation ecosystem consists of a number of steps.

Step 1. Bringing "raw" data to the normalized values of indicators. The methodology for calculating the normalized values of indicators is slightly different when calculating the integral development index UIE of a particular university and a group of universities.

a) for an individual university, data reduction to normalized values of indicators is carried

out according to the formula:

$$\dot{\chi}_i = \frac{\chi_i - \chi_i^{\min}}{\chi_i^{\max} - \chi_i^{\min}}, \quad (4.1)$$

where: $\dot{\chi}_i$ - normalized value of the i-th indicator; χ_i - the value of the i-th indicator; χ_i^{\min} - the minimum value of the i-th indicator; χ_i^{\max} - the maximum value of the i-th indicator.

To calculate this indicator, it is important to determine the minimum and maximum values of the indicator. They can be determined from Internet sources, statistical data or any other. Table 4.11 shows the calculation of the normative values of indicators of functional components on a conditional example.

Table 4.11. Bringing indicators of functional components to normalized values [developed by the author]

I_k	Subindex symbol	$\chi_i, \%$	$\chi_i^{\min}, \%$	$\chi_i^{\max}, \%$	$\dot{\chi}_i$
Academic research and entrepreneurship (I_{ARE})	$X_{ARE\ 1}$	7	5	12	0,29
	$X_{ARE\ 2}$	74	65	79	0,64
	$X_{ARE\ 3}$	20	15	30	0,33
	$X_{ARE\ 4}$	30	14	35	0,76
	$X_{ARE\ 5}$	75	72	80	0,38
Interactions and Networks (I_{IN})	$X_{IN\ 1}$	45	35	60	0,4
	$X_{IN\ 2}$	28	27	32	0,2
	$X_{IN\ 3}$	68	60	70	0,8
	$X_{IN\ 4}$	55	45	70	0,4
	$X_{IN\ 5}$	46	42	50	0,5
Processes (I_P)	$X_{P\ 1}$	28	20	36	0,5
	$X_{P\ 2}$	27	20	30	0,7
	$X_{P\ 3}$	65	42	70	0,82
	$X_{P\ 4}$	85	70	85	1
Resources (I_R)	$X_{R\ 1}$	9	8	11	0,33
	$X_{R\ 2}$	81	70	81	1
	$X_{R\ 3}$	60	40	70	0,67
	$X_{R\ 4}$	82	65	82	1
	$X_{R\ 5}$	82	72	84	0,83

The normalized values of indicators of a given university will make it possible to bring them to a homogeneous form and compare the indicators with similar indicators identified as a result of research.

c) for a group of universities, data reduction to normalized values of indicators is carried out according to the formula:

$$\dot{\chi}_i^j = \frac{\chi_i^j - \chi_i^{\min}}{\chi_i^{\max} - \chi_i^{\min}}, \quad (4.2)$$

where: χ_i^j - normalized value of the i-th indicator in the j-th university; χ_i^j - the value of the i-th indicator in the j-th university; χ_i^{min} - the minimum value of the i-th indicator for the group of universities; χ_i^{max} - the maximum value of the i-th indicator for the group of universities.

Calculation of normalized values of indicators is necessary to achieve homogeneity and comparability of indicators when comparing and ranking a group of universities being evaluated (Appendix 60). To eliminate the pressure of the absolute values of indicators of the functional components of large universities, the author proposes to use relative values presented as specific weights or per scientific and pedagogical workers.

Step 2. Calculation of partial indices (subindices) of functional components (I_f^k). Their value can be calculated as the arithmetic mean of the normalized values of the indicators:

a) for an individual university:

$$I_f^k = \frac{\sum_{i=1}^n \chi_i}{n}, \quad (4.3)$$

where: I_f^k - index of the k-th functional component of the innovation ecosystem; n - the number of indicators characterizing the k-th functional component.

The calculation of sub-indices for a particular university (Appendix 61) can be carried out in dynamics (Figure 4.10) to monitor the indicators of functional components and develop directions for their improvement.

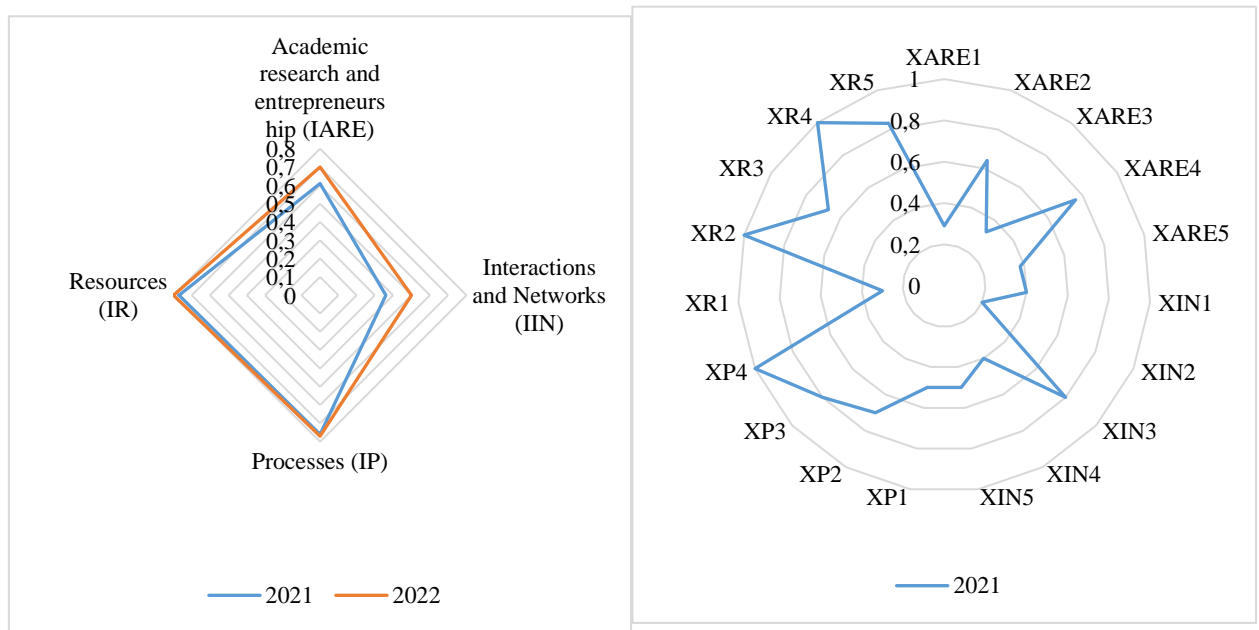


Figure 4.10. Functional components of the integral index of development of the innovation ecosystem of a separate university [developed by the author]

The data show the indices of functional components (sub-indices) in dynamics for two years (figure on the left) and the normalized values of the indicators of each of them for one year (figure on the right).

c) for a group of universities:

$$I_{f_j}^k = \frac{\sum_{i=1}^n \chi_i^j}{n}, \quad (4.4)$$

where: $I_{f_j}^k$ - index of the k-th functional component of the innovation ecosystem of the j-th university; n - the number of indicators characterizing the k -th functional component.

Figure 4.11 shows the indexes of functional components for five conditional universities for one year, the calculation of which is given in Appendix 61.

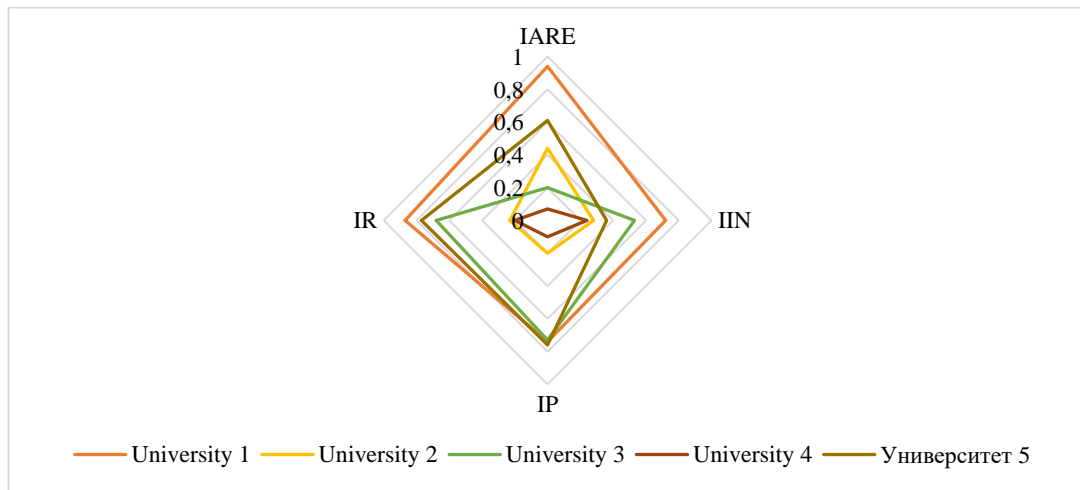


Figure 4.11. Functional components of the integral index of the development of the university innovation ecosystem group of universities [developed by the author]

The calculation of sub-indices will make it possible to rank universities by forming private ratings for each of the four components of the innovation ecosystem of universities.

Step 3. Calculation of the integral index of development of the university innovation ecosystem (I_{IEU}) can be determined using the weighted arithmetic mean of the sub-indices, taking into account weighting factors that equalize the contribution of the components to the final score:

a) for an individual university:

$$I_{IEU} = \sum_{k=1}^4 I_{f_j}^k \cdot f_k, \quad (4.5)$$

where: I_{IEU} - integral index of innovation ecosystem development; $I_{f_j}^k$ - index of the k-th functional component of the innovation ecosystem; f_k - weight coefficient of the contribution of the k -th functional component to the final assessment of the innovation ecosystem.

c) for a group of universities:

$$I_{IEUj} = \sum_{k=1}^4 I_{f_j}^k \cdot f_k, \quad (4.6)$$

where: I_{IEUj} - integral index of development of the innovation ecosystem of the j-th university; $I_{f_j}^k$ - index of the k-th functional component of the innovation ecosystem of the j-th university; f_k -weight coefficient of the contribution of the k-th functional component to the final assessment of the innovation ecosystem.

The values of the weight coefficients of the sub-indices are expressed in fractions of a unit and are determined by the expert method. Experts can be the most competent specialists - UIE participants (from the university, business and others), who are well acquainted with the problems of this study and take a practical part in solving issues of the university's innovative activities. The assessment of the degree of agreement between the opinions of experts was carried out using the coefficient of variation, which characterizes the degree of differences in the opinions of experts in relation to the average value of the group assessment (Table 4.12).

Table 4.12. Calculation of the coefficient of variation to assess the degree of agreement between experts [developed by the author]

Functional component	Average value of the weighting coefficients	Standard deviation	The coefficient of variation
Academic research and entrepreneurship (I_{ARE})	0,35	0,051	0,155
Interactions and Networks (I_{IN})	0,12	0,055	0,229
Processes (I_P)	0,14	0,038	0,253
Resources (I_R)	0,39	0,052	0,186

Since the variation in the estimates of weight coefficients does not exceed 30%, the degree of agreement between the opinions of experts is generally satisfactory.

Step 4. Comparison of the obtained integral development index UIE:

a) for an individual university:

The level of development of the UIE of the university is determined on the basis of a multi-interval numerical school, consisting of 4 intervals (from 0 to 1) (Figure 4.12).

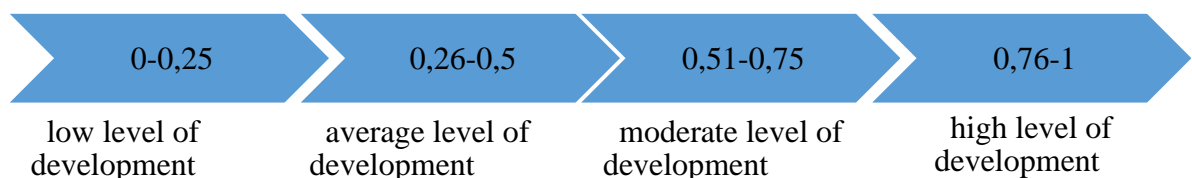


Figure 4.12. Scale of methods of assessment of the level of development of the university's innovation ecosystem [developed by the author]

The integral development index of the innovation ecosystem of the conditional university was 0.66, which corresponds to a moderate level of development. The UIE Evaluation Expert Council may develop directions to improve the UIE 's level of development through the

improvement of the performance of the functional components.

c) for a group of universities:

The UIE Integral Development Index can be used to rank the level of development of innovation ecosystems among universities. Based on the data in Appendix 61, one can rank the universities of the conditional example shown in Table 4.13.

Table 4.13. Ranking of universities according to the integral index of innovation ecosystem development [developed by the author]

	Rating				
	1	2	3	4	5
Universities	1	5	3	2	4

The data in the table show that the conditional university 1 occupies the first place in the ranking due to the higher sub-indices "Academic research and entrepreneurship" and "Resources".

The author's assessment of the development of the university's innovation ecosystem using a balanced scorecard is to meet the following conditions:

1) the subject of management (university) should be interested in the results of the implementation of innovative projects and the activities of university spin-off companies and start-ups;

2) embedding academic entrepreneurs in the value chains with the effective use of the existing scientific and technical reserve;

3) the presence of the necessary range of actors - resource providers and partners, the main support institutions in the university innovation ecosystem ;

4) the necessary resource provision, in the form of financial and human capital for research.

In the presence of all these conditions, the university innovation ecosystem can function and develop.

Building the Balanced Scorecard is carried out by performing the following steps (Appendix 62): Stage 1. Determining the initial data; Stage 2. Expert assessment and data collection; Stage 3. Evaluation of the UIE and calculation of the integral index; Stage 4. Summing up.

Stage 1. Definition of initial data. At the stage of determining the initial data, it is necessary to formulate the goal of assessing the development of the innovation ecosystem. Each strategic goal is linked to one of the UIE development directions. Determining and documenting causal relationships between individual strategic goals is one of the main elements of BSC. Established cause-and-effect relationships reflect the presence of dependencies between individual goals. Strategic goals are not independent and isolated from each other, on the contrary, they are closely related to each other and influence each other. The achievement of one goal serves the achievement of another, and so on, up to the main goal of the university.

It is necessary to identify the objects of assessment: an assessment of the development of the

innovation ecosystem of an individual university and its functional components or a group of universities to determine the rating of the development of the innovation ecosystem. It is also necessary to determine the period for assessing the development of the UIE (a year or several years).

Stage 2. Peer review and data collection. At the stage of peer review and data collection, it is necessary to determine the strategic aspects of the functional components of the UIE based on the specification of the strategic goals of the university's innovation strategy and select the main indicators of the functional components from the expanded list.

All indicators of the strategic aspects of functional components should correspond to a strategic map that reflects the cause-and-effect relationships between these aspects and the four functional components. To graphically display these relationships, the author has developed a strategic map (Figure 4.13).

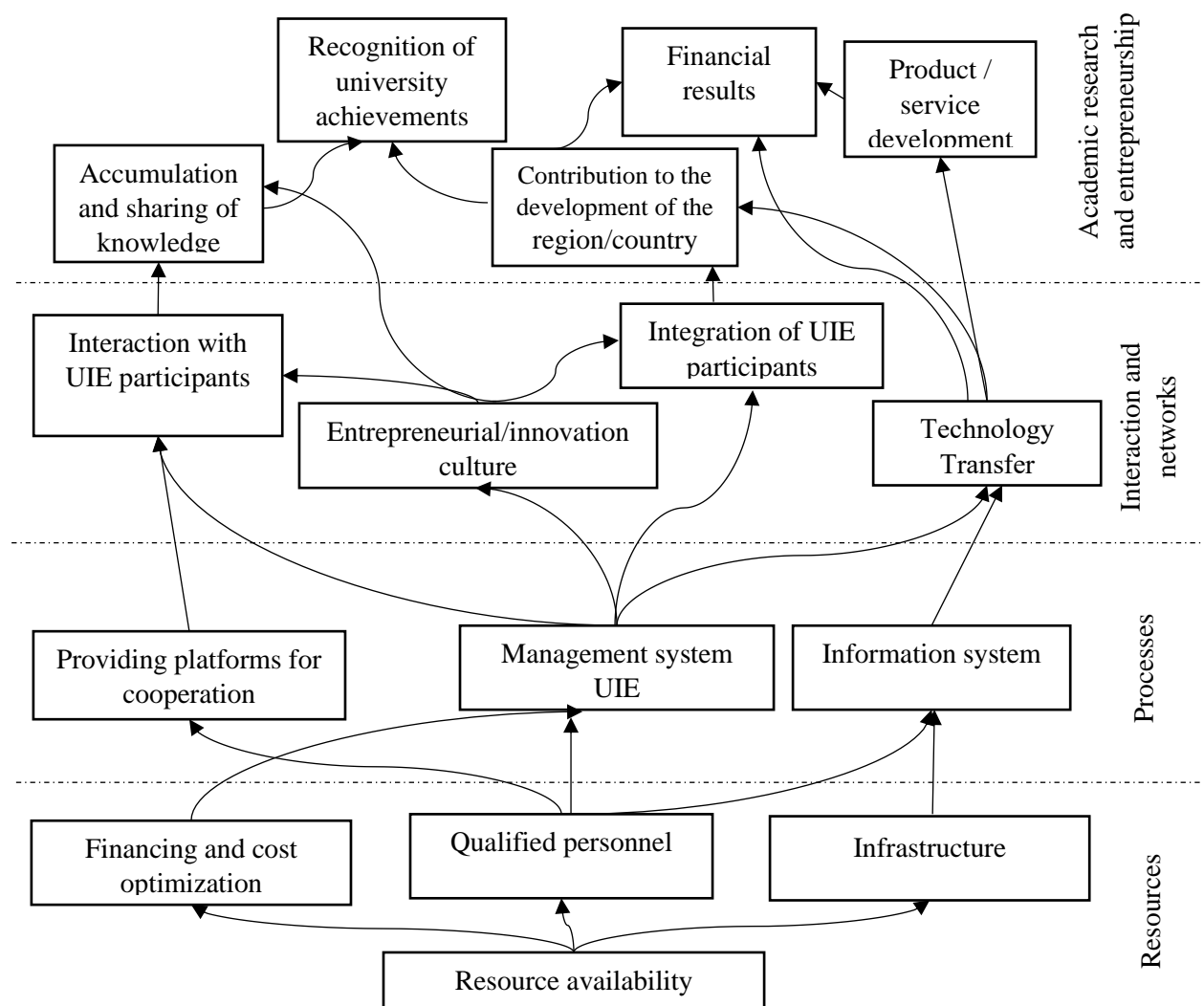


Figure 4.13. Strategic map of the relationship between strategic aspects and functional components of the university's innovation ecosystem [developed by the author]

Unlike existing approaches, the UIE Strategic Aspects-Functions Map takes into account the

intermediate link between resource allocation, stakeholder engagement, and the emergence of successful academic entrepreneurs. This link is the dynamics of interaction in the innovation ecosystem, the formation of social capital, entrepreneurial culture, co-evolution and collaboration practices.

The construction of a balanced scorecard to achieve strategic goals and activities for their implementation can be carried out by an expert council established in the UIE. The work should be carried out with the involvement of IE participants and specialists in relevant areas of management.

Stage 3. Evaluation of the development of the UIE and calculation of the integral index. At this stage, information is collected from available sources or data from a group of universities being evaluated. Then the results of the expert survey are evaluated. The main point at this stage is the calculation of the UIE integral development index. The determination of the weight coefficients of the functional components for calculating the integral index of the development of the university's innovation ecosystem is carried out on the basis of an expert assessment.

Stage 4. Summing up. The debriefing stage analyzes the data obtained in the previous stages and develops activities to improve the development of the UIE, as well as determine the university's UIE development ranking among others.

The advantages of the balanced scorecard methodology are: the presence of financial and non-financial indicators in the system; a comprehensive description of the UIE's activities in four areas; linking operating performance indicators to the innovation strategy. The disadvantages of this system are: the lack of its own accounting system and communication with existing accounting systems in organizations participating in the ecosystem; difficulty in determining cause-and-effect relationships and balancing indicators between the functional components of the UIE.

The formation and development of an innovation ecosystem is a complex and multi-stage process. Insufficient attention to certain aspects is fraught with risk for the university's innovation ecosystem in general and for its participants in particular. In this regard, the author developed a system and algorithm for assessing the development of the university's innovation ecosystem. During the development process, various approaches and methods were studied, but the most relevant, according to the author, was the balanced scorecard method. This methodology has been adapted for use as the basis for constructing an author's tool for assessing the development of the university's innovation ecosystem.

The author proposed a list of indicators for assessing the development of the university's innovation ecosystem in terms of its functional components. A balanced scorecard can be recommended for implementation if there is a strategy or a strategic plan with directions for the innovative development of the university. This is a tool for managing and monitoring the

implementation of strategic goals, an assistant for managing the university's innovation ecosystem. The tool shows how to set up the innovation activity of the university with a focus on achieving a strategic goal.

The method developed by the author for calculating the integral index of development of the university innovation ecosystem will allow mutually linking the tasks that the state and business sets for the university with the structure of innovation units, information and human resources with the results of research obtained at the university for business, enterprises (organizations) and government agencies. The integral index of development of the university innovation ecosystem developed by the author will allow the top management of the university and responsible persons (the leadership of the Coordination Center) to constantly monitor, analyze and evaluate the activities of the university innovation ecosystem, taking into account market requirements.

In order to further effectively use this methodology for assessing the development of the university's innovation ecosystem, the author has developed an appropriate algorithm consisting of four stages. The algorithm for evaluating the development of the university's innovation ecosystem will allow modifying, supplementing, regulating and improving the process of managing and monitoring the development of the university's innovation ecosystem.

4.4. Conclusions to the chapter 4

1. The author has developed and proposed a mechanism for managing the innovation ecosystem of higher educational institutions, including a set of such elements as: goals, objectives, management principles, subject, object, coordination center, methods, ways of interaction of elements, conditions and factors of functioning of the mechanism and the results of the mechanism. It is advisable to consider this mechanism from two sides: structural and managerial. The structural side should provide flexible and effective support for the development of R&D, intellectual property and infrastructure. The management side should include the selection of participants in the innovation ecosystem of higher education institutions and the management of network relationships between them, the elements of leadership (including the level of hierarchy, leadership and personal characteristics of managers), incentive and control mechanisms. According to the author, the internal management mechanisms of universities should form and ensure actions for the development of the innovation ecosystem, maximize the interaction of internal ecosystem participants, bring them closer to the market and thus contribute to the evolution of society. The management mechanism of the university's innovation ecosystem will identify a set of methodological tools for a specific university innovation ecosystem (a set of principles,

procedures and processes) for the creation of new technologies, products or services and their commercialization.

2. The author has developed and proposed an approach to developing a strategy for the formation and development of an innovation ecosystem. It can be effective and useful for higher education institutions and interested parties to implement in three consecutive stages: conducting theoretical and practical research; creation of an algorithm for forming a strategy; development of the substantive component of strategic scenarios.

3. When developing the strategy, the author considered two scenarios for the formation and development of an innovation ecosystem: the university is the creator of the ecosystem or the university is a participant and is part of one or more innovation ecosystems. According to the first scenario, the substantive component of the university's strategy includes the development of a line of behavior and actions in response to changes in the external environment, the consolidation of potential participants in innovation processes, the provision of resources, support for innovation and entrepreneurship, the promotion of a culture of the innovation process, as well as the promotion of cooperation between stakeholders. When developing the substantive component of the second strategic scenario, the author identifies four strategies for the university's behavior as a participant in the existing innovation ecosystem: a coordinated approach strategy, a cooperation strategy, a platform creation strategy, and an innovation center creation strategy. These strategies characterize the sequence of the university's activity manifestation as a member of the ecosystem (ascending from the conditionally passive role of the university to the active one).

3. A methodology for assessing the development of the university's innovation ecosystem based on Balanced Scorecard has been developed and proposed for implementation, the use of which will increase the efficiency of management and implement in practice a systematic approach to academic entrepreneurship and the development of a strategy for the formation of an innovation ecosystem. Evaluation of the development of the university innovation ecosystem involves the calculation of an integral index for the development of the innovation ecosystem of higher education institution on the basis of the functional components of the university.

4. A methodology for assessing the development of the university's innovation ecosystem based on the Balanced Scorecard has been developed and proposed for implementation. the use of this assessment methodology will increase the effectiveness of management and put into practice a systematic approach to academic entrepreneurship and the development of a strategy for the formation of an innovation ecosystem. The assessment of the development of the university's innovation ecosystem involves the calculation of the integral index of the development of the university's innovation ecosystem based on functional components (Academic research and entrepreneurship, Interactions and Networks; Processes, Resources), which in turn consist of 19

key private indicators. The calculation of this indicator will make it possible to track the dynamics of the development of the UIE of an individual university; comparison of universities by the level of the innovation ecosystem development as a whole and in its individual components, including a comparison of specific evaluation indicators; it will identify the "weak points" and reserves for the universities innovative activities development; monitor; provide the management of the UIE with the necessary information in the process of making management decisions; contribute to improving the competitiveness of the university and a worthy position in national and world rankings.

5. A methodology for evaluating the effectiveness of the university's innovation ecosystem has been developed, consisting of four stages (the stage of determining the initial data; the stage of expert evaluation and data collection; the university's innovation ecosystem assessment stage and the calculation of the integral index; the summarizing stage). This methodology is an approach to assessing the effectiveness of the strategic aspects of the functional components of the university's innovation ecosystem, related to common goals and the developed strategic map of the relationship between strategic goals and directions of the university's innovation ecosystem.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

The following conclusions presented are based on the conducted research:

1. As a result of the research, the author highlighted the fundamental approaches and the main aspects of the concept of the innovation ecosystem. It is revealed that the research of scientists focuses both on individual aspects of the innovation ecosystem (knowledge transfer, connections and configuration of structures, etc.), and on its individual participants (from the standpoint of universities, central firm, small and medium-sized enterprises, etc.). The diversity and completeness of interpreting the concept of "innovation ecosystem" should imply a parallel consideration of innovation ecosystems from the standpoint of their participants or aspects, i.e. integration approach.

2. Summarizing the conceptual and theoretical provisions of various researchers on the composition elements of the innovation ecosystem, the author came to the conclusion that there is no single methodology for the formation of its composition and structure. Understanding the composition of innovation ecosystems as interrelated actors, processes and connections between them are determined by their formal and informal nature, institutional and infrastructure support (technoparks, incubators, services, etc.) allows the participants of the innovation ecosystem to coordinate their technological solutions, structure, style of behavior based on common goals. The need for missing knowledge and technologies, the need to significantly reduce the processes of initiation and implementation of innovations unite actors and build relationships on certain principles (self-organization and self-development; joint generation and use of information and intellectual resources; openness to external challenges and others).

3. Based on the existing definitions of the university innovation ecosystem, the author formulated a generalized concept of this process, which covers the main priority aspects identified by the researchers. The university innovation ecosystem is a complex of relationships between the subjects of the innovation process, its participants have different competencies and capabilities, constantly exchange knowledge, manage its flows, distribute, and use this knowledge, are interdependent from each other and interact based on partnership agreements in the process of commercialization.

4. The emergence of the "innovation ecosystem" concept in the scientific and educational environment means a transition to a new paradigm in management, which has its own philosophy and requires a different behavior in strategic and operational management, and for practitioners it simplifies the introduction of innovative opportunities and training, reducing the time to market new products (technologies and/or services), expansion of market access. The concept of a higher education institutions innovative ecosystem should become not only a new educational concept, but also a natural, harmonious, open and innovative model for the development of modern higher

education. A higher education institution, as the core of an innovation ecosystem, should have a few specific qualities, including: the development of an effective development strategy; focus on leading positions in the field of territorial innovative development; positioning the university as a leader in innovative development; creation of intellectual property and the ability to offer breakthrough technologies and solutions. The process of forming and developing the innovative ecosystems of higher education institutions is aimed at increasing their competitiveness, impact on the regional and national economies, and human development. For the successful implementation of this process, it is necessary to modernize the system of higher education, taking into account national specifics and innovative development of the country.

5. In the dissertation work, the author defines a number of special criteria for the university innovation ecosystem: the direction of the higher educational institution, the level of education, the approach to science, the degree of diffusion of innovations, the level of entrepreneurship development, the quantity and quality of links with the external environment, the physical infrastructure and its capabilities, and much more. The development degree of these and other criteria has a direct impact on the functioning, establishment and further development of the university's innovation ecosystem.

6. In the dissertation work, the author defines approaches to assessing the innovation ecosystem: institutional, structural, network, platform, factorial and traditional (rating). The conclusion is made about the need for an integrated approach to assessing the universities innovation ecosystem, which requires the study of institutions, participants, networks of their interaction, the specifics and influence of environmental factors (culture, resources, technologies, and so on), as well as the internal environment.

7. As a result of research, the author revealed that thanks to the interaction of the state, business and the academic sector, the Israeli development model has turned into a high-tech innovative industry, a startup industry. The role of the Israeli public sector, which supports the interaction between R&D in the military and civilian sectors, has been defined; programmes of cooperation with the private sector; incentives for foreign R&D centres of transnational corporations in Israel; the industrial sector benefits from access to advanced knowledge and technologies developed by research universities. The author notes that state structures support the priority industries for the state (low-tech, nanotechnology, biotechnology, cybersecurity technologies, environmental protection technologies) through grant programs of the R&D Fund and special programs, targeted assistance to industry research institutes, the creation of specialized incubators and venture financing funds, the organization of specialized centers in academic institutions, etc.

8. The relationship between science, education and high-tech industry of Israel in the field of innovation, which is developing consolidated and is systematic on the basis of the accumulated national innovative potential and international cooperation with leading countries, has been determined. According to the author, in this process, state policy in the field of financing R & D, training and providing highly professional personnel, bridging the gap between the technical sector and the rest of the economy should stimulate and accelerate the introduction of new technologies. The functioning of the national innovation ecosystem involves many tools: protection of property (both material and intellectual), capital management, labor, financial market and consumers. However, the interaction of the state, science and business, and, accordingly, the order of functioning of innovative development tools (protection of property, both material and intellectual; capital management, labor and others) depends on the specifics of the country, its economic and legal conditions.

9. The problems of the innovation ecosystem of Israeli universities are revealed on the basis of the analysis of the main elements (scientific, personnel, organizational, financial, interaction of participants): the desire to conduct applied research to a greater extent than fundamental research does not in each case have a positive impact on the research activities of universities; the preservation of the trend of low number and insufficient motivation of university researchers reduces the innovative activity of universities. low amounts of government funding for university R&D force universities to look for other sources. As a result, a gap is developing between the formation of an innovation infrastructure and obtaining noticeable results of the functioning of the innovation ecosystem. It affects the support and stimulation of the commercialization of intellectual activity, the lack of a management mechanism for the formation and development of innovation ecosystems hinders the effective relationships of its participants; the lack of consistency in the presentation of statistical data on the innovative activities of ecosystem participants impedes decision-making on its further development trajectory.

10. It is concluded that at the moment the universities innovation ecosystem is non-systematic and fragmented due to the lack of their participants: a single concept (only contractual obligations are fulfilled); collective assets located at different stages of the value chain; readiness for additional "investments" in a joint product. At the same time, key universities represent Israel's research cluster and are the anchor of Israel's technology and innovation system.

11. The analysis of competitiveness factors made it possible to identify external opportunities and internal reserves of the innovation ecosystem of Israeli universities, and also made it possible to determine strategic directions for developing a competitive strategy for the development of the university innovation ecosystem . The development of the university innovation ecosystem directly depends on the development of the external environment (state

policy, integration of economic sectors with science, infrastructure and development programs, etc.), as well as on the internal potential of universities for development (partnerships, human capital, infrastructure and programs, entrepreneurial culture).

In order to improve the assessment and management of the innovation ecosystem of higher education institutions, based on the results of the study, the author formulated the following recommendations:

1. Researchers and practitioners in the field of innovation ecosystems are encouraged to use the author's definition of the university's innovation ecosystem management mechanism. The structure of the mechanism is a set of processes, principles and methods that ensure the achievement of certain goals, the necessary dynamics of increasing funding, resources and connections in the process of interaction of its participants, their communities regarding the creation and commercialization of innovations. This definition reveals the essence of the structure of the management mechanism, which consists of interrelated elements that characterize the direction of the innovation ecosystem (mission, goals, and principles), the type of managerial activity of the subject (function). It consequently sustains an organizational and managerial impact on the process of creating and commercializing innovations, providing resources, interacting with ecosystem participants, entrepreneurial culture, results. The developed mechanism will allow regulating the management process based on the creation of a coordinating center based on the university and improve the productivity of relations between participants within the framework of their behavior models (autonomy, partnership, consensus, and division of functions) during the formation and development of the UIE. In order to facilitate the process of cognition and improve the accuracy of the conclusions formulated in the dissertation work, according to the author, it is advisable to conduct more of theoretical research on the study of the main approaches and concepts of the university's innovation ecosystem, using analytical, empirical methods.

2. The Israel Innovation Authority, the Israeli Ministry of Education, is invited to apply an integrated approach to the analysis of the formation and development of the innovation ecosystem of universities to maximize opportunities and minimize threats, which will form a common understanding of the problems of ensuring the growth of the ecosystem and develop strategic measures to eliminate them. To do this, it is necessary to develop a unified concept, policies, initiatives and specific support programs to ensure the formation and development of innovation ecosystems, improve the migration situation with scientific personnel in the country, provide universities with access to resources and support the national culture of entrepreneurship.

3. The Government of Israel is recommended to increase the allocated budget funds for university R&D as an investment to strengthen the material and technical base of higher education

institutions, create a more comfortable educational infrastructure, attract more talent and innovators.

4. The Israel Innovation Authority, the Israeli Ministry of Education, the Israeli National Bureau of Statistics are recommended to develop a database for managing innovation activities of various subjects, which is understood as an automated information system that allows collecting, storing, processing and transmitting (issuing) information. To do this, it is necessary to put into practice the provision of periodic reporting, reflecting the level of innovation activity of higher education institutions and other participants in the country's innovation ecosystem, in order to improve the efficiency of planning, organization, motivation, control, coordination and decision-making in the interests of all stakeholders.

5. Subjects of the Israeli higher education system are encouraged to develop their own model of the innovation ecosystem, taking into account the specifics of the university and the innovation environment, taking the model proposed by the author as a basis. The model includes: human capital, applicable regulations and procedures, tangible and intangible assets, organizational structures and other elements.

6. As recommendation for the higher education system in Israel was to take as a basis the mechanism for managing the innovation ecosystem of the university proposed by the author to form an effective system of interactions between participants in order to increase their innovative activity. The author proposes to apply in practice a set of management measures at the stages of formation and development of the innovation ecosystem, taking into account the specifics of the activities of a particular university. The creation of a coordination center as an element of the management mechanism proposed by the author will improve and structure management processes, distribute tasks between participants and improve interaction between them. The activities of the coordination center should be aimed at managing the provision of resources for the process of creating and commercializing innovations in order to obtain high results.

7. Universities and interested parties are recommended to implement a strategic approach to developing a strategy for the formation and development of an innovation ecosystem within the framework of three consecutive stages: carrying out theoretical and practical research; creation of an algorithm for the formation of strategies. Development of a content component of strategic scenarios. At the same time, universities are recommended to adhere to one of the strategic scenarios (university - creator of IE or university - participant of existing IE) when choosing an approach to developing a strategy for the formation and development of the innovation ecosystem. Performers (research units, technology transfer support units, business development units and companies, etc.) are recommended to carry out complex strategic activities that correspond to the specific strategies of the first or second scenario, depending on the stage of the IE life cycle.

8. The Israeli Ministry of Education, the National Bureau of Statistics of Israel, subjects of the higher education system are recommended to calculate an integral index of the development of the university's innovation ecosystem based on indicators of functional components (Academic research and entrepreneurship, Interactions and Networks, Processes, Resources), for comparison with other UIE and the formation of a national rating for the development of innovation ecosystems; Encourage higher education institutions that provide such data to adapt to the new reporting form, to track which indicators affect Israel's composite index of higher education integration. To calculate the integral index of the development of the university innovation ecosystem , it is recommended to use a balanced system of indicators, which is a universal mechanism for interpreting the university's strategy through a set of interrelated indicators.

9. Senior managers of universities are encouraged to create their own balanced scorecard to develop goals and management indicators of the strategy for the formation and development of the innovation ecosystem, harmonize strategic and current plans, and provide the necessary information on predetermined strategic aspects and indicators. The proposed four perspectives for building a strategic map for the formation of an innovation ecosystem (“technological entrepreneurship”, “interactions and connections”, “resources”, “infrastructure”) cover the “hard” and “soft” components of the innovation ecosystem in their causal relationships.

10. Subjects of the Israeli higher education system are recommended to put into practice the methodology developed by the author for assessing the development of the university's innovation ecosystem, which consists of four stages (the stage of determining the initial data; the stage of expert evaluation and data collection; the stage of assessing the UIE and calculating the integral index; the stage of summing up). This approach will accurately assess the effectiveness of the activities of various strategic aspects of the functional components of the UIE.

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APPENDIXES

Description of the fundamental aspects of the concept of innovation ecosystem

Elements of an innovation ecosystem	Content
Focal firm	Focal firm is responsible for management, depending on the specifics of the ecosystem, controls access to the platform or the right to use its brand and benefit from it; responsible for stability and creating joint results ²⁵⁶ .
Actors	The range of potential IE contributors (ranging from internal R&D contributors to numerous potential contributors outside the organization ²⁵⁷) and their number is determined by the degree of openness of the ecosystem. The goal of the collective efforts of a set of interrelated actors is to ensure technological and innovative development ²⁵⁸ . Actors perform various roles in the ecosystem: idea generators, researchers, investors, suppliers, and others. In other words, an innovation ecosystem can be characterized as a set of functions and purposes (search for investors, exchange of ideas and criticism of ideas, commercialization of ideas/knowledge, creation of functional structures that will implement these innovations, etc.). New actors, when included in the ecosystem, interact with the processes of other participants in the system.
Idea transformation process	Innovative ideas are a necessary element in the development of companies and organizations. Without them, it is impossible for organizations to remain socially significant organizations, provide competitive services, and strengthen their positions in the market. New ideas can be generated from research and development or are the result of non-R&D activities (e.g. managerial and organizational innovations, etc.) ²⁵⁹ .
Value proposition	A value proposition is a statement of the benefits that consumers will receive when purchasing a product or service. A particular IE member has the opportunity to personally benefit from the value created with the participation of other members of the ecosystem. For small organizations, participation in the ecosystem is a chance to be competitive in the global market.
Connections between actors	In the course of interactions between actors, a new organizational order or an integral model of ecosystem behavior spontaneously arises. The position, diversity of the members of the innovation ecosystem and the connections between them are essential for the successful functioning of the entire structure ²⁶⁰ . The unification of actors into an ecosystem occurs on the basis of self-organization, when the relationship between them forms connections based on the principles of cooperation and partnership. Reacting to feedback, the actors adapt to the emerging new organizational order: they change their technological solutions,

²⁵⁶ AUTIO, E., THOMAS, L.D. *Innovation Ecosystems: Implications for Innovation Management*. In: The Oxford Handbook of Innovation Management. London, 2013, p. 204–228. ISSN 978-0198746492.

²⁵⁷ OBERG, C., ALEXANDER, A.T. *The openness of open innovation in ecosystems — Integrating innovation and management literature on knowledge linkages*. In: Journal of Innovation & Knowledge, 2018, nr. 4(4), p. 211–218. DOI: 10.1016/j.jik.2017.10.005.

²⁵⁸ WESSNER, C. *Innovation Policies for the 21st Century: Report of a Symposium*. Washington, DC: The National Academies Press, 2007. 222 p. ISBN 978-0-309-10316-9.

²⁵⁹ SMORODINSKAYA, N., RUSSELL, M., KATUKOV, D., STILL, K. *Innovation ecosystems vs. innovation systems in terms of collaboration and co-creation of value*. In: Proceedings of the 50th Hawaii international conference on system sciences, 2017, p. 5245–5254. ISSN 978-0-9981331-0-2.

²⁶⁰ KOLLOCH, M., DELLERMANN, D. *Digital innovation in the energy industry: The impact of controversies on the evolution of innovation ecosystems*. In: Technological Forecasting and Social Change, 2018, nr. 136, p. 254–264. ISSN 0040-1625.

	structure, and behavior. Innovation networks characterize organizational forms of production in the digital age. Networks of collaborative innovation in which organizational members involved in the functions of knowledge production, wealth creation, and governance norms interact with each other to form co-evolution and interdependent relationships ²⁶¹ . Network members can unite in communities that are formed around a specific goal and act as a catalyst for the interaction of participants for the transformation, exchange, dissemination and effective distribution of knowledge and other resources. Innovation ecosystems are focused either on the direct co-creation of innovations, or on the formation of an innovation environment ²⁶² based on inter-firm or inter-organizational networks. The innovation environment is considered by some scientists as an innovation ecosystem that promotes the generation of ideas and their implementation in the form of new products, services or processes ²⁶³ . It is made up of ideas, technologies, rules of the game, social interactions and culture ²⁶⁴ .
Relationships between actors	Relationships between IE members are constantly changing as the companies aim to gain certain benefits. But companies can form such relations on the basis of which they create a mechanism for the distribution of benefits between actors and create conditions for joint development. The development and evolution of IE is closely based on the cooperation and coordination of its members. At the same time, the mechanisms of cooperation and interaction can be based on already existing integration forms (for example, clusters). At the same time, the ecosystem model expands the idea of local clustering to cover the network economy and various interdependent entities ²⁶⁵ .
Resources	Innovative resources are the basic conditions for any system for the implementation of innovative activities. Members of the innovation ecosystem can use various resources of the central entity to improve their financial performance. The model of cooperation between companies and universities promotes the exchange of talents, material resources, information, etc.
Innovation Ecosystem Strategy	The innovation ecosystem must match the innovation strategy and vice versa. The ability of a central firm to successfully commercialize a new product will depend on its own strategy and how it manages the strategy of the entire ecosystem.
Ecosystem boundaries	The boundaries of an ecosystem can be established on certain grounds. An individual company or organization can be a member of several ecosystems at the same time. At the same time, it can be a customer, a supplier of unique resources, or an executor of various projects.

Source: developed by the author based on ²⁵⁶⁻²⁶⁵

²⁶¹ CAI, Y., MA, J., CHEN, Q. *Higher Education in Innovation Ecosystems*. In: Sustainability, 2020, nr. 12(11), p. 43-56. ISSN 2071-1050.

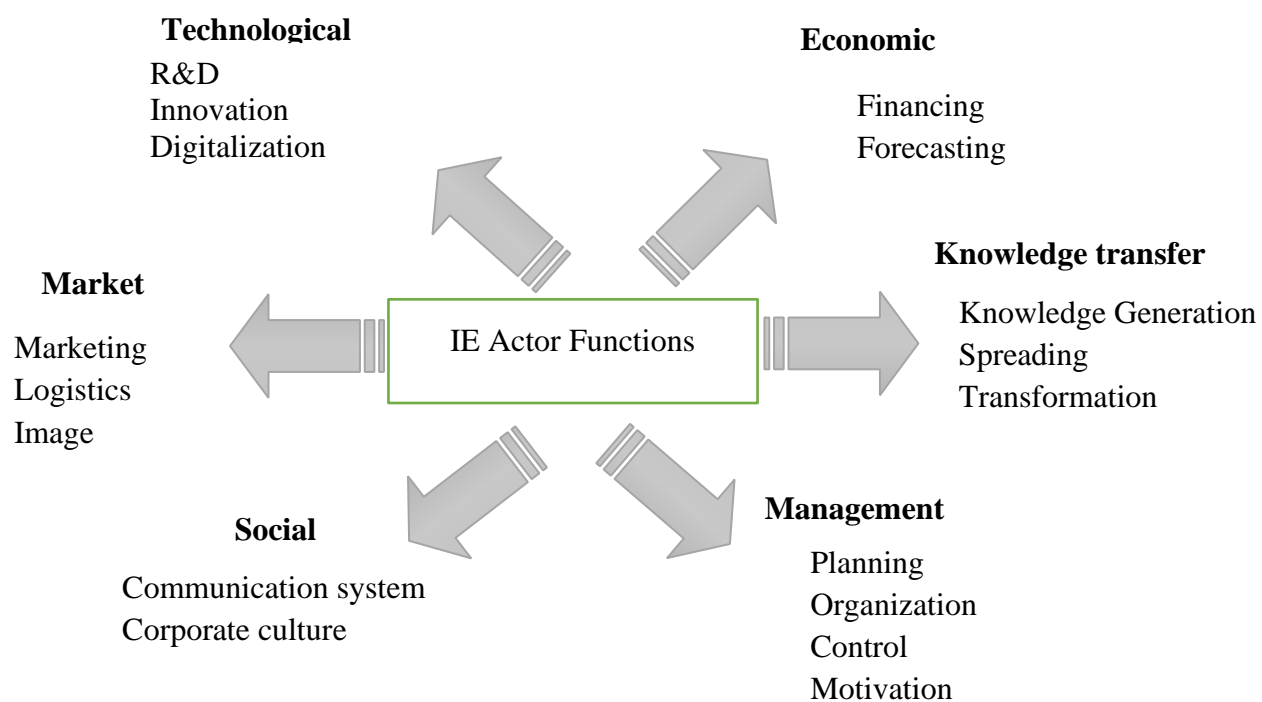
²⁶² WESSNER, C.W., *Entrepreneurship and the Innovation Ecosystem Policy Lessons from the United States*. In: Local Heroes in the Global Village. Boston: Springer, MA, 2005, p. 67-89. ISBN 9780387234755.

²⁶³ *The Global Competitiveness Report 2015–2016*. World Economic Forum, Geneva, 2015. 393 p. [accessed 03.09.2021]. Available at: https://www3.weforum.org/docs/gcr/2015-2016/Global_Competitiveness_Report_2015-2016.pdf.

²⁶⁴ MERCAN, B., GOKTAS, D. *Components of innovation ecosystems: a cross-country study*. In: International research journal of finance and economics, 2011, nr. 76(16), p. 102-112. ISSN 1450-2887.

²⁶⁵ RUBENS, N., STILL, K., HOHTAMKI, J., RUSSELL, M.G. *A Network Analysis of Investment Firms as Resource Routers in Chinese Innovation Ecosystem*. In: Journal of Software, 2011, № 9, p. 1737–1745. ISSN 1796-217X.

Functions of actors in the formation of an innovation ecosystem



Source: developed by the author

Definition of the concept of "innovation ecosystem"

The authors	Definition
Russell M. G., Smorodinskaya N. V. ²⁶⁶	Networks of sustainable connections between people, organizations and their decisions arising from a shared vision in about the desired changes.
Chessell M. ²⁶⁷	A networked community whose members combine their resources on mutually beneficial principles in order to jointly achieve innovative results.
Munro T. ²⁶⁸	A dynamic and adaptive organism that creates, consumes and transforms knowledge into innovative products.
Moore J.F. ²⁶⁹	Relationships between different companies are built as a network of interaction, similar to an ecosystem in nature.
Mitleton-Kelly E. ²⁷⁰	Organizations coexist in a social ecosystem, influencing and being dependent on other business participants, economic, cultural and legal institutions. The social ecosystem includes firms and institutions (not people) that coexist and develop together.
Ayres R. ²⁷¹	The purpose of the ecosystem is to improve the interaction of the company with its partners, increase competitive advantages, expressed in the creation of innovative products that will be the leader in their industry and involve the introduction of new standards for these products.
Wessner C. W. ²⁷²	Describes the complex synergies among various attempts to bring innovation to the market, including small and large businesses, universities, research institutions, venture capital capitalists and financial markets.
Fukuda K., Watanabe C. ²⁷³	Principles of functioning of the national IES: (a) Sustainable development through mutual exchange (b) Spontaneous reproduction through co-evolution (c) Organizational inertia and inspiration from competitors (d) Heterogeneous (diverse) synergy
Maxwell I. E. ²⁷⁴	It exists as a link that allows you to rally around yourself the resources necessary for the transfer of knowledge and teach companies to build their ecosystems.

Source: developed by the author based on ²⁶⁶⁻²⁷⁴

²⁶⁶ RUSSELL, M.G., SMORODINSKAYA, N.V. *Leveraging complexity for ecosystemic innovation*. In: Technological Forecasting and Social Change, 2018, nr. 136, p. 114-131. ISSN 0040-1625.

²⁶⁷ CHESSELL, M. *Innovation ecosystems-an IBM Academy of technology study: What are the characteristics of teams that makes collaborative innovation work between organizations*. Cambridge: Cambridge-MIT Institute Workshop on Open Innovation, 2008. 124 p. 978-9087900397.

²⁶⁸ MUNRO, T. *Triple Helix Newsletter*. In: Triple Helix Association, 2012, nr. 1, p.12-15. ISSN 2281-4515.

²⁶⁹ MOORE, J.F. *The death of competition: leadership and strategy in the age of business ecosystems*. New York: Harper Business, 1997. 320 p. ISBN 0887308503.

²⁷⁰ MITLETON-KELLY, E. *Ten Principles of Complexity and Enabling Infrastructures*. In: Complex Systems and Evolutionary Perspectives on Organizations, 2003, p. 2-31. [accessed 22.10.2022]. Available at: https://www.researchgate.net/publication/38959109_Ten_principles_of_complexity_and_enabling_infrastructures

²⁷¹ AYRES, R. *On the lifecycle metaphor: where ecology and economics diverge*. In: Ecological Economics, nr.48(4), p. 425-438. ISSN 0921-8009.

²⁷² WESSNER, C.W. *An assessment of the SBIR Program at the National Institutes of Health*. Washington: National Research Council. 2009. DC: The National Academies Press. ISBN 978-0-309-10951-2.

²⁷³ FUKUDA, K., WATANABE, C. *Japanese and US perspectives on the National Innovation Ecosystem*. In: Technology in society, 2008, nr. 30, p. 49-63. ISSN 0160-791X.

²⁷⁴ MAXWELL, I. *Managing Sustainable Innovation: The Driver for Global Growth*. New York: Springer, 2009. 200 p. ISBN 978-0-387-87580-4.

Comparative characteristics of ecosystem types

Year	Term/Author	Description
1989	Industrial Ecosystem (Frosch & Gallopoulos ²⁷⁵ ; Korhonen ²⁷⁶)	Based on an analogy in the total recycling of waste in a natural ecosystem. The idea did not take root, because not all waste can be recycled and reused, but it has influenced the raising of environmental standards.
1996	Entrepreneurial Ecosystem (Moore J.F. ²⁷⁷)	Relationships between different companies are built as a network of interaction, similar to an ecosystem in nature. The main idea is that with the help of cooperation it is possible to achieve much greater results than competing head-on. Stages of ecosystem evolution: creation, expansion, establishment of dominance in the created ecosystem, renewal or death.
2003	Social ecosystem (Mitleton-Kelly, E. ²⁷⁸)	Organizations coexist in a social ecosystem, influencing and being dependent on other business participants, economic, cultural and legal institutions. The social ecosystem includes firms and institutions (not people) that coexist and develop together. The work of such ecosystems is explained from the standpoint of complexity theory.
2004	Innovation Ecosystem (Ayres R. ²⁷⁹) (Wessner C. W. ²⁸⁰)	1. The purpose of the ecosystem is to improve the interaction of the company with its partners, increase competitive advantages, expressed in the creation of innovative products that will be the leader in their industry and involve the introduction of new standards for these products. The idea correlates with the approach to the formation of entrepreneurial ecosystems based on a product or technology, i.e. essentially creating complementary goods. 2. “describes the complex synergies among various attempts to bring innovation to the market. These efforts include small and large businesses, universities, research institutions, venture capitalists, and financial markets. (...) IE is also shaped by social norms and value systems, especially those related to attitudes towards failure, social mobility and entrepreneurship. (...) is characterized by the strength of its connections”.
2008	National Innovation Ecosystem (Fukuda K.,	Principles of functioning of the national IE: (a) Sustainable development through mutual exchange (b) Spontaneous reproduction through co-evolution (c) Organizational inertia and inspiration from competitors (d) Heterogeneous (diverse) synergy

²⁷⁵ FROSCH, R.A., GALLOPOULOS, N.E. *Strategies for manufacturing*. In: Scientific American, 1989, nr. 261, p. 144-152. ISSN 0036-8733.

²⁷⁶ KORHONEN, J. *Four ecosystem principles for an industrial ecosystem*. In: Journal of Cleaner Production, 2001, nr. 9, p. 253-259. ISSN 0959-6526.

²⁷⁷ MOORE, J.F. *Predators and prey: the new ecology of competition*. In: Harvard Business Review, 1993, nr. 71, p. 75-83. ISSN 0017-8012.

²⁷⁸ MITLETON-KELLY, E. *Ten Principles of Complexity and Enabling Infrastructures*. In: Complex Systems and Evolutionary Perspectives on Organizations, 2003, p. 2-31. [accessed 22.10.2022]. Available at: https://www.researchgate.net/publication/38959109_Ten_principles_of_complexity_and_enabling_infrastructures

²⁷⁹ AYRES, R. *On the lifecycle metaphor: where ecology and economics diverge*. In: Ecological Economics, nr.48(4), p. 425-438. ISSN 0921-8009.

²⁸⁰ WESSNER, C.W. National Research Council, Committee on Capitalizing on Science, Technology, and Innovation: An Assessment of the Small Business Innovation Research Program – 2004. [accessed 17.10.2022]. Available at: www.6cp.net/downloads/03vancouver_wessner.ppt.

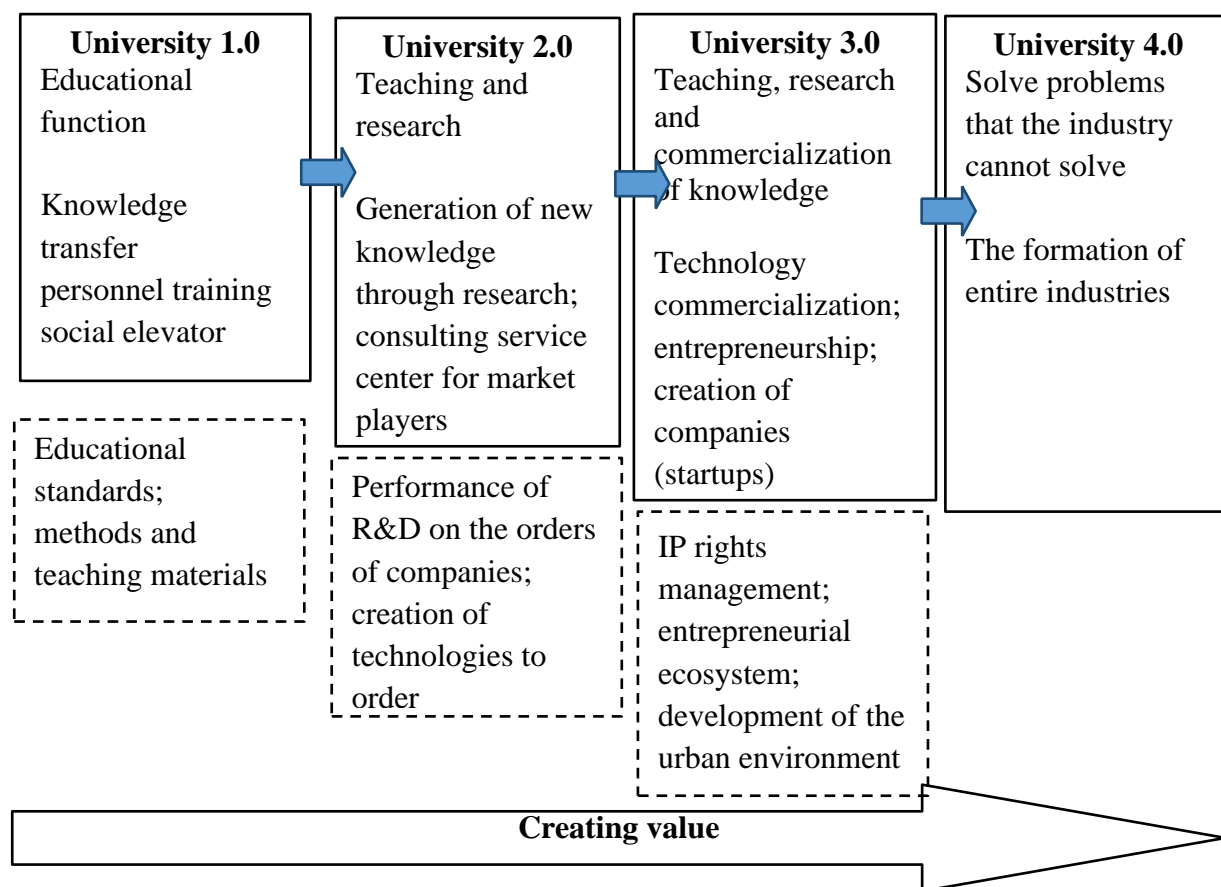
	Watanabe C. ²⁸¹⁾	
2009	University Entrepreneurial Ecosystem (Maxwell I. ²⁸²⁾	It exists as a link that allows you to rally around yourself the resources necessary for the transfer of knowledge and teach companies to build their ecosystems.

Source: developed by the author based on ²⁷⁵⁻²⁸²

²⁸¹ FUKUDA, K., WATANABE, C. *Japanese and US perspectives on the National Innovation Ecosystem*. In: Technology in society, 2008, nr. 30, p. 49-63. ISSN 0160-791X.

²⁸² MAXWELL, I. *Managing Sustainable Innovation: The Driver for Global Growth*. New York: Springer, 2009. 200p. ISBN 978-0-387-87580-4.

University Models



Source: developed by the author based on²⁸³

²⁸³ KARPOV, A.O. *University 3.0—social mission and reality*. In: Sociological Studies, 2017, nr. 9(9), p. 114-124. DOI: 10.7868/S0132162517060137.

The Role and Importance of University Entrepreneurial Ecosystems in Regional and National Development

The authors	The roles of universities
The European University Association (EUA) ²⁸⁴	EUA has formulated four roles for universities in regional innovation systems: <ul style="list-style-type: none"> - providing human capital to create innovations through education, - co-production of knowledge to create private and public value through research, - technology transfer for co-creation of innovations through knowledge sharing, - introduction of innovations through institutional transformations and development strategies.
Cai, Y. ²⁸⁵	Cai Y. reveals several more aspects of the role of universities in the innovation ecosystem: <ul style="list-style-type: none"> - the role of the university is changing from a central player to an anchor organization through trust between participants in the transfer of technologies (knowledge exchange) for joint value creation; - social relations to build trust between participants is identified as a key factor in the successful exchange of knowledge and the creation of a network of collaborative innovations; - institutional entrepreneurs (politicians, top managers or some scientists) play a significant role in the process of stimulating innovation.
Tartari, V., Stern, S. ²⁸⁶	The authors reveal the roles of universities in local entrepreneurial ecosystems: <ul style="list-style-type: none"> - universities focus on the quality and level of relationships with entrepreneurship, - demographic and economic factors affect both the location of the university and entrepreneurial ecosystems, - the role of resource availability, including increased research-oriented funding, develops and improves the quality of entrepreneurship.
Lehmann, E. E., Meoli, M., Paleari, S., Stockinger, S. A. ²⁸⁷	The relationship between higher education and the entrepreneurial ecosystem is revealed in two directions: the development and improvement of the internal structures of universities, adaptation to external conditions based on the policy of higher education and interaction with the business environment.
Audretsch, D. B., Hülsbeck, M., Lehmann E. E. ²⁸⁸	Universities are seen as key agents contributing to regional economic growth and competitiveness.
Cunningham, J. A., Lehmann E.E., Menter M., Seitz N. ²⁸⁹	The role of universities as key players contributes to the economic growth of companies, stimulates entrepreneurial behavior and innovative activity, and supports private sector entities.

Source: developed by the author based on ²⁸⁴⁻²⁸⁹

²⁸⁴ REICHERT, S. *The Role of Universities in Regional Innovation Ecosystems*. In: EUA study, Brussels: European University Association, 2019, p. 22-47. ISBN 9789078997030.

²⁸⁵ CAI, Y. FERRER, B.R., LASTRA, J.L. *Building University-Industry Co-Innovation Networks in Transnational Innovation Ecosystems: Towards a Transdisciplinary Approach of Integrating Social Sciences and Artificial Intelligence*. In: Sustainability, 2019, nr. 11, p. 46-53. ISSN 2071-1050.

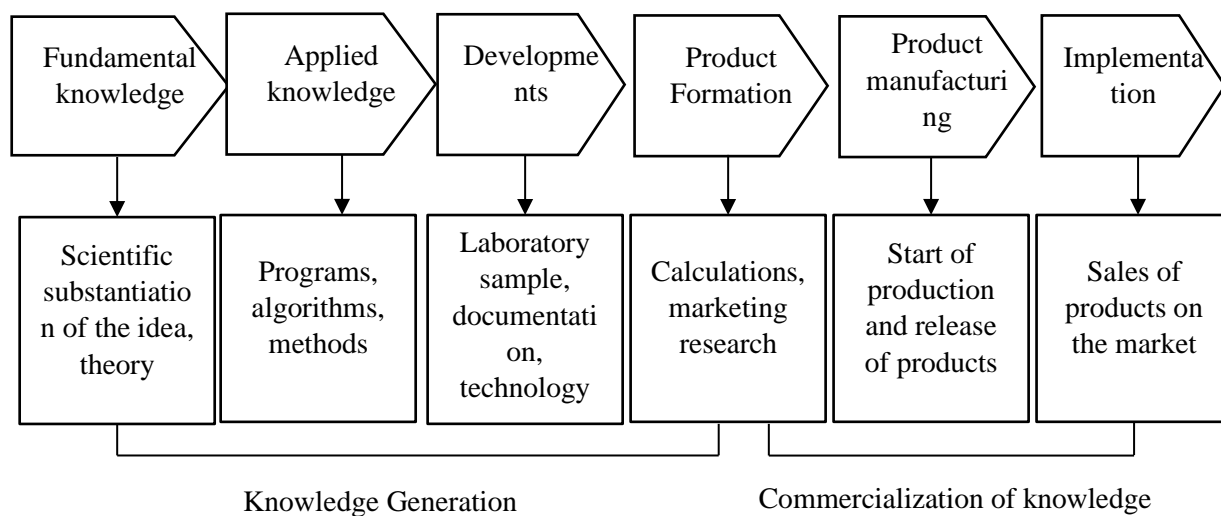
²⁸⁶ TARTARI, V., STERN, S. *The Role of Universities in Local Entrepreneurial Ecosystems*. In: Conference Druid 2018, p. 42-91. ISSN 15329194.

²⁸⁷ LEHMANN, E.E., MEOLI, M., PALEARI, S., STOCKINGER, S.A. *The role of higher education for the development of entrepreneurial ecosystems*. In: European Journal of Higher Education, 2020, nr. 10(1), p. 1-9. ISSN 21568235.

²⁸⁸ AUDRETSCH, D.B., HÜLSBECK, M., LEHMANN, E.E. *Regional competitiveness, university spillovers, and entrepreneurial activity*. In: Small business economics, 2012, nr. 39(3), p. 587-601. ISSN 1573-0913.

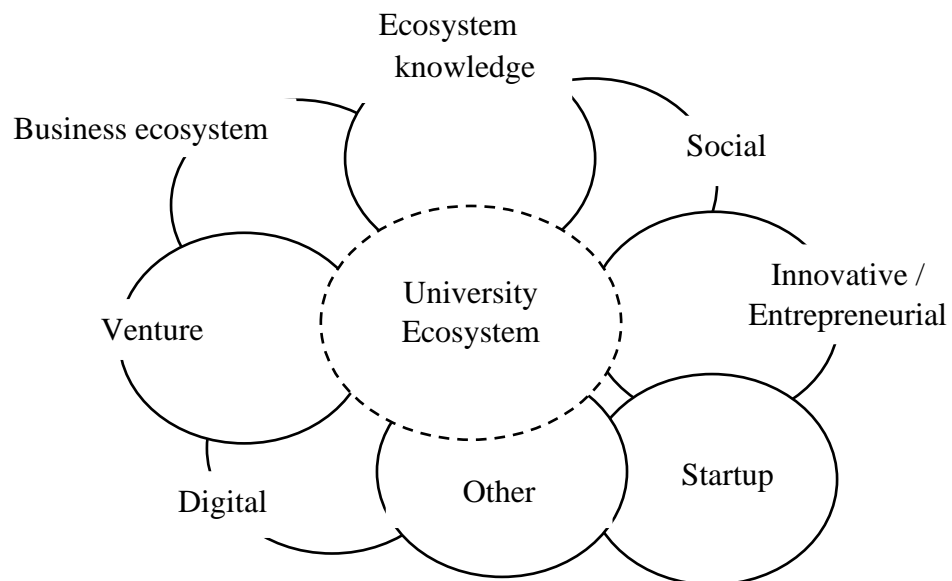
²⁸⁹ CUNNINGHAM, J.A., LEHMANN, E.E., MENTER, M., SEITZ, N. *The impact of university focused technology transfer policies on regional innovation and entrepreneurship*. In: The Journal of Technology Transfer, 2019, nr. 44(5), p. 51-75. ISSN 8929912.

General scheme of knowledge generation and commercialization



Source: developed by the author

University as a component of various ecosystems



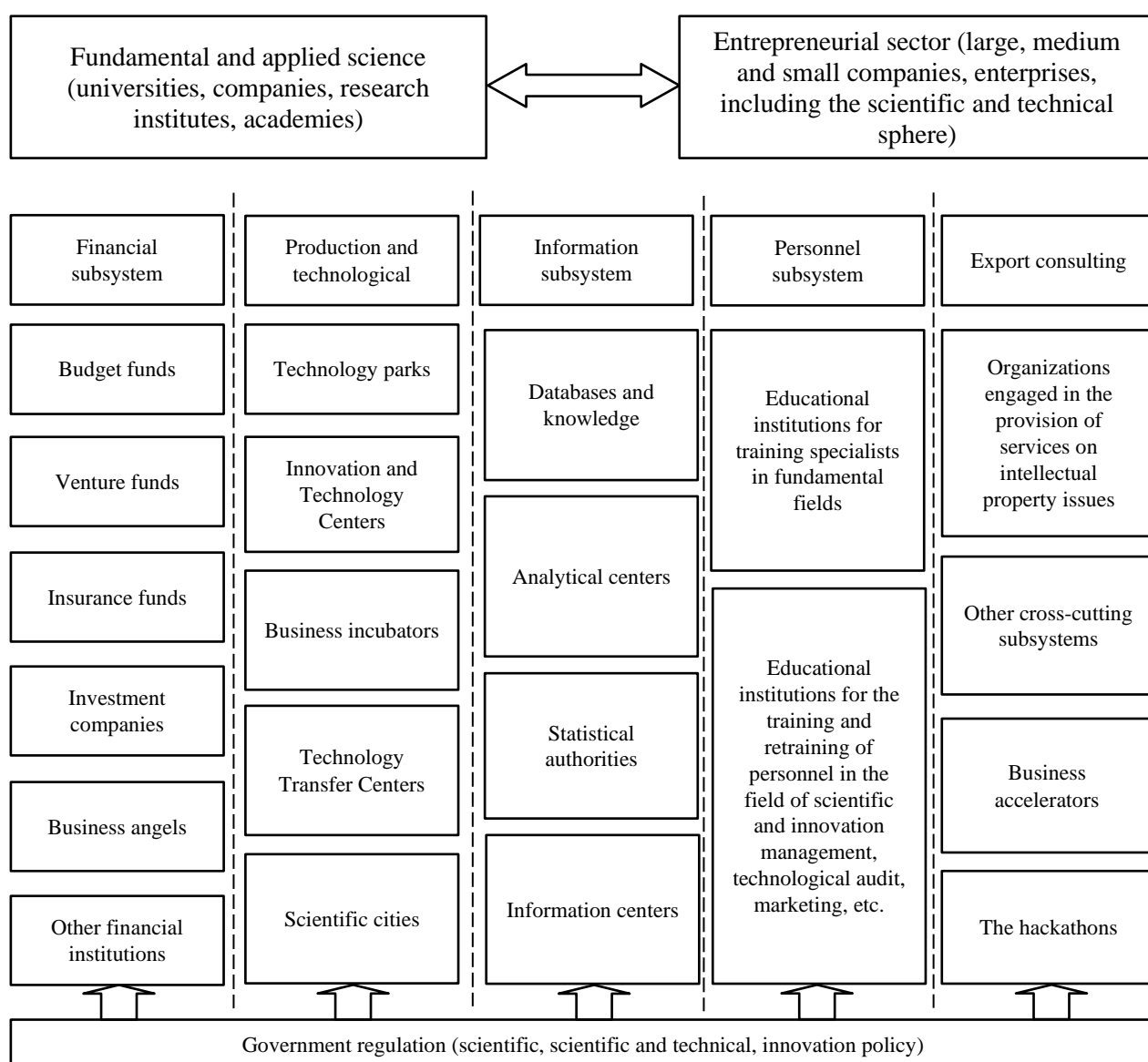
Source: developed by the author

Comparative characteristics of network interaction between UIE participants and ordinary network associations

Indicators	Key features of an ecosystem	Features that do not correspond to the ecosystem approach
Composition of participants and goals of their interaction	Diversity of participants, person-centered approach to the result of interaction	A network of homogeneous participants (for example, employers in the same industry), focusing on general performance indicators that are not related to the training and development of a particular participant
Control Format	Decentralized governance	Initiated "from above" hierarchical structure
Providing forms of interaction	Variety of financial and other resources	Association with the support of one sponsor
Principles of interaction	<ul style="list-style-type: none"> -Cooperation and synergy -Integrating solutions (platforms and knowledge centers) -Maximum implementation of each and the efficiency of the entire system through cooperation 	<ul style="list-style-type: none"> - An association with a low level of cooperation, where the members do not benefit from the association - Partnership, where the user does not have access to the resources of different participants - An alliance without a common goal

Source: developed by the author

System of elements of the national innovation infrastructure



Source: developed by the author

**Israel's Innovation Strengths and Weaknesses in the context of Global Innovation Index
2019, 2020, 2021**

**Table 11.1. Israel's Innovation Strengths in the context of Global Innovation Index
2019, 2020, 2021**

Code	Indicator name	Rank		
		2019	2020	2021
2.	Human capital and research	14	15	19
2.3	Research & development (R&D)	2	3	8
2.3.1	Researchers, FTE/mn pop.	1	1	n/a
2.3.2	Gross expenditure on R&D, % GDP	1	1	1
4.	Market sophistication	16	14	8
4.2.3	Venture capital deals/bn PPP\$ GDP	3	5	1
4.2.4	Venture capital recipients, deals/bn PPP\$ GDP	-	-	1
5.	Business sophistication	3	3	8
5.1.3	GERD performed by business, % GDP	1	1	1
5.1.5	Females employed w/advanced degrees, %	3	23	25
5.2	Innovation linkages	1	1	1
5.2.1	University/industry research collaboration	2	1	1
5.2.3	GERD financed by abroad, %	3	1	1
5.2.4	Joint venture/strategic alliance deals/bn PPP\$ GDP	8	5	3
5.2.5	Patent families 2+ offices/bn PPP\$ GDP	2	1	8
5.3.5	Research talent, % in business enterprise	1	1	n/a
6.	Knowledge and technology outputs	7	4	6
6.1.2	PCT patents by origin/bn PPP\$ GDP	-	-	1
6.3	Knowledge diffusion	-	-	2
6.3.3	ICT services exports, % total trade	1	1	-
6.3.4	ICT services exports, % total trade	-	-	1
7.	Creative outputs	14	26	30
7.2.1	Cultural & creative services exports, % total trade	4	4	5
7.3.3	Wikipedia edits/mn pop. 15–69	1	3	1
7.3.4	Mobile app creation/bn PPP\$ GDP	1	1	1

Notes: highlighted in color Israel's Innovation Strengths in the context of GII

Source: developed by the author based on ²⁹⁰ ²⁹¹ ²⁹²

²⁹⁰ *Global Innovation Index 2019*. [accessed 07.12. 2020]. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2019/il.pdf

²⁹¹ *Global Innovation Index 2020*. [accessed 07.12. 2020]. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020/il.pdf

²⁹² *Global Innovation Index 2021*. [accessed 07.12. 2020]. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2021/il.pdf

**Table 11.2. Israel's Innovation Weaknesses in the context of Global Innovation Index
2019, 2020, 2021**

Code	Indicator name	Rank		
		2019	2020	2021
1.	Institutions	31	35	34
1.1.1	Political and operational stability	46	49	60
1.2.3	Cost of redundancy dismissal, salary weeks	111	113	114
2.	Human capital and research	14	15	19
2.1.2	Government funding/pupil, secondary, % GDP/cap	56	57	50
2.1.4	PISA scales in reading, maths & science	38	39	39
2.1.5	Pupil-teacher ratio, secondary	26	30	68
2.2	Tertiary education	72	59	77
2.2.2	Graduates in science and engineering, %	n/a	n/a	85
2.2.3	Tertiary inbound mobility, %	67	68	70
3.	Infrastructure			
3.1.4	E-participation	43	43	66
3.2.3	Gross capital formation, % GDP	89	81	84
4.	Market sophistication	16	14	8
4.1.1	Ease of getting credit*	54	44	44
5.	Business sophistication	3	3	8
5.1.2	Firms offering formal training, % firms	76	76	81
5.1.4	GERD financed by business, %	54	49	52
5.3.1	Intellectual property payments, % total trade	65	65	64
7.	Creative outputs	14	26	30
7.1	Intangible assets	39	65	75
7.1.1	Trademarks by origin/bn PPP\$ GDP	101	105	109

Notes: highlighted in color Israel's Innovation Weaknesses in the context of GII

Source: developed by the author based on ^{293 294 295}

²⁹³ *Global Innovation Index 2019.* [accessed 07.12. 2020]. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2019/il.pdf

²⁹⁴ *Global Innovation Index 2020.* [accessed 07.12. 2020]. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020/il.pdf

²⁹⁵ *Global Innovation Index 2021.* [accessed 07.12. 2020]. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2021/il.pdf

Israel ranking in the National Entrepreneurship Context Index (GEM NECI)

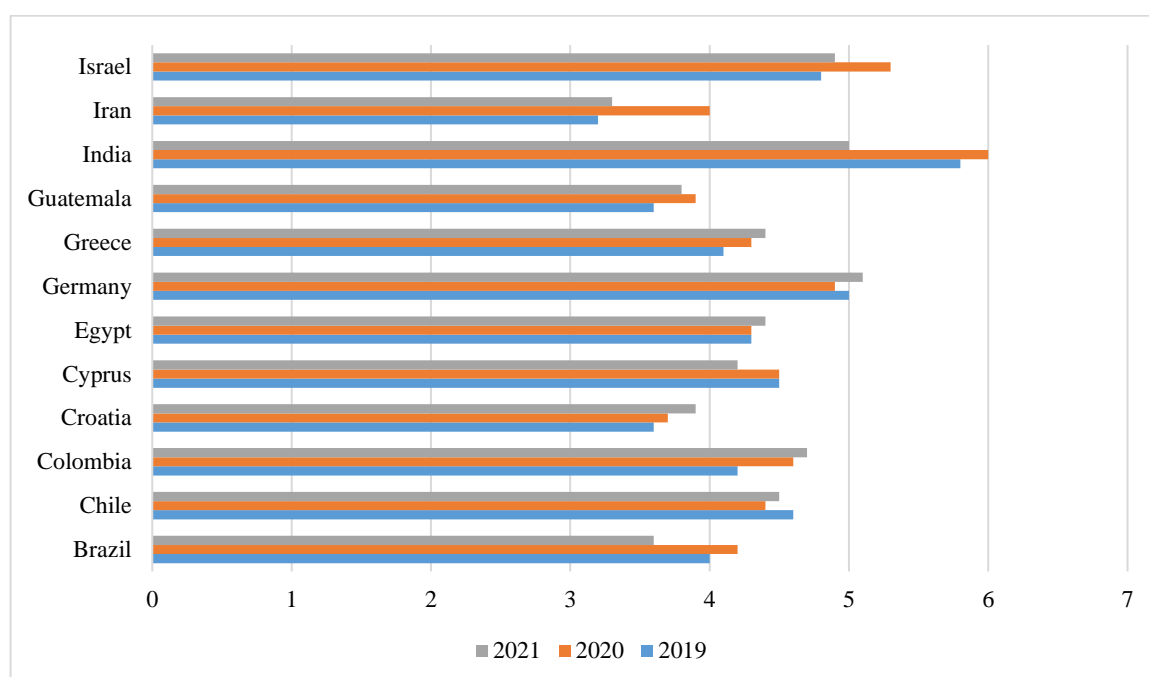


Figure 12.1. Comparison of National Entrepreneurship Context Index (NECI) across 2019, 2020, 2021

Source:²⁹⁶



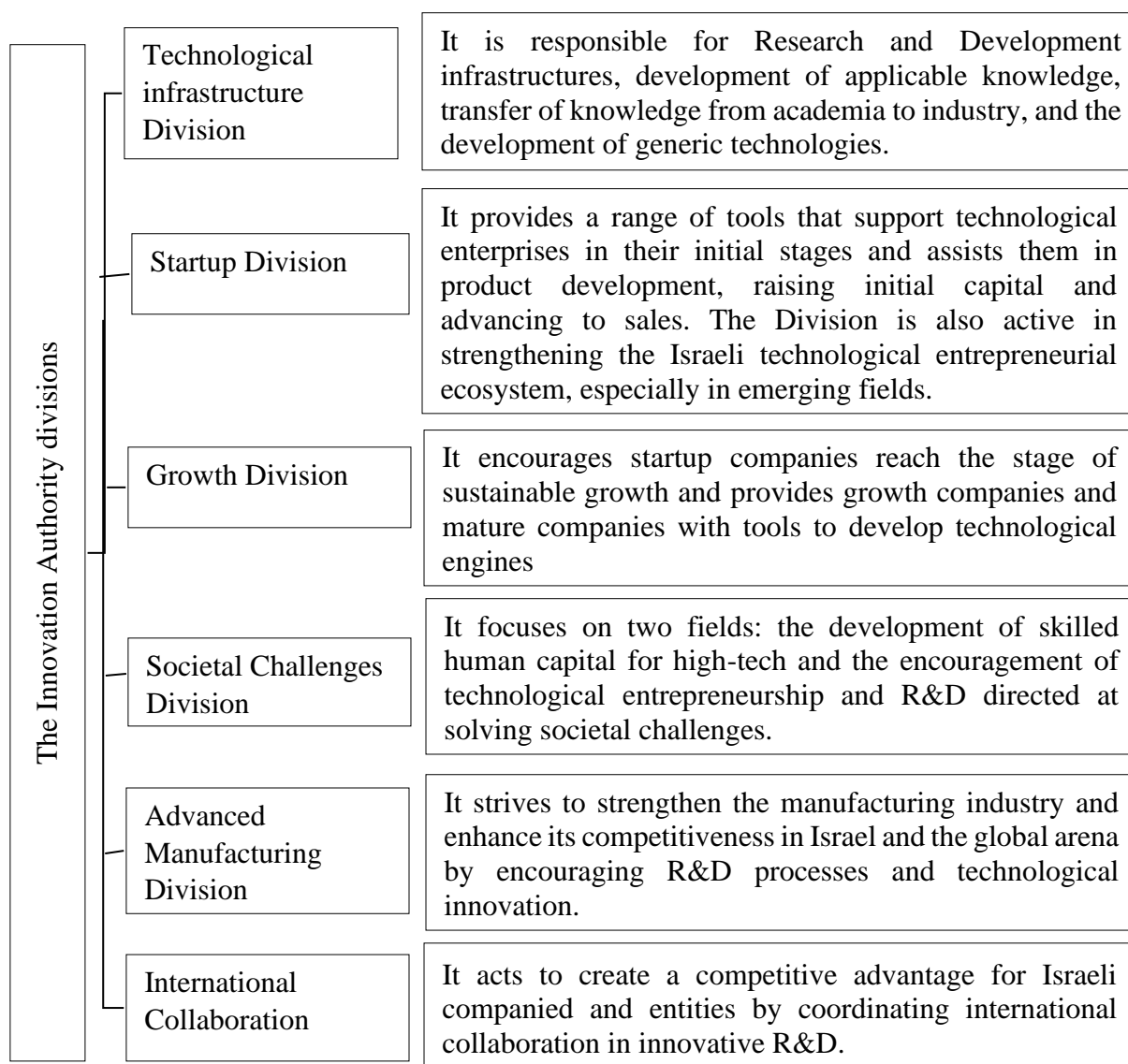
Figure 12.2. Entrepreneurial Framework Conditions of Israel 2021

Source:²⁹⁷

²⁹⁶ Which are the best countries in the world for entrepreneurs in 2022? World Economic Forum. [accessed 12.04.2023]. Available at: <https://www.weforum.org/agenda/2022/04/new-research-reveals-best-countries-entrepreneurs/>

²⁹⁷ *Entrepreneurial Behaviour and Attitudes*, 2021. [accessed 18.08.2022]. Available at: <https://www.gemconsortium.org/economy-profiles/israel-2#:~:text=On%20Government%20Policy%3A%20Support%20and,down%20from%204.6%20in%202020>

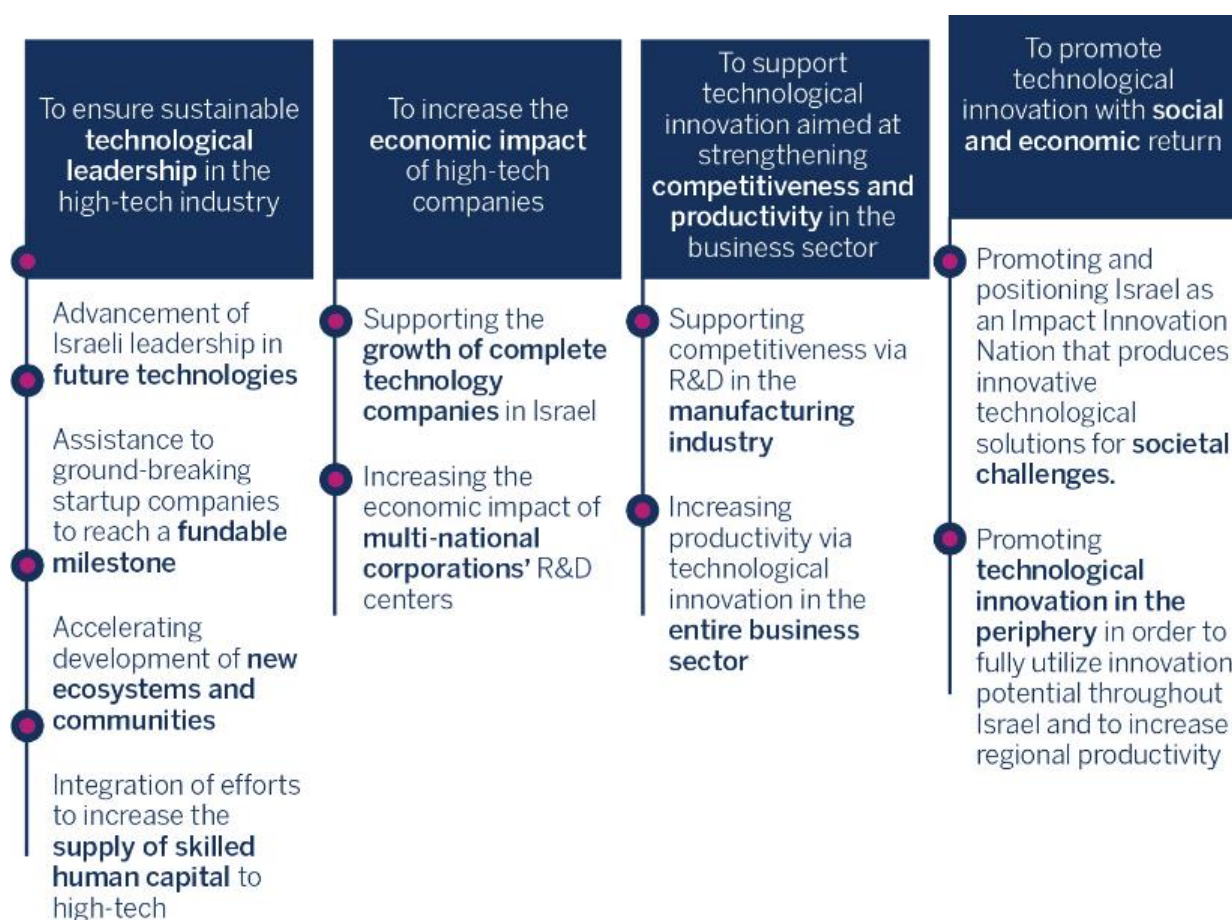
Tasks of the main divisions of the Israel Innovation Authority



Source: developed by the author based on²⁹⁸

²⁹⁸ *The Innovation Authority*. Soaring achievements. Israel Innovation Authority, 2020. [accessed 15.05.2020]. Available: <https://innovationisrael.org.il/en/reportchapter/innovation-authority>.

Strategic Objectives of Innovation Authority 2018-2022



Source: ²⁹⁹

²⁹⁹ *The Innovation Authority*. Soaring achievements. Israel Innovation Authority, 2020. [accessed 15.05.2020]. Available: <https://innovationisrael.org.il/en/reportchapter/innovation-authority>

High Tech Sector Indicators

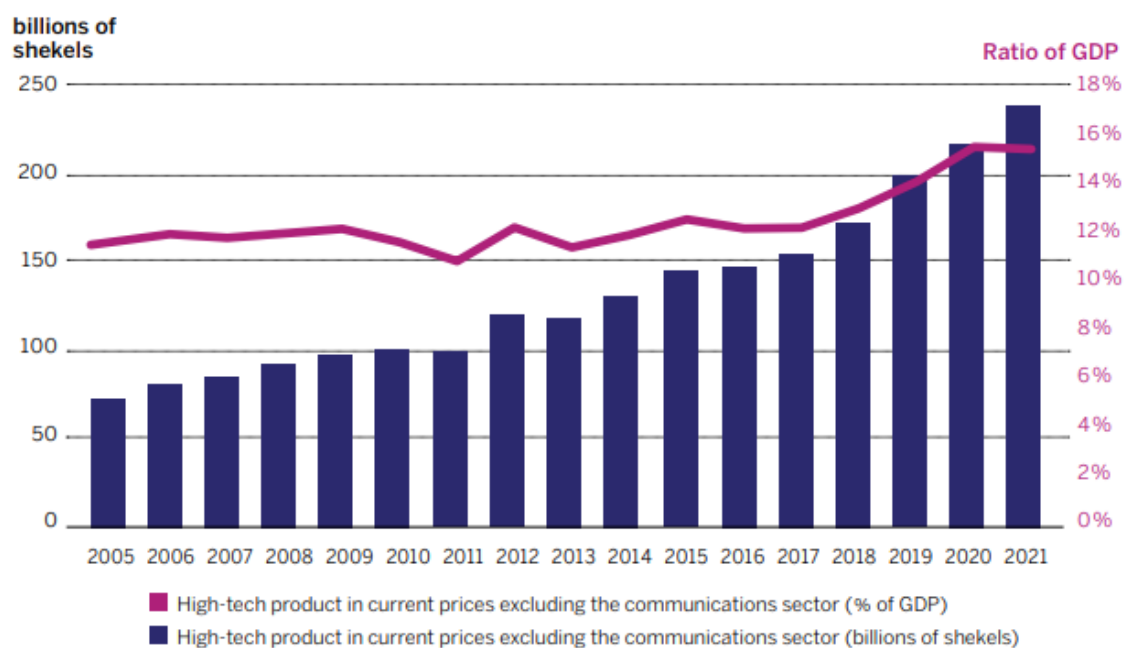


Figure 15.1. High-Tech product in current prices excluding the communications sector 2005-2021 (% of GDP, ILS billions)

Source:³⁰⁰

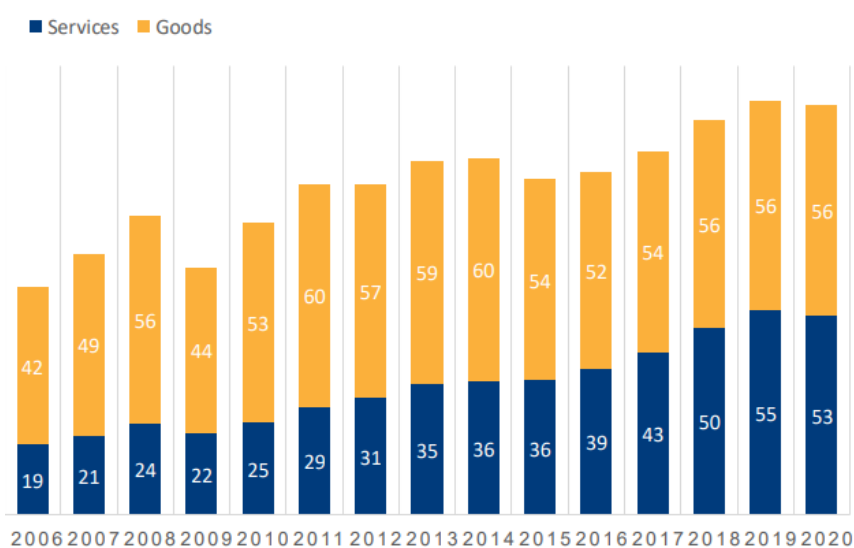


Figure 15.2. High-tech services: the main growth engine of exports in recent years 2006 - 2020 (billions of USD)

Source:³⁰¹

³⁰⁰ Annual Innovation Report State of High-Tech 2022. Israel Innovation Authority. [accessed 21.08.2022]. Available at: <https://innovationisrael.org.il/en/sites/default/files/Annual%20Innovation%20Report%20-%20State%20of%20High-Tech%202022.pdf>

³⁰¹ Israeli Economy: Past, Present, Future. 2021. [accessed 03.02.2022]. Available at: <https://www.export.gov.il/api/Media/Default/Files/IsraelsEconomy.pdf>

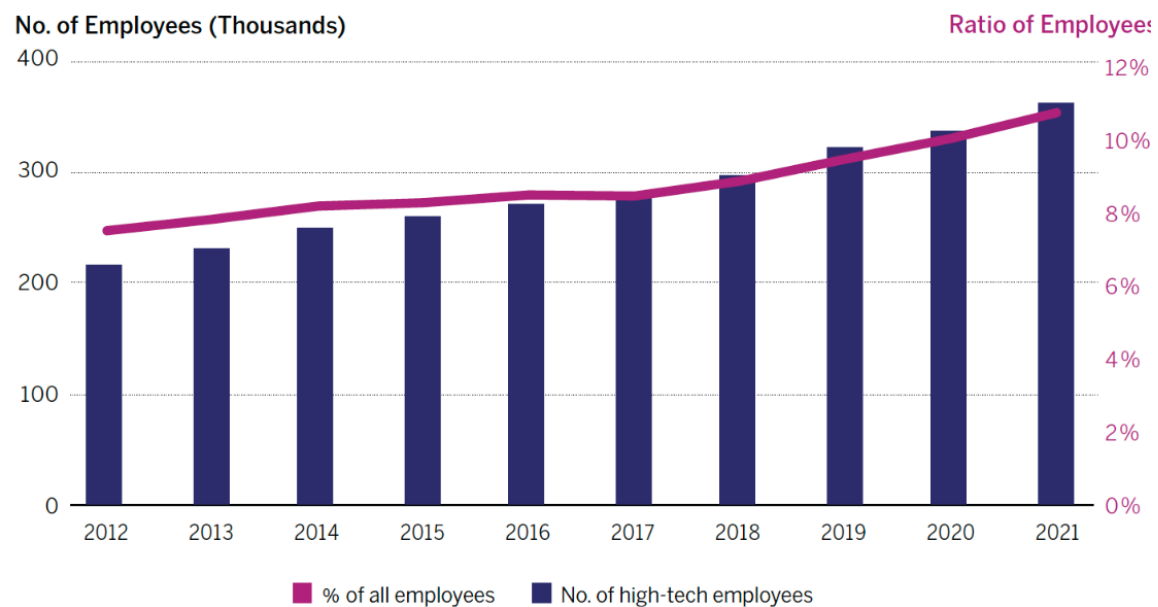


Figure 15.3. Ratio of salaried high-tech employees to all employees 2012-2021

Source:³⁰²

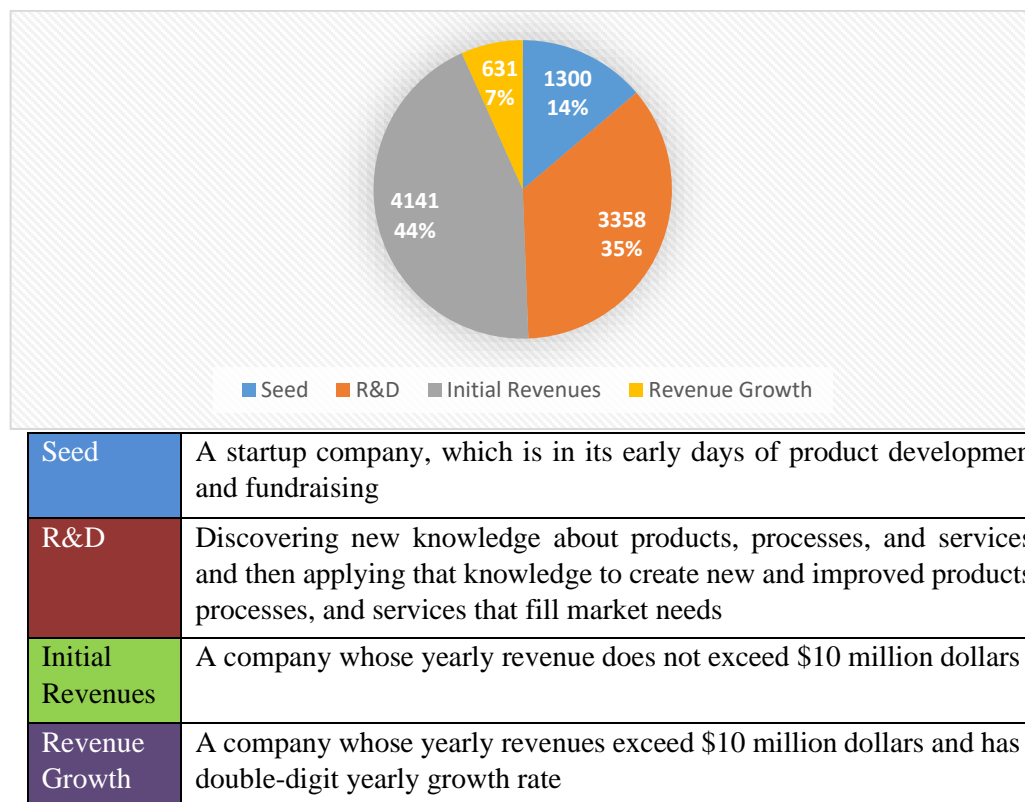


Figure 15.4. Active High-Tech Companies by Stage

Source: developed by the author based on³⁰³

³⁰² *Annual Innovation Report State of High-Tech 2022*. Israel Innovation Authority. [accessed 21.08.2022]. Available at: <https://innovationisrael.org.il/en/sites/default/files/Annual%20Innovation%20Report%20-%20State%20of%20High-Tech%202022.pdf>

³⁰³ *Israeli tech ecosystem. Overview: Entrepreneurs, Companies, Investors and Major Trends 2015-2020*. [accessed 01.08.2022]. Available at: [https://www.ivc-online.com/Portals/0/RC/POSTS/IVC Israeli Entrepreneurial FEB 2021 Final.pdf?ver=2021-02-07-115759-273×tamp=1612691886497](https://www.ivc-online.com/Portals/0/RC/POSTS/IVC%20Israeli%20Entrepreneurial%20FEB%202021%20Final.pdf?ver=2021-02-07-115759-273×tamp=1612691886497)

Characteristics of R&D sectors

Criteria	R&D Research Sector		
	Commercial	Scientific	Governmental
Research types	Applied research	Basic research	Applied research
Research area	Different sectors of the economy		Agriculture, healthcare, environmental quality, education, etc.
Organizations	Business structures	Research universities	Government research institutes or government departments
Financing	Funds of the companies themselves, local and foreign investors, venture capital funds, The R&D Fund, etc.	ISF*, PBC**, national, binational and the research foundations, general university fund	Public funds

* ISF - the Israel Science Foundation

** PBC - the Planning and Budgeting Committee is a sub-committee of the Council for Higher Education

Source: developed by the author based on³⁰⁴

³⁰⁴ *Technology Transfer in Countries in Transition: Policy and Recommendations*. WIPO, 2012. [accessed 19.11.2020]. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_transition_2_b.pdf.

Patent Sector of Israel

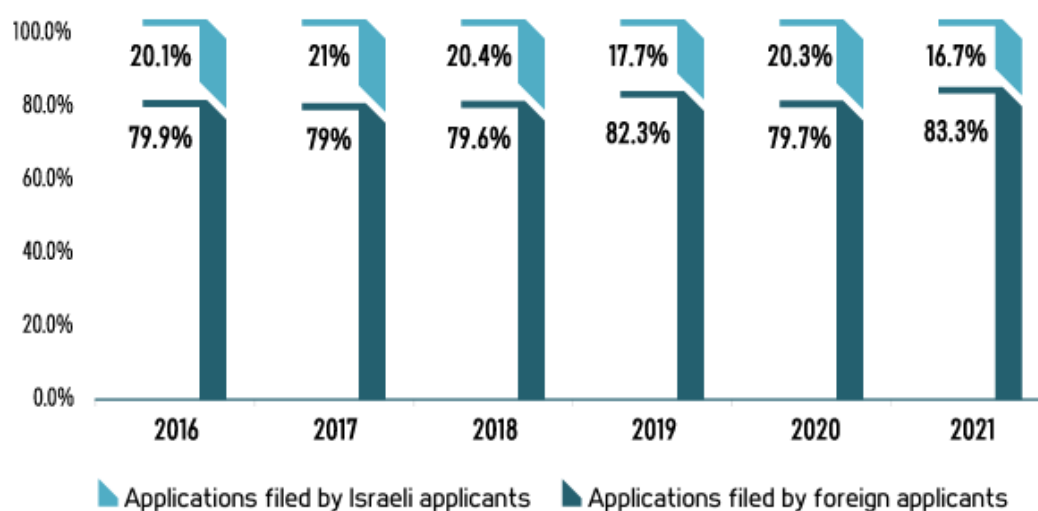


Figure 17.1. Israeli Applicants vs. Foreign Applicants, 2016-2021

Source:³⁰⁵

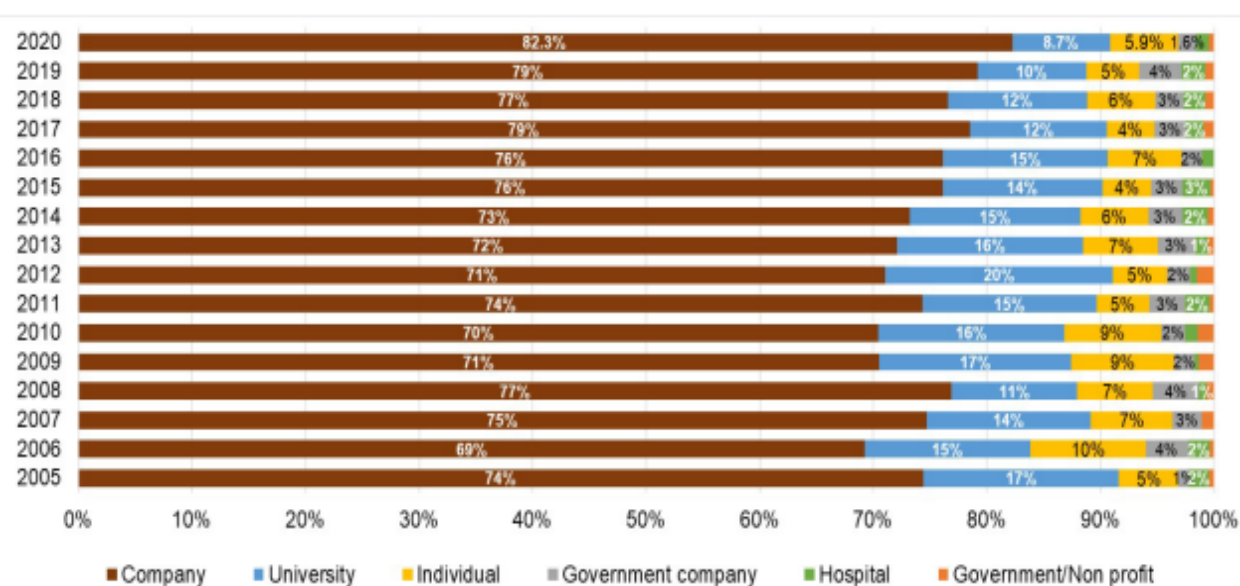


Figure 17.2. Patent Sector Distribution in the EPO in the years 2005-2020

Source:³⁰⁶

³⁰⁵ Israel Patent Office. *Annual Report 2021*. [accessed 27.01.2023]. Available at:

https://www.gov.il/BlobFolder/reports/new-annual-reports/en/annual-reports_eng_main-annual-report-2021-eng.pdf

³⁰⁶ LECK, E., GETZ, D., ZETCOVETSKY, I. *Research and Development Outputs in Israel: 2000-2020 Academy-Industry Cooperation Final Report*. Israel: Samuel Neaman Institute, 2021. 74 p. [accessed 07.05.2022]. Available at: https://www.neaman.org.il/EN/Files/Report_Patent%20report%202021%20Final%20with%20access.pdf

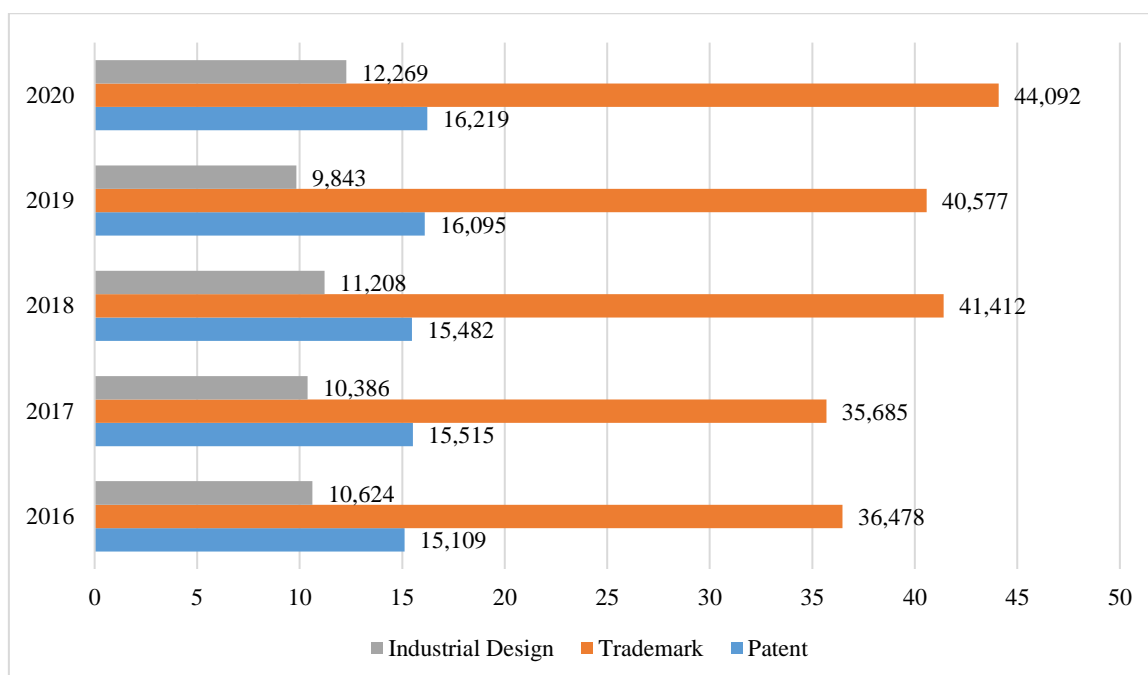


Figure 17.3. Israeli Intellectual Property Applications (residents and foreign applicants) in 2016-2020

Source: ³⁰⁷

³⁰⁷ *Statistical Country Profiles*. Israel. WIPO statistics database, 2021. [accessed 03.02.2022]. Available at: https://www.wipo.int/ipstats/en/statistics/country_profile/profile.jsp?code=IL

Characteristics of technology transfer organizations

Participating organizations	Characteristic	Target	Examples in Israel
technology parks	Components of technoparks: scientific and industrial base; availability of funding (mainly venture capital); the presence of entrepreneurs (startups, spinoffs); a network of relationships built on trust at the individual level; opportunities for interaction between universities, business, government, and other structures.	Development of the region by creating conditions for the commercialization of knowledge and technologies.	Israel has 5 Science Parks ³⁰⁸ and 28 Hi-Tech Industry Parks ³⁰⁹ . Science Parks: Hi-Tech Park of the Ben-Gurion University, Kiryat Weizmann Science Park, The Malha Technology Park (Jerusalem Technology Park), MATAM/Haifa Industrial Park for R&D Centres, Migdal Ha'emek Science Park.
Incubators	Incubators are designed to invest in new start-up companies and provide them with technological, business and administrative support. The Incubator offers a supporting framework for starting a company and developing a concept into a commercial product.	Transforming theoretical knowledge into financial benefits through informal contacts and networks of innovation between the parties involved.	Incubator Incentive Program developed by the Startup Division. Division programs include: Tnufa, Incubators Incentive Program, Early Stage Companies, Innovation Labs. In 2018 73 entrepreneurs received support as part of the Tnufa Program, 5 innovation labs began operating in the fields of advanced manufacturing, transportation, construction, food-tech and advanced materials.
Venture capital institutions	The availability of venture capital plays an important role in the financing mechanism of the Israeli innovation ecosystem ³¹⁰ .	Investment in the company at all stages, including the initial stage.	YOZMA Program ³¹¹ ; local and global angels (iAngels, iStartup Angels, Angel Investment Network Israel, Access Silicon Valley Tel Aviv, Spinach Angels), venture capitalists (Singulariteam, Carmel Ventures, Innovation Endeavors, Magma, First Time, JVP, Vintage, Pontifax, Marker, Blumberg, OrbiMed Israel, Plus Ventures and Disruptive), micro-venture funds (Lool Ventures, Peregrine, Elevator Ventures and InovGate. Transnational corporation), crowdfunding platforms and

³⁰⁸ *Science Policy and Capacity-Building*, UNESCO. [accessed 04.04.2022]. Available at: <http://www.unesco.org/new/en/natural-sciences/science-technology/university-industry-partnerships/science-parks-around-the-world/science-parks-in-middle-east/>

³⁰⁹ *Israel Science and Technology Directory*. [accessed 04.04.2022]. Available at: <https://www.science.co.il/technology/Parks.php>.

³¹⁰ WONGLIMPIYARAT, J. *Mechanisms behind the successful VC nation of Israel*. In: *The Journal of Private Equity*, 2015, nr. 18(4), p. 82-89. ISSN 10965572.

³¹¹ BAR-EL, R., SCHWARTZ, D., BENTOLILA, D. *Singular Factors behind the Growth of Innovation in Israel*. In: *Athens Journal of Mediterranean Studies*, 2019, nr. 5/3, p. 137-150. ISSN 2407-9480.

			international conglomerates and others.
Startup ecosystem	Startup ecosystems provide assistance to young companies at the very start so that they can attract investments from venture capital funds for further growth.	Creation of successful projects, infrastructure and space for the creation and development of business.	At the stage of the idea of developing independent projects: in startup media (CTech, NoCamels, Startup Digest Tel Aviv, etc.); at master classes for startups ("Bad-Idea-Start-Up"-Meetup), at the session of the AI Week conference, Cybertech Tel Aviv, etc.; at regular trainings at various venues (B2B Marketing of Software, Technology and Startups; City Accelerator TLV Meetup, etc.). At the startup launch stage, there are acceleration programs (365x, 8200 Impact, iLog Accelerator, etc.).
Other Israeli local firms	Local companies are on the periphery and are characterized by lower productivity but understanding of the local home market.	Creation of innovations not only in the central regions, but also on the periphery.	A program to encourage innovation and entrepreneurship in the periphery. For example, the program Doing Business assists private firms in some aspects of the regulatory framework ³¹² .

Source: developed by the author based on ³⁰⁸⁻³¹²

³¹² *Doing Business 2020*. World Bank Group.

<https://www.doingbusiness.org/content/dam/doingBusiness/country/i/israel/ISR.pdf>

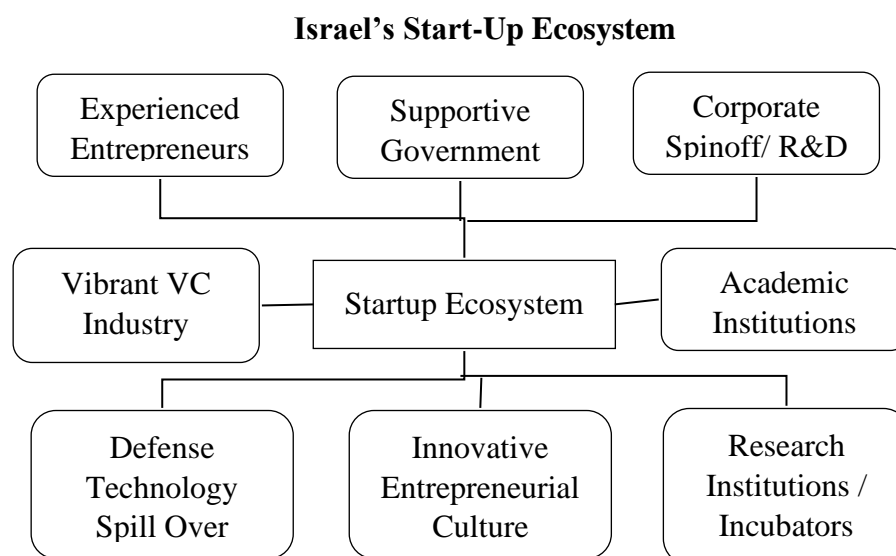


Figure 19.1. Elements of Israel's start-up ecosystem

Source: developed by the author based on³¹³

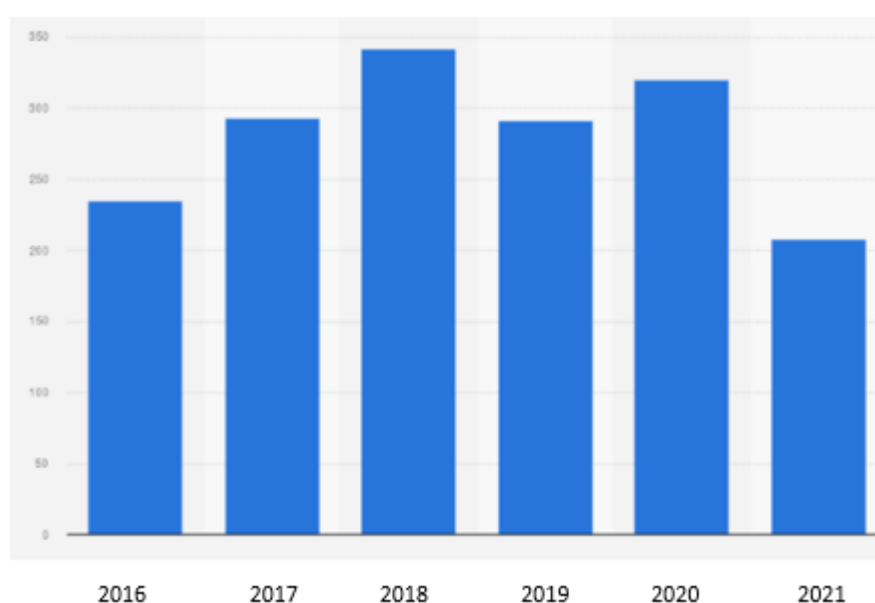


Figure 19.2. Number of startup capital deals in Israel 2016 - 2021

Source:³¹⁴

³¹³ GETZ, D., GOLDBERG, I. *Best Practices and Lessons Learned in ICT Sector Innovation: A Case Study of Israel*. World Development Report Digital Dividends, 2016. 43 p.

³¹⁴ Statista Research Department, 2021. [accessed 07.05.2022]. Available at: <https://www.statista.com/statistics/1246815/israel-number-of-startup-capital-deals/>

Venture capital investments in Israel

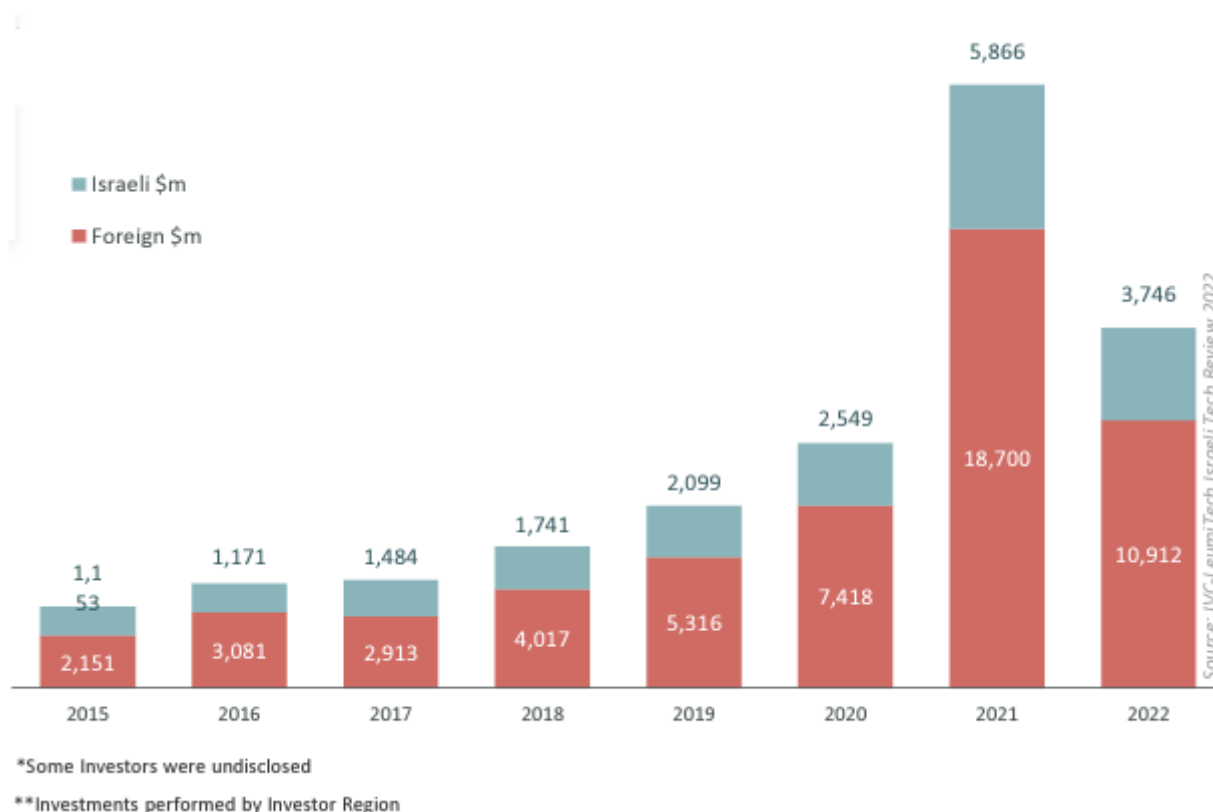


Figure 20.1. Israeli vs. Foreign Investments \$m 2015 -2022

Source:³¹⁵

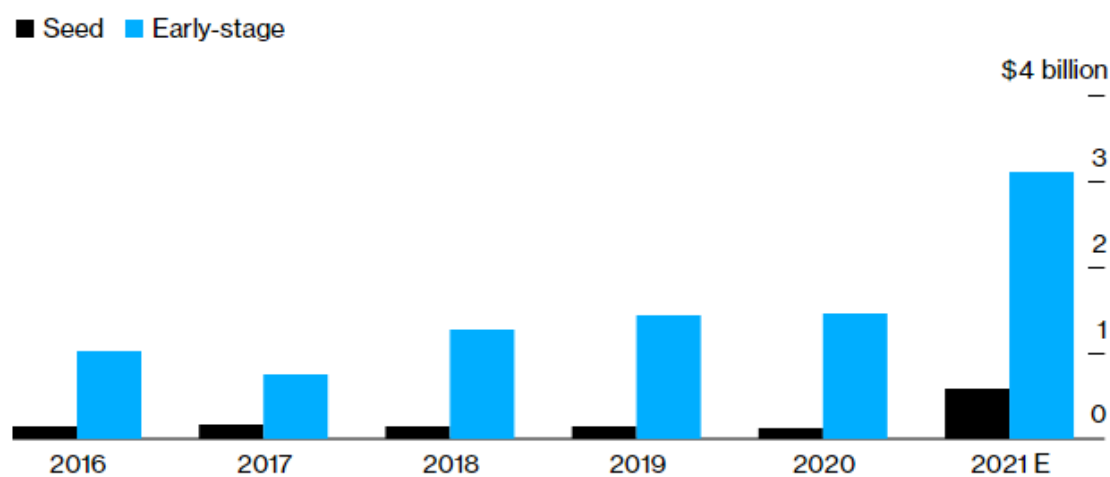


Figure 20.2. Venture investments investment in nascent Israeli tech startups

Source:³¹⁶

³¹⁵ *Israeli Tech Review 2022*. [accessed 14.03.2023]. Available at: https://www.ivc-online.com/LinkClick.aspx?_atcid=7_134353_62449185_2349683_0_Twxeejzjxcsw8d8s&fileticket=H1_uQBYFEkg%3d&portalid=0×tamp=1673278559731

³¹⁶ BENMELEH, Y. *A Flood of Cash Flows Into Israel's Red-Hot Tech Industry*. In: Bloomberg, 2020. [accessed 24.07.2022]. Available at: <https://www.bloomberg.com/news/articles/2022-01-19/tiger-global-insight-lead-gold-rush-for-tech-startups-in-israel>

Students in Universities by Institution in Israel

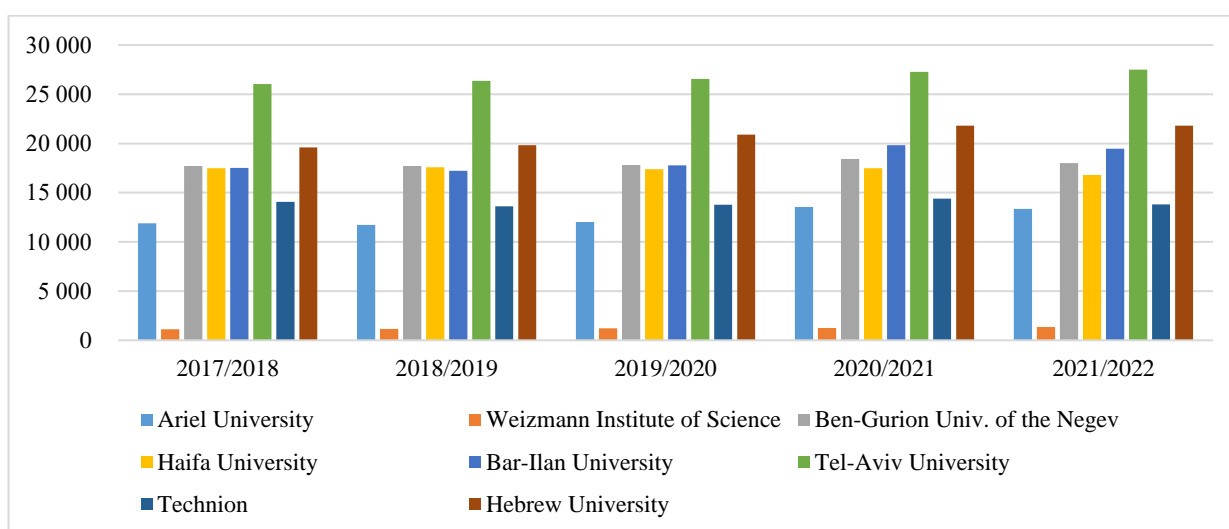


Figure 21.1. Number of students by universities in Israel

Source: developed by the author based on³¹⁷

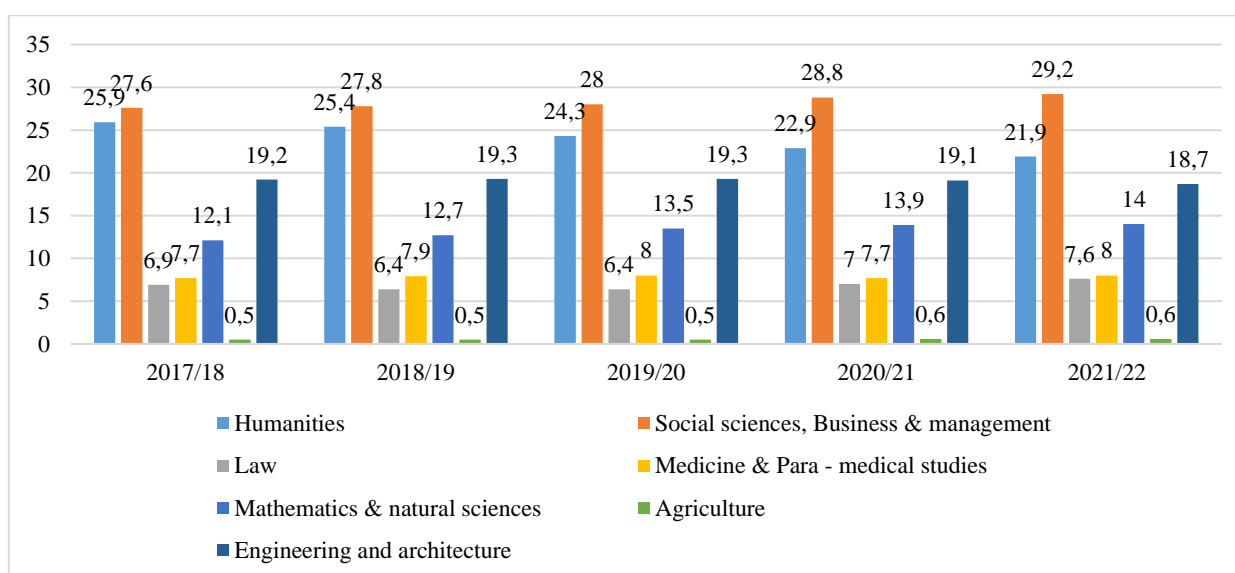


Figure 21.2. Undergraduate Students in Israel by Fields of Study for 2017-2022 (in percentages)

Source: developed by the author based on³¹⁸

³¹⁷ Council for Higher Education of Israel. [accessed 20.10.2022]. Available at: <https://che.org.il/en/>.

³¹⁸ Idem. Council for Higher Education of Israel. [accessed 20.10.2022]. Available at: <https://che.org.il/en/>

Table 21.1. Students in Universities by Institution and Level of Degree

	Technion- Israel Institute of Technology	Hebrew University	Weizmann Institute of Science	Bar-Ilan University	Tel Aviv University	University of Haifa	Ben-Gurion University of the Negev	Ariel University	Total
Number of students									
2016/2017	14501	19784	1108	18830	26342	18047	17797	11582	127991
2017/2018	14054	19582	1129	17523	26023	17471	17724	11899	125405
2018/2019	13611	19837	1148	17231	26361	17570	17699	11741	125198
2019/2020	13787	20898	1215	17764	26570	17396	17820	12016	127466
2020/2021	14405	21818	1251	19819	27265	17480	18428	13541	134007
2021/2022	13795	21822	1344	19454	27486	16790	18010	13359	140754
Number of Master's degree									
2016/2017	3585	6056	386	6716	9288	7952	4040	1015	39038
2017/2018	3296	5978	420	6459	9127	7773	4088	1127	38268
2018/2019	3082	6085	432	6450	9132	7843	4068	1056	38148
2019/2020	3243	6323	474	6573	8955	7826	4028	1181	38603
2020/2021	3377	6119	498	7321	9049	7743	4089	1394	39590
2021/2022	3009	5900	598	6890	8957	7171	3838	1406	39582
Number of PhD									
2016/2017	1111	2242	691	1925	2040	1404	1587	-	11000
2017/2018	1149	2198	687	2102	2112	1467	1634	-	11349
2018/2019	1155	2312	697	2192	2169	1513	1681	-	11719
2019/2020	1158	2338	725	2018	2143	1576	1683	-	11641
2020/2021	1295	2329	738	2049	2095	1655	1668	-	11829
2021/2022	1320	2228	733	2017	2120	1607	1660	-	11727

Source:³¹⁹³¹⁹ Statistical data files on higher education in Israel. Council for Higher Education. [accessed 20.03.2023]. Available at: <https://che.org.il/en/statistical-data/>

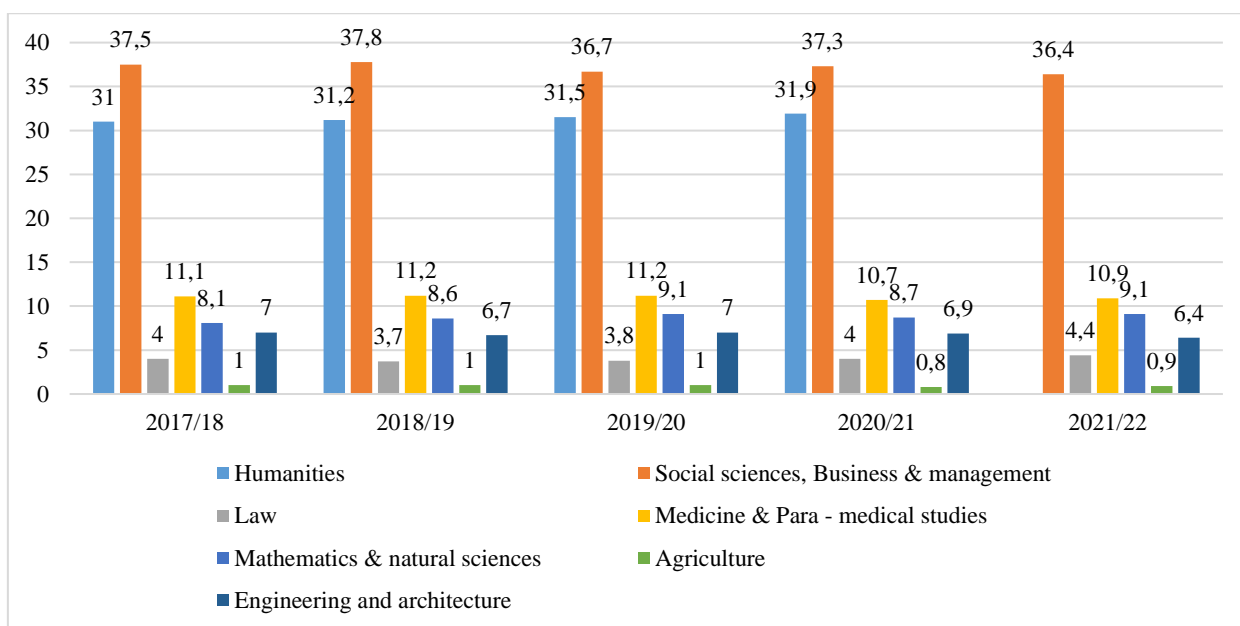


Figure 21.3. Master's Degree Students in Israel by Fields of Study for 2017-2022 (in percentages)

Source: developed by the author based on³²⁰

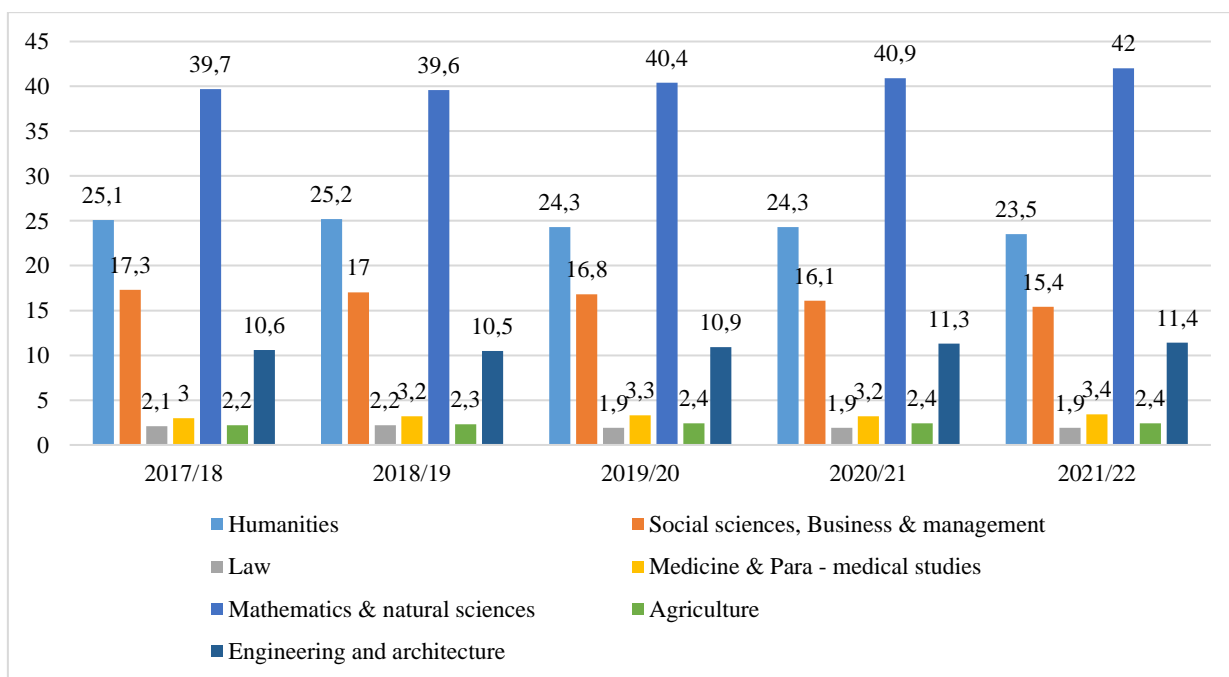


Figure 21.4. Doctoral students in Israel by Fields of Study for 2017-2022 (in percentages)

Source: developed by the author based on³²¹

³²⁰ Council for Higher Education of Israel. [accessed 20.10.2022]. Available at: <https://che.org.il/en/>.

³²¹ Idem. Council for Higher Education of Israel. [accessed 20.10.2022]. Available at: <https://che.org.il/en/>

Israeli Universities in World Rankings

Table 22.1. Ranks of Israeli Universities in World Rankings

		Tel Aviv University	Hebrew University	Bar-Ilan University	University of Haifa	Technion	Weizmann Institute of Science	Ben-Gurion University of the Negev
THE ³²²	2022	201-250	301-350	601-800	601-800	451-500	-	801-1000
	2021	191	226	551	701	451	-	-
	2020	189	226	551	551	451	-	-
	2019	230	226	451	701	326	-	701
QS ³²³	2022	255	198	477	701	330	-	471
	2021	230	177	556	726	291	-	446
	2020	219	162	551	676	257	1001+	419
	2019	230	154	626	676	247	-	407
ARWU ³²⁴	2022	176	77	351	551	83	83	451
	2021	176	90	451	551	94	92	451
	2020	176	126	451	651	126	93	451
	2019	176	126	451	651	85	126	451
CWTS ³²⁵	2022	85	219	567	617	267	585	306
	2021	78	214	539	622	244	541	303
	2020	80	201	521	605	231	508	293
	2019	77	187	506	616	218	490	291
Web ³²⁶	2022	101	249	574	554	320	345	430
	2021	122	127	562	552	277	307	402
	2019	149	200	522	575	282	293	408
SIR ³²⁷	2022	247	557	1418	2969	558	491	915
	2021	265	503	1120	2978	584	440	1048
	2020	280	426	1090	2892	583	348	999
	2019	229	344	1142	2542	535	337	967

Source: developed by the author based on ³²²⁻³²⁷

³²² The Times Higher Education World University Rankings. [accessed 16.01.2022]. Available at: https://www.timeshighereducation.com/world-university-rankings/2020/world-ranking#!/page/0/length/25/locations/IL/sort_by/scores_research/sort_order/asc/cols/scores.

³²³ QS World University Rankings. [accessed 16.01.2023]. Available at: <https://www.topuniversities.com/university-rankings/world-university-rankings/2018>.

³²⁴ Shanghai Jiao Tong Ranking. [accessed 18.01.2023]. Available at: <https://www.universityrankings.ch/results/Shanghai/2021?ranking=Shanghai&year=2021®ion=&q=Israel>

³²⁵ CWTS Leiden Ranking 2022. [accessed 18.01.2023]. Available at: <https://www.leidenranking.com/ranking/2022/list>

³²⁶ Ranking Web. [accessed 18.01.2022]. Available at: <https://www.webometrics.info/en/asia/israel>.

³²⁷ SCImago Institutions Rankings. [accessed 18.01.2023]. Available at: <https://www.scimagoir.com/rankings.php?sector=Higher+educ.&country=ISR&year=2015>

Table 22.2. Criteria for research and innovation in international university rankings

Name	Index	relative value, %	Rating Feature
Times Higher Education (THE)	Average number of citations per article	37,5	selection of the best universities for the quality of teaching and research activities, the level of knowledge dissemination and innovation
	Scope and reputation of research work	30	
	Research income	2,5	
QS World University Rankings	Academic reputation	20	the rating pays attention to the reputation of universities in the academic environment
	The number of citations per one scientific and pedagogical worker (in the Scopus database)	40	
	Reputation among employers	10	
Academic Ranking of World Universities (ARWU or Shanghai)	Number of articles published in Nature&Science journals	20	the rating is focused on the scientific and academic activities of universities
	Number of articles indexed in the Science Citation Index Expanded and Social Sciences Citation Index databases (Thomson Reuters)	20	
CWTS Leiden Ranking	The number and proportion of cited university publications in a particular field are compared with other publications based on the Web of Science database	Full or fractional counting method	the ranking is focused on the scientific and academic activities of universities in terms of the number and share of cited publications
World Wide Web	The number of search results on the university website by the scientific search engine Google Scholar and the number of citations of the found documents	12,5	is devoted to the study of webometric indicators and ranking on their basis of the websites of universities and research institutes
	The number of files on the site with the results of studies in four formats: PDF, PS, DOC and PPT)	12,5	
Scimago institutions rankings (SIR)	Research Performance Based Metrics	50	Ranking indicators reflect the scientific, economic and social characteristics of research institutions based on the Scopus scientific publications database and the PATSTAT patent database
	Metrics based on innovation outcomes	30	
	Societal Impact Metrics	20	

Source: developed by the author based on ³²²⁻³²⁷

Analysis of scientific publications of Israeli universities

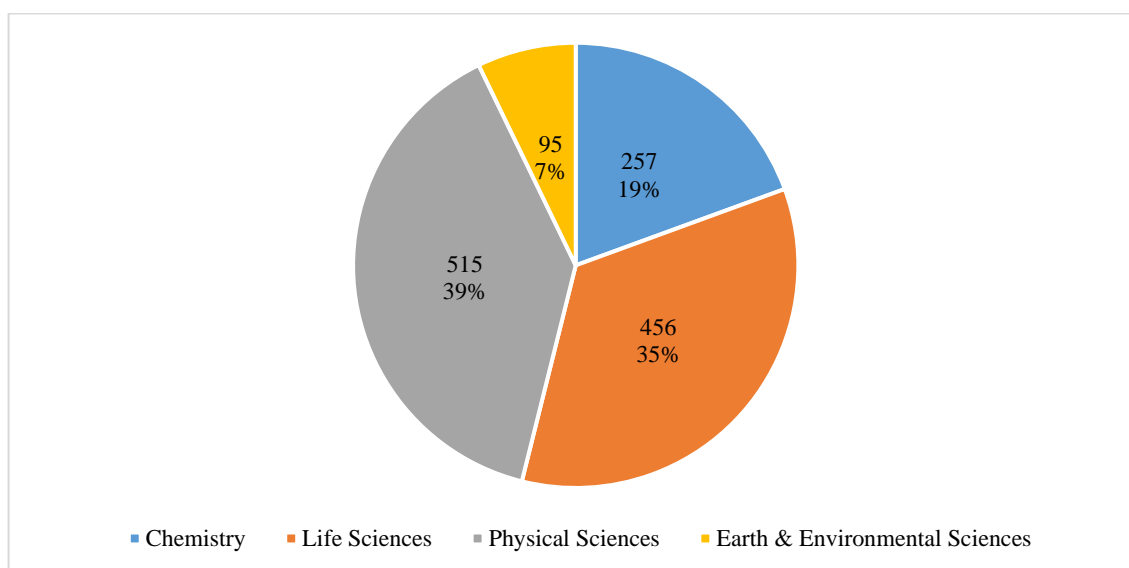


Figure 23.1. Numbers of Israeli publications and research results December 01, 2021 to November 30, 2022, tracked by the Nature Index

Source:³²⁸

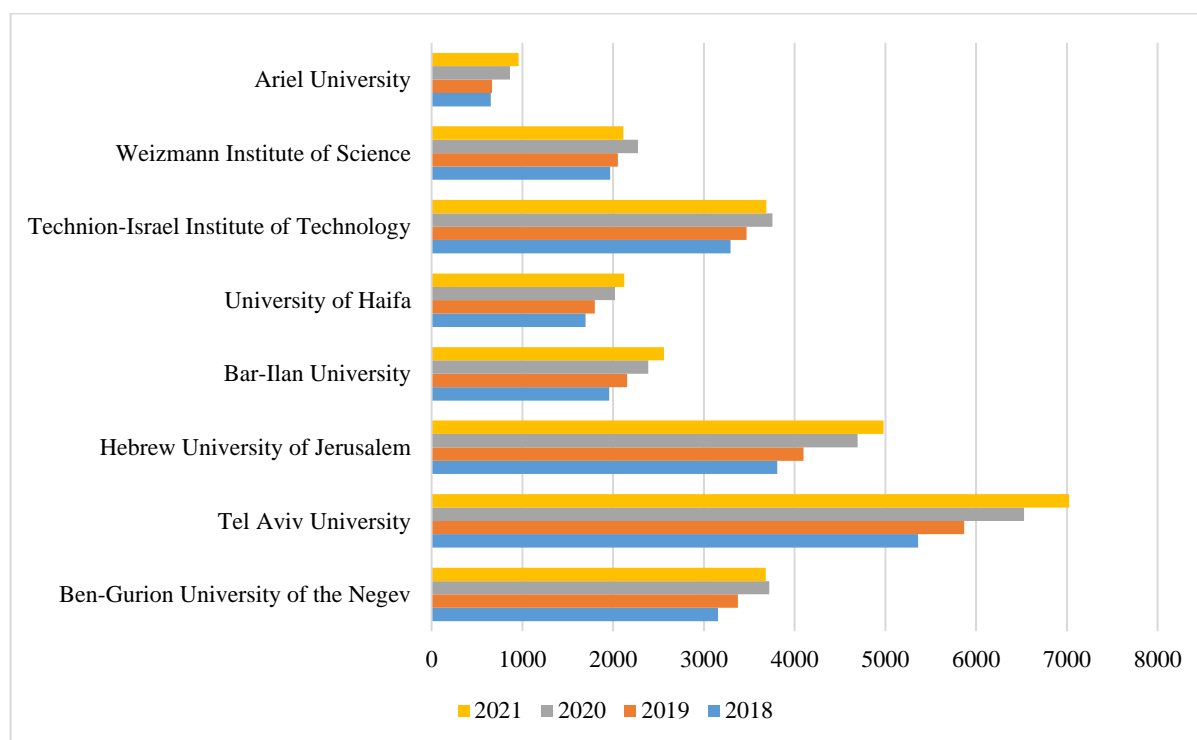


Figure 23.2. Number of publications by Israeli universities

Source: developed by the author based on³²⁹

³²⁸ *Nature Index*. Israeli. [accessed 06.03.2023]. Available at: <https://www.natureindex.com/country-outputs/Israel#research>

³²⁹ *List of 36 best universities in Israel*. [accessed 06.03.2022]. Available at: <https://edurank.org/geo/il/>

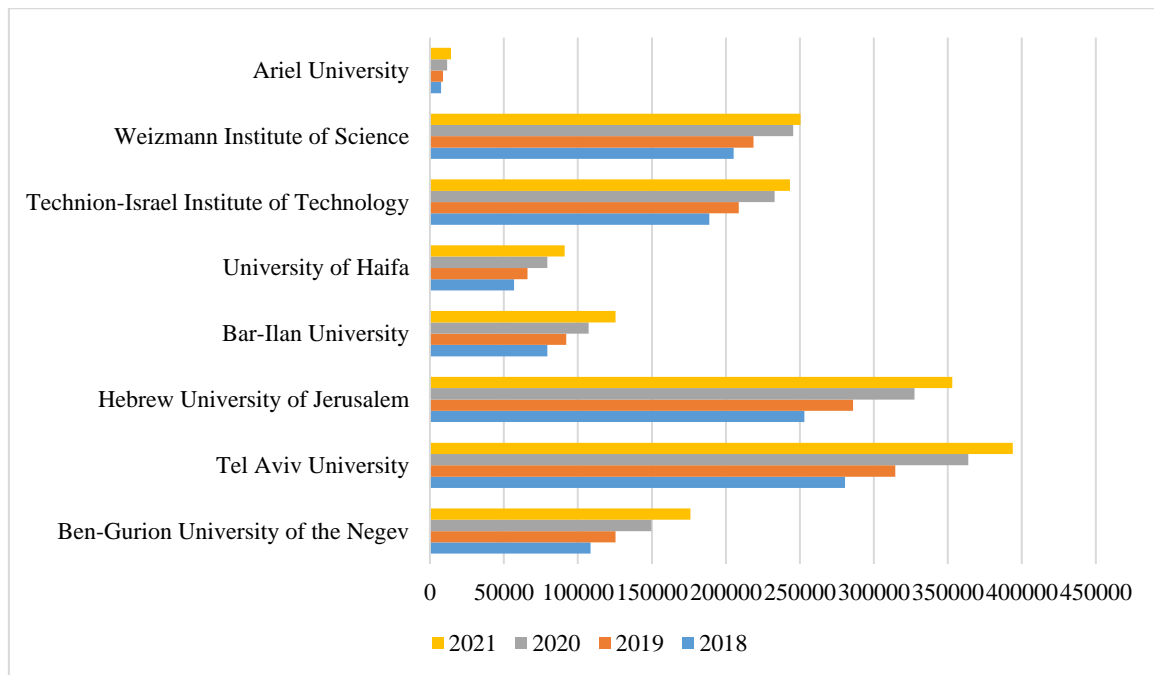


Figure 23.3. Number of citations by Israeli universities

Source: developed by the author based on³³⁰

³³⁰ *List of 36 best universities in Israel*. [accessed 06.03.2022]. Available at: <https://edurank.org/geo/il/>

Analysis of the results of testing the question of teaching courses related to entrepreneurship

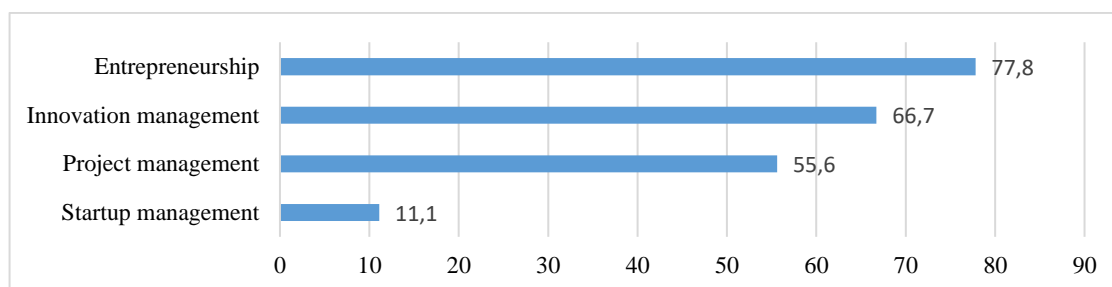


Figure 24.1. The results of testing teachers on the teaching of subjects related to entrepreneurship, %

Source: developed by the author

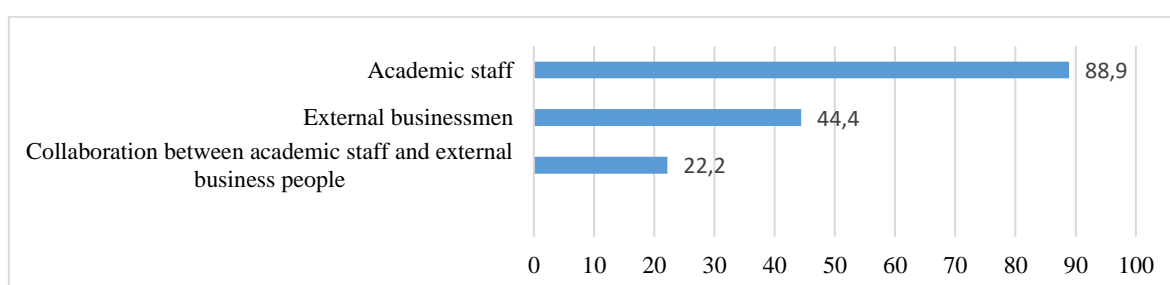


Figure 24.2. Participation of business representatives in teaching entrepreneurship based on test results, %

Source: developed by the author

Distribution of graduates of doctoral programs in Israeli universities

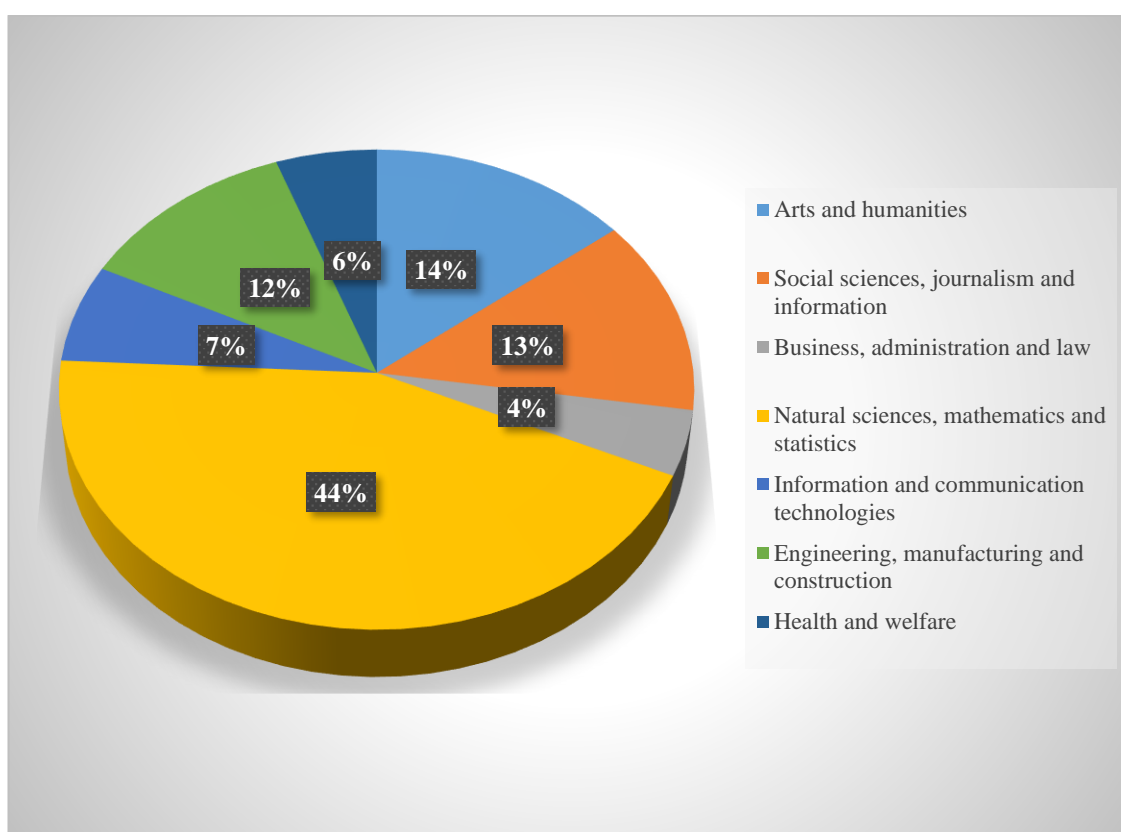


Figure 25.1. Distribution of graduates of doctoral programs

Source: developed by the author based on³³¹

³³¹ Council for Higher Education of Israel. [accessed 16.03.2022]. Available at: <https://che.org.il/en/>

Table 25.1. Distribution of graduates of doctoral programs by type of science

	Design Arts Humanities	Business Politics Social Sciences	Languages Culture Linguistics	Nursing Health Pharmacy Medicine	Engineering IT	Maths Natural Sciences
Ben-Gurion University of the Negev	+	+	+	+	+	+
Tel Aviv University	+	+	+	+	+	+
Hebrew University of Jerusalem	+	+	+	+	+	+
Bar-Ilan University	-	-	-	-	-	-
University of Haifa	-	-	-	-	-	-
Technion- Israel Institute of Technology	-	-	-	+	+	+
Weizmann Institute of Science	-	-	-	-	-	+
Ariel University	-	-	-	-	-	-

Source: developed by the author based on³³²

³³² *List of 36 best universities in Israel*. [accessed 16.03.2022]. Available at: <https://edurank.org/geo/il/>

The structure of the teaching staff of Israeli universities

Indicators	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022
1.Total number of teaching staff at universities, people	23374	23823	24081	24369	24590
Including:					
Freelance teachers	3958	4006	3976	3740	3651
Senior lecturers	8553	8611	8742	8867	8906
Junior lecturers	10863	11193	11316	11762	12033
2.Share in the total number of PPR, in%:					
Freelance teachers	16,9	16,8	16,5	15,3	14,8
Senior lecturers	36,6	36,1	36,3	36,4	36,2
Junior lecturers	46,5	47,0	47,0	48,3	48,9
3.Number of full-time teaching staff at universities, people	10657	10629	10853	11047	11184
Including:					
Freelance teachers	747	764	762	496	502
Senior lecturers	6618	6467	6688	6436	6584
Junior lecturers	3292	3397	3384	4114	4098
4.The share of full-time PPR in the total number, %:	45,6	44,6	45,1	45,3	45,5
5.The share of PPR by age in the total population, %:					
up to 40	40,5	40,1	39,6	39,5	39,5
41-54	31,0	31,6	32,1	32,6	32,4
+55	28,0	27,9	27,7	27,4	28,1

Source: developed by the author based on ³³³

³³³ Council for Higher Education of Israel. [accessed 12.03.2022]. Available at: <https://che.org.il/en>

Directions of research at universities in Israel

Name of the university	Research directions
Tel Aviv University	Strong in the university faculties of medicine (including a business school), the faculty of natural sciences (especially the departments of physics and astronomy), the faculty of art and the faculty of engineering and innovation
Technion-Israel Institute of Technology	An advanced technological university, owns one of the largest departments of computer science in the world, conducts research in the field of engineering, mathematics, computer science, natural sciences, etc.; civil engineering and electronic systems engineering programs established
Hebrew University of Jerusalem	Famous for its strongest faculties of mathematics, medicine, research in Jewish studies, Arabic studies and Islamic studies, also conducts research on environmental protection and agricultural development, as well as in the field of historical analysis and biological sciences
Ben-Gurion University of the Negev	Known for the Faculty of Computer Science and Informatics (these departments have an extremely high research index), well-known faculties of engineering and medicine. The university is known for its research in immunology, wind and solar energy, biotechnology, nanotechnology and civil engineering; is the nation's largest desert research center
Weizmann Institute of Science	Institute is a world-famous research center in the field of exact and natural sciences. The main focus of research is directed to biology, mathematics, chemistry, computer science and physics. The research of the Faculty of Biology and Neuroscience develops ideas for the treatment of neurodegenerative diseases and the structure of the brain. In addition, the Faculty of Medicine is also known for research in the fields of immunology, genetics and cytology.
University of Haifa ³³⁴	It conducts research in the areas of: public health, security research, Holocaust research, cancer research, neuroscience, bioinformatics, marine science, education, and epigenetics
Bar-Ilan University ³³⁵	It conducts research in the field of: Judaic, medicine, engineering, law, life sciences, exact sciences, social sciences, education and humanities, but the university is considered one of the best in the field of "Informatics"
Ariel University	Research is carried out in the field of engineering, natural, social and human sciences, medical sciences.

Source: developed by the author based on ³³⁴⁻³³⁶

³³⁴ *University of Haifa*. [accessed 13.04.2022]. Available at: <https://www.haifa.ac.il/about-the-university/?lang=en>

³³⁵ *Bar-Ilan University website*. [accessed 02.02.2022]. Available at: <https://www.biu.ac.il/en/science-and-research>

³³⁶ *Unipage website*. [accessed 13.04.2022]. Available at: https://www.unipage.net/en/206/technion_israel_institute_of_technology.

Technology Transfer Offices (TTO)

Universities	Company	The role of the university	The role of TTO
Holon Institute of Technology	A.Y.Y.T, the Technology Transfer Company	It is responsible for the commercialization of know-how	inventions of the institute's researchers
Ariel University	Ariel- University R&D Company Ltd or Ariel R&D	Creation of new technologies	The company transfers technologies and is responsible for commercialization and is looking for partners and investors for their commercialization
Ben-Gurion University (BGU)	B.G. Negev Technologies & Applications Ltd. or BGN Technologies	Creates technologies, builds an IP portfolio	BGN transfers technology and is responsible for the commercialization of BGU's know-how and inventions, applies for patents worldwide, manages BGU's IP portfolio, seeks partners and investors to commercialize its inventions and know-how
Technion-Israel Institute of Technology	BioRap Technologies (The Rappaport Institute is affiliated with the Rappaport Faculty of MTIIT)	develops biotechnological concepts based on new scientific discoveries and new technologies in healthcare	The company offers investors and potential partners new technologies; provides support for the creation and protection of intellectual property of biomedical research, establishes joint ventures with academic institutions and firms on an international scale
Bar-Ilan University	BIRAD Research and Development Company Ltd	creation of new inventions	The company transforms new inventions into useful products for commercialization
University of Haifa	Carmel - Economic Corporation of Haifa University	research, creation of new products, services, technologies, participation in research projects	The company creates and protects the intellectual property of the university, creates joint ventures with external partners
Tel Aviv University	Ramot at Tel Aviv University Ltd	Creation of new knowledge and technologies	The company is engaged in technology transfer
Technion – Israel Institute of Technology	T3 – Technion Technology Transfer, Technion R&D Foundation Ltd.	Develops new concepts, inventions, technologies, creates subsidiaries based on IP Technion	The company initiates, analyzes and promotes the transfer of research results and new technologies of the university to the world market, protects and licenses the intellectual property of the university, registers subsidiaries based on the IP Technion

Weizmann Institute	Yeda Research and Development Co.	Creation of new concepts, inventions, technologies	The company is engaged in the commercialization of the intellectual property of the university
Hebrew University of Jerusalem	Yissum Research and Development Company	Creation of new inventions and know-how in various fields	The company is engaged in the transfer of technology to different countries, the marketing of inventions and know-how, the commercialization of the intellectual property of the university

Source: developed by the author based on³³⁷

³³⁷ *Technology Transfer Offices* (TTO). [accessed 07.10.2021]. Available at: <https://www.iati.co.il/category/24/technology-transfer-offices-tto>

Intellectual Property Applications for Israeli Universities

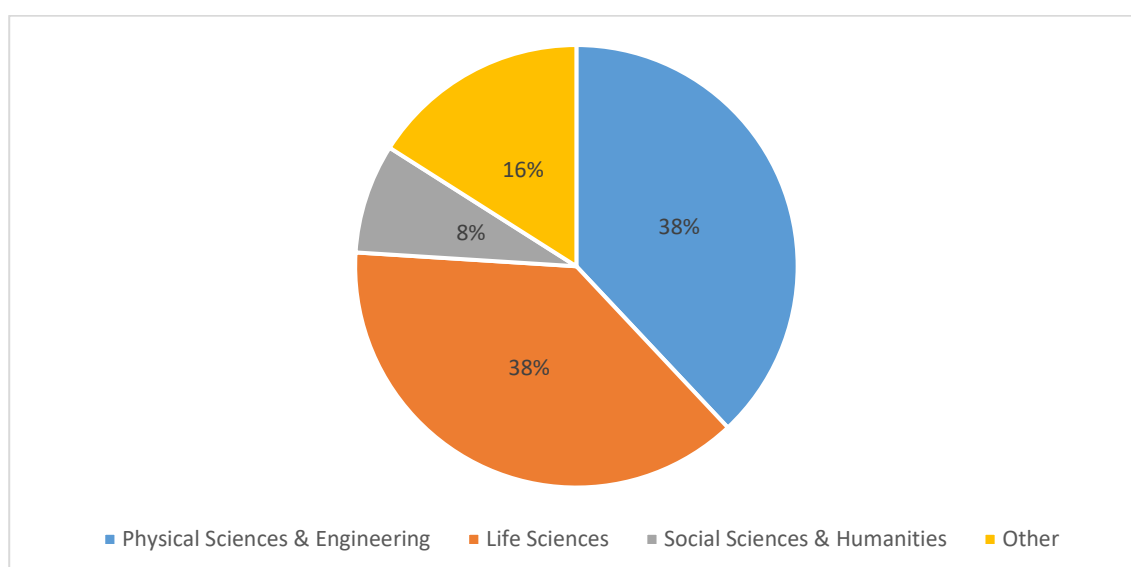


Figure 29.1. Israeli IP applications of Israeli universities by research areas with ERC Grants

Source:³³⁸

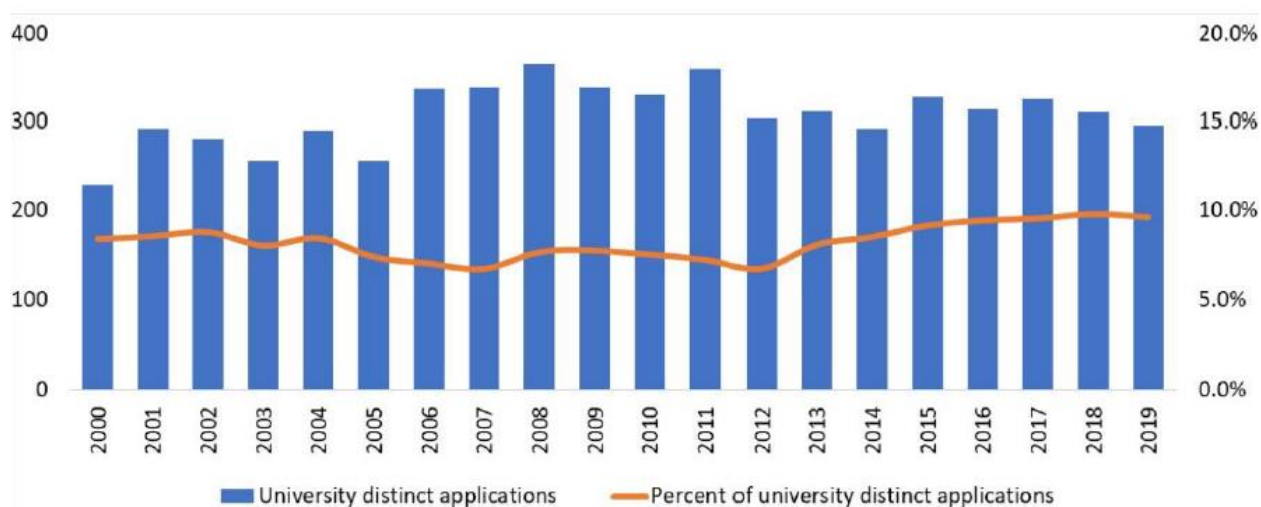


Figure 29.2. Number of unique inventions in the higher education research sector and their share of the total number of unique inventions by Israeli applicants 2000-2019

Source: ³³⁹

³³⁸ GETZ, D., KLEIN, R., BARZANI, E. *R&D outputs in Israel. Analysis of Scientific Publications 2021*. Israel, Haifa: Samuel Neaman Institute, 2022. [accessed 13.04.2022]. Available at: <https://www.neaman.org.il/EN/R&D-Outputs-in-Israel-Analysis-of-Scientific-Publications-2021>

³³⁹ LECK, E., GETZ, D., ZETCOVETSKY, I. *Research and Development Outputs in Israel: 2000-2020 Academy-Industry Cooperation Final Report*. Israel: Samuel Neaman Institute, 2021. 74 p. [accessed 14.04.2022]. Available at: https://www.neaman.org.il/EN/Files/Report_Patent%20report%202021%20Final%20with%20access.pdf

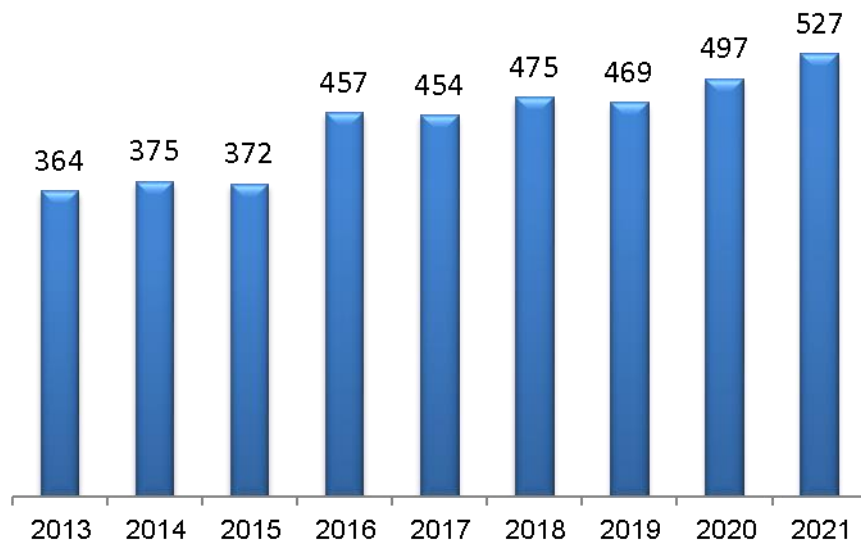
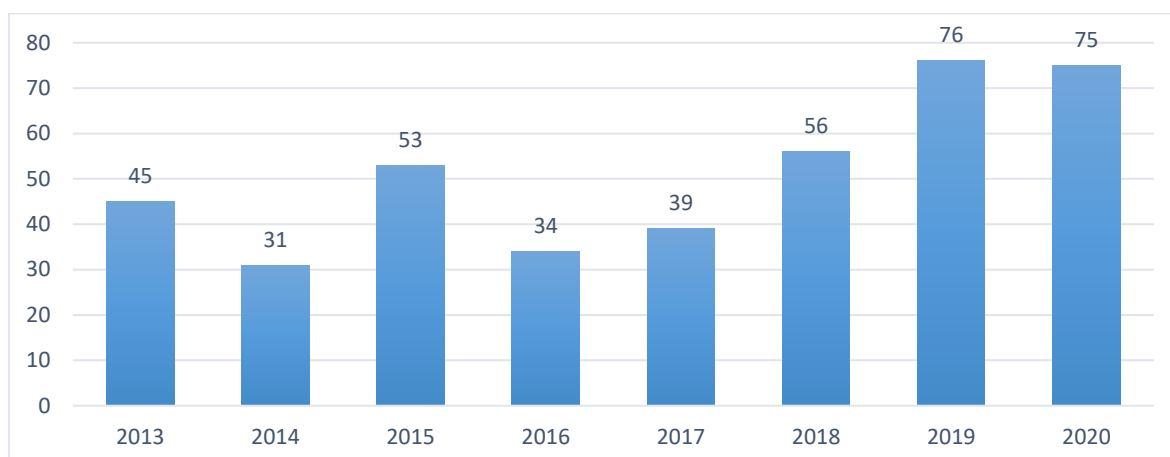


Figure 29.3. Original Patent Applications in Israel and Abroad in Companies Associated with Universities

Source:³⁴⁰

³⁴⁰ *Survey of Knowledge Commercialization Companies in Israel 2020-2021*. [accessed 07.03.2023]. Available at: <https://www.cbs.gov.il/en/mediarelease/Pages/2022/Survey-of-Knowledge-Commercialization-Companies-in-Israel-2020-2021.aspx?fbclid=IwAR0aixOHI9KIB-J8FFWoDAHHwyci66IpV82CeMc1HkIxKkcvLbjkTFMOeNg#losExcelos>

Number of academic startups in Israel for 2013-2020

Source:³⁴¹

³⁴¹ *Annual Report of State Tech-High 2022*. Israel Innovation Authority, 2022. [accessed 17.06.2022]. Available at: <https://innovationisrael.org.il/en/sites/default/files/Annual%20Innovation%20Report%20-%20State%20of%20High-Tech%202022.pdf>

Research activity of Israeli universities

Universities	Researchers ³⁴²	Research centers and institutes	Research labs
Ariel University ³⁴³	137	25	140
Tel Aviv University ³⁴⁴	492	340	400
Hebrew University of Jerusalem ³⁴⁵	607	100	35
Bar-Ilan University ³⁴⁶	221	71	300
University of Haifa ³⁴⁷	197	65	15
Technion-Israel Institute of Technology ³⁴⁸	386	60	25
Weizmann Institute of Science ³⁴⁹	321	128	250
Ben-Gurion University of the Negev ³⁵⁰	998	47	3

Source: developed by the author based on ³⁴²⁻³⁵⁰

³⁴²Track more of your research impact. Publons. [accessed 02.02.2022]. Available at: <https://publons.com/institution/49022/>

³⁴³ Ariel University website. [accessed 02.02.2022]. Available at: <https://www.ariel.ac.il/wp/rnd/en/>

³⁴⁴ Tel Aviv University website. [accessed 02.02.2022]. Available at: https://english.tau.ac.il/research_institutes

³⁴⁵ Hebrew University of Jerusalem. Research. [accessed 02.02.2022]. Available at: <https://overseas.huji.ac.il/research/>

³⁴⁶ Bar-Ilan University website. [accessed 02.02.2022]. Available at: <https://www.biu.ac.il/en/science-and-research>

³⁴⁷ University of Haifa. Research Authority Portal. [accessed 12.05.2022]. Available at: <https://ra2.haifa.ac.il/index.php/en/research-centers.html>

³⁴⁸ Technion-Israel Institute of Technology website. [accessed 02.02.2022]. Available at: <https://www.technion.ac.il/en/home-2/>

³⁴⁹ Weizmann Institute of Science website. [accessed 02.02.2022]. Available at: <https://www.weizmann.ac.il/pages/research-activities>

³⁵⁰ Ben-Gurion University of the Negev website. [accessed 02.02.2022]. Available at: <https://in.bgu.ac.il/en/Pages/Centers.aspx>

Results of testing the innovation ecosystem of universities in Israel

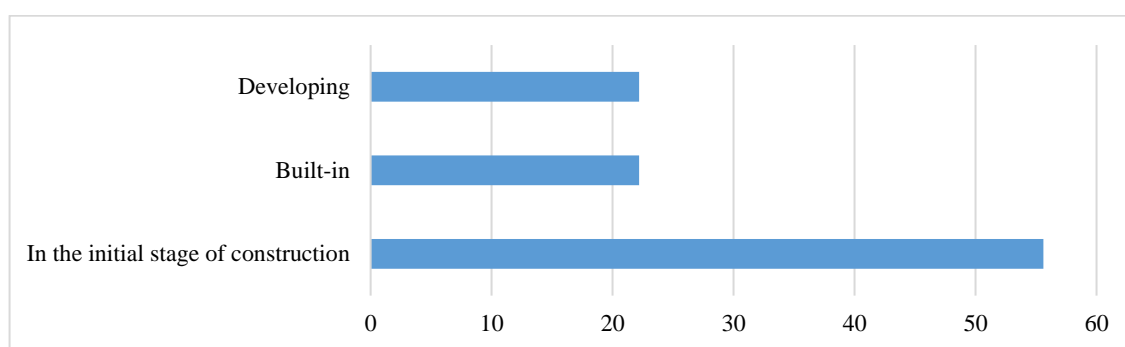


Figure 32.1. Test results on the stage of development of the university's innovation ecosystem

Source: developed by the author

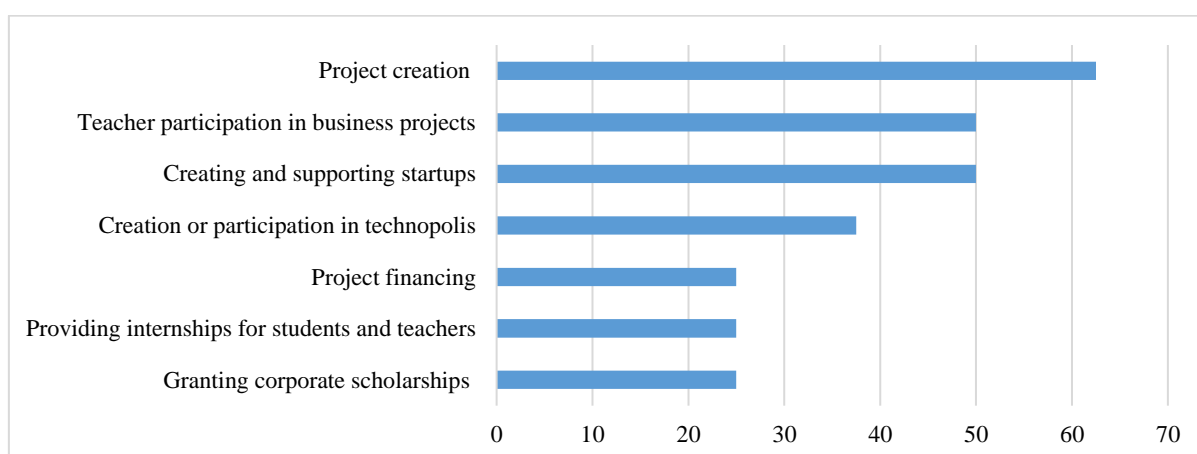


Figure 32.2. Types of partnerships between universities and various organizations based on the results of testing, %

Source: developed by the author

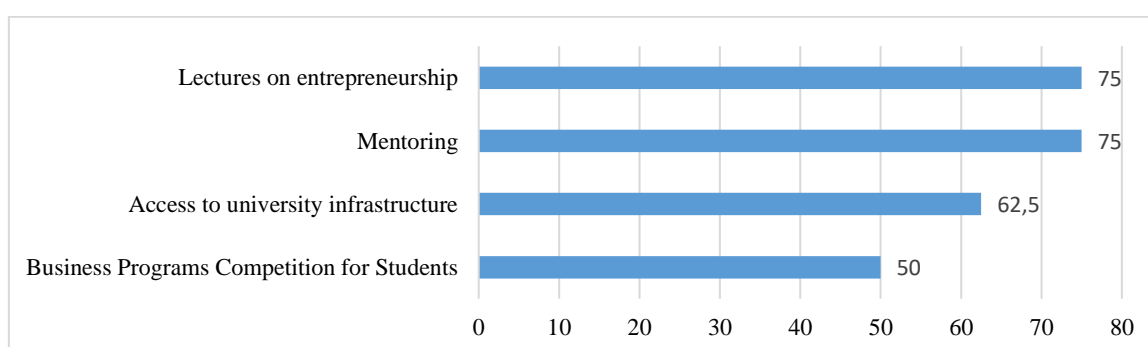


Figure 32.3. Types of partnerships between universities and local firms based on the results of testing, %

Source: developed by the author

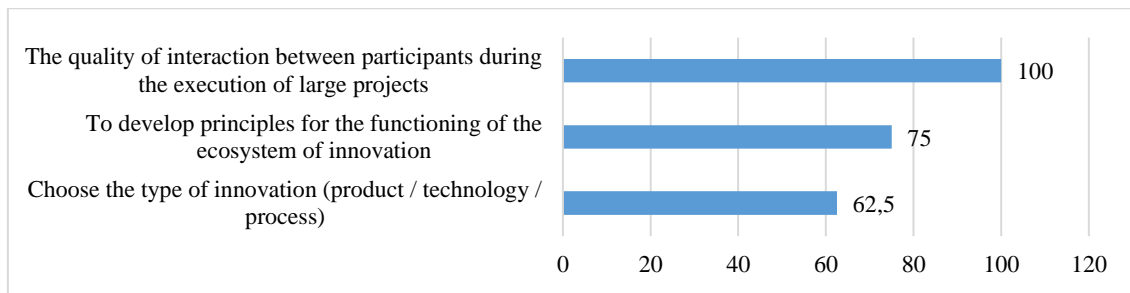


Figure 32.4. The main accents of the interaction of UIE participants on the results of testing, %

Source: developed by the author

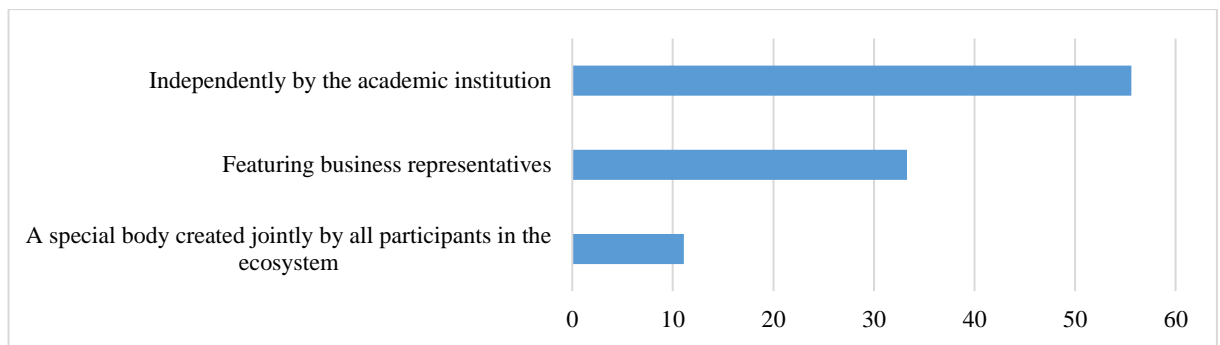


Figure 32.5. Test results on the management of the university's innovation ecosystem (answer to the question: “How is an innovative collaborative system managed?”)

Source: developed by the author

Collaborations between academia and industry

Table 33.1. Reasons for the need for interaction between universities and business

Reasons for cooperation on the part of universities	Reasons for business engagement
implementation of the results of own scientific research (possibility of commercialization)	use of unique equipment and infrastructure of the university
obtaining additional financial resources from business to commercialize their own developments	solution relatively quickly and inexpensively applied scientific and technical problems at the expense of the university
support for youth innovation activity at the university by fulfilling orders for R&D from business	creation of project teams at the expense of the university
receipt by students and doctoral students practical experience and development of competencies in the field of business, due to: participation in real projects, expertise from the business of final theses in the specialty	the possibility of pilot production at the expense of the university
the possibility of employment of the best students in enterprises with which the university cooperates	recruitment at the expense of the university

Source: developed by the author

Table 33.2. Conditions for the integration of the university and business within the innovation ecosystem

Terms	Required Funds
Ability to generate new ideas	<ul style="list-style-type: none"> - modern equipment; - professional personnel; – a high degree of innovative activity among students and employees
Ability to develop an idea	<ul style="list-style-type: none"> - modern equipment; - professional personnel; – a high degree of innovative activity among students and employees
Ability to commercialize an idea	<ul style="list-style-type: none"> - commercialization experience - a specially created structure in universities for the commercialization and implementation of developments; – special personnel for organizing and maintaining interaction with the business; - creation and maintenance of the innovative image of the university (due to the activity of the university in various events, information openness and transparency of the procedures for innovation activities at the university).

Source: developed by the author

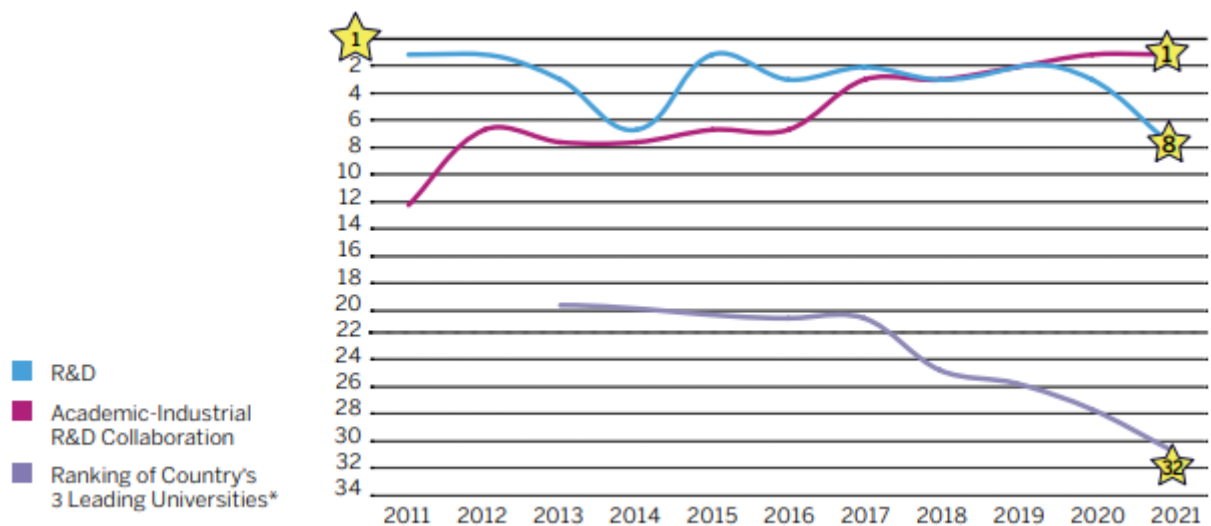


Figure 33.1. Israel in the GII ranking for indicators characterizing the collaboration of science and industry for 2011-2021

Source:³⁵¹

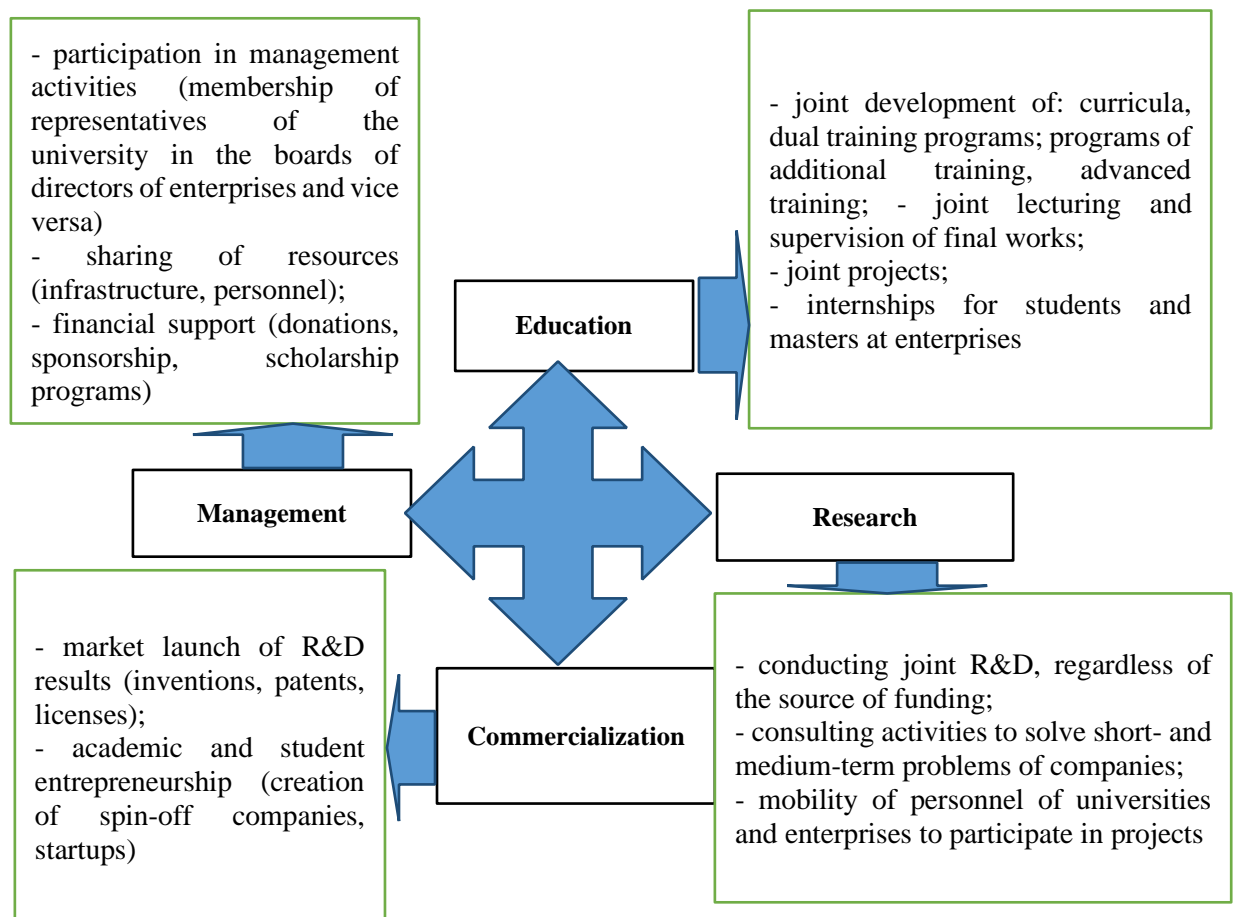


Figure 33.2. Possible types of joint activities of universities and business

Source: developed by the author

³⁵¹ *Annual Innovation Report State of High-Tech 2022*. Israel Innovation Authority, 2022. 70 p. [accessed 07.03.2022]. Available at: <https://innovationisrael.org.il/en/sites/default/files/Annual%20Innovation%20Report%20-%20State%20of%20High-Tech%202022.pdf>

Criteria of the university's innovation ecosystem

Criterion	Content
Helping Partners Create Value	This criterion affects the openness of the ecosystem to other participants. That is, if the company is ready to meet the needs of partners, then such an ecosystem will exist in the long term..
Delegation of roles in the ecosystem	Centralization of power in the organizer is not always the key to development, if the university is ready to cede a leading role in the implementation process, then further interaction between the participants will flexibly adapt to external and internal conditions..
System Login Conditions	An ecosystem can be both open and closed. In an open ecosystem, any partner can easily become a part of it and bring their developments both inside and into other external systems. A closed system has an entry barrier, which is determined by certain conditions of the organizers of the system. The disadvantage of an open ecosystem is poor quality, but this disadvantage is a positive factor of a closed ecosystem.
Ability to adapt the ecosystem flexibly	Ecosystem participants must be able to adapt quickly: consumer demands, as well as the willingness of partners to cooperate, can change at any time.
Ability to adapt the ecosystem flexibly	Entrepreneurial education is built into the entrepreneurial ecosystem of universities and is aimed at forming students' competencies necessary for private, corporate and social entrepreneurship. It includes both individual courses in bachelor's programs of all areas of training, and specialized bachelor's and master's degree programs in the field of entrepreneurship. Student projects developed within the framework of specialized educational programs can be further developed on the platforms of accelerators, incubators and technology parks.

Source: developed by the author

Initial Mapping of Entrepreneurial Activities at the Technion

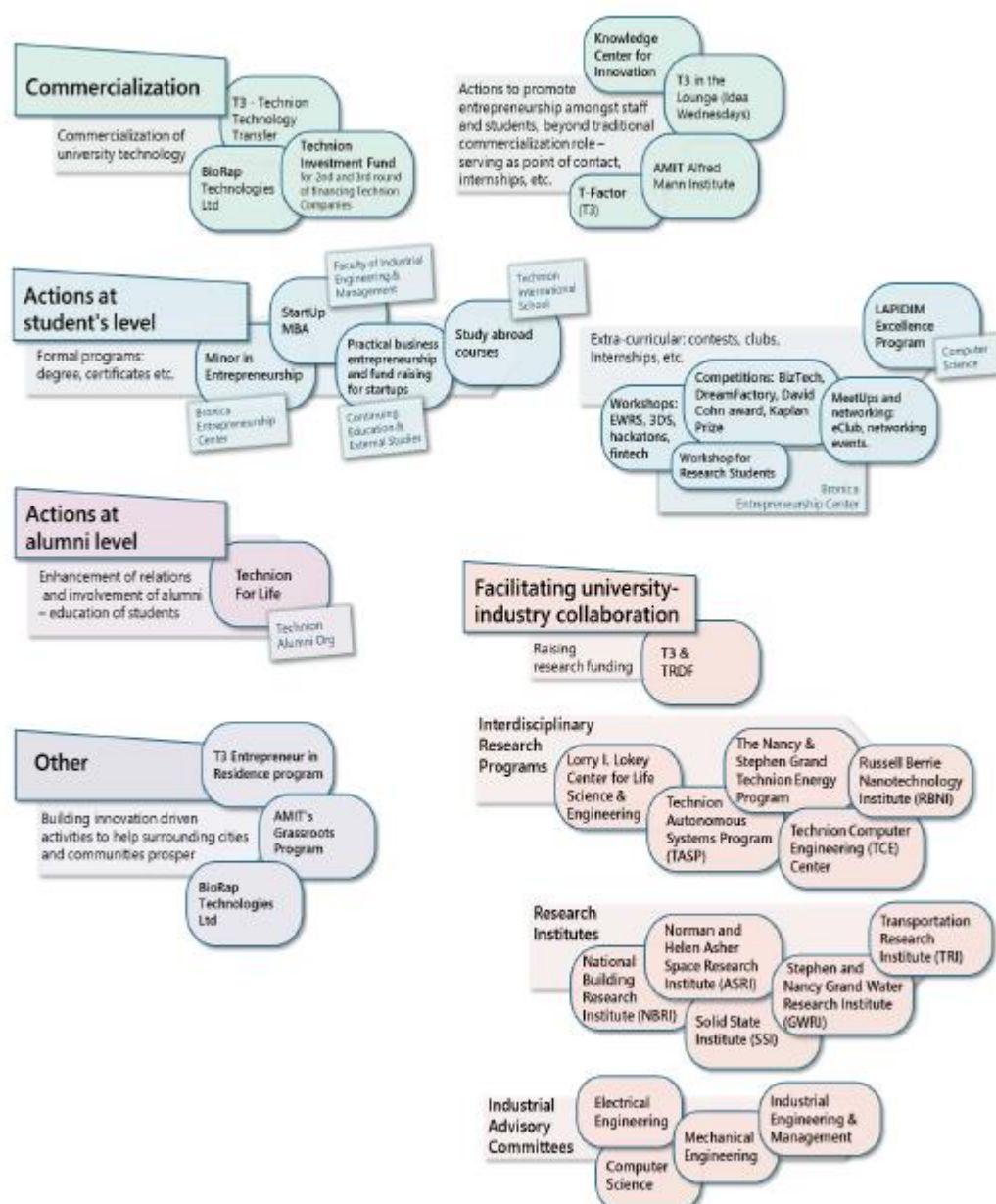


Figure 35.1. Initial Mapping of Entrepreneurial Activities at the Technion

Source:³⁵²

³⁵² BENATUR, A., BARZANI, E., GETZ, D., DEHAAN, U., KATZ-SHAHAM, U., MI-TAL, S. *Entrepreneurship at the Technion. A background document for the formulation of a technical policy*. Technion, 2017. 152 p. (Hebrew).

Table 35.1. Ecosystem Technion - Israel Institute of Technology

Educational system	
Faculties	Civil Engineering, Cartography and Geoinformation, Mechanical Engineering, Electrical Engineering, Computer Technology, Biochemical Technology, Chemical Technology, Agriculture, Aircraft Engineering, Industry and Business Administration
Entrepreneurship Training Centers	Bronica Entrepreneurship & Innovation Center ³⁵³ : 18 academic courses, Minor in Entrepreneurship ³⁵⁴ . The Center offers programs for those wishing to start their own business, which are aimed at supporting new technology start-ups and strengthening the connection between academic science and industry; is engaged in teaching students entrepreneurship: he works with both students and the staff of the Technion; Center StartUp MBA (Faculty of Industrial Engineering and Management): The Azrieli StartUp MBA program that offers a professional graduate degree in business administration with focus on entrepreneurship, innovation, and technology management; Technion International School: four Study Abroad courses in Entrepreneurship and Innovation. Continuing Education and External Studies: Practical Business Entrepreneurship. T3 in the Lounge (Idea Wednesdays)
Extra-curricular: contests, clubs, internships, etc.	Technion 3DS (3 Day Startup), eClub, BizTEC, The Technion Dream Factory, Hackatons, The Stanford Kaplan Prize, The David Cohn Award, The LAPIDIM Excellence Program (Computer Science Department)
Cooperation with alumni	Technion For Life (TFL) (The Technion Alumni Organization): The Project goals are set to support the implementing of Technion graduates' innovative technological developments, In addition to grooming the Nation's future business leadership with corporate social responsibility
Commercialization of University Technologies	
Technion Technology Transfer (Extracurricular activities: competitions, clubs, internships, etc. T3)	T3 provides legal support for innovative projects developed at the Technion, licensing of the Technion's intellectual property (IP) for registered companies.
BioRap Technologies Ltd	Technology transfer company that is built upon the creative innovations and patented technologies developed by the research scientists of the Rappaport Family Institute for Research in the Biomedical Sciences at the Technion.
UIE Participants and Stakeholders	
Alfred Mann Institute (AMIT) (T3)	AMIT serves as a hub for Technion students, faculty and alumni who envision the making of their discoveries into medical devices for the benefit of patients and healthcare providers.
Technion R&D Foundation Ltd., TRDF	TRDF is a subsidiary of the Technion Israel Institute of Technology, part of the Technion R&D Fund, is engaged in training, creation and support of start-ups
Facilitating University - Industry collaboration	
Raising research funding	
Technion Liaison Office	Office promotes research and development opportunities for Technion researchers and partners in Israel and around the World.

³⁵³Bronica Entrepreneurship Center. Academic courses. Technion, 2015. (Hebrew). [accessed 01.10.2020]. Available at: <http://www.yazamut.technion.ac.il/activity/courses/>.

	Liaison Office attracts financial resources, ensures cooperation between industry and researchers of the institute, compiles a list of requests from enterprises for a particular development, and also selects a team of scientists from the Technion who will conduct the necessary research ³⁵⁵ .
Interdisciplinary Research Centers	
Lorry Lokey Interdisciplinary Center ³⁵⁶ includes Life Sciences & Engineering infrastructure Center	The interdisciplinary center combines various but related fields of medicine, life sciences and engineering. It offers Technion scientists tools to help solve problems related to basic life sciences and biomedical engineering. Loki Center faculty members are recruited by one of the Technion's faculties, but their laboratories and infrastructure are mostly located in the Emerson Family Life Sciences Building, where the Loki Center is located.
The Nancy and Stephen Grand Technion Energy Program	Nancy and Stephen Grand Technion Energy Program is bringing together the best science and engineering researchers to work in a broad interdisciplinary track to discover and exploit alternative and renewable energy sources, to search for and develop alternative non-carbon based fuels, to seek solutions for more efficient energy use, and to reduce the environmental damage caused by the production and burning of fossil fuels.
Russell Berrie Nanotechnology Institute (RBNI)	Supported by the Russell Berrie Foundation, the Government of Israel through TELEM, and Technion, RBNI was inaugurated in 2005 and aims at positioning the Technion and the State of Israel at the forefront of global Nanotechnology research and development.
Technion Autonomous Systems Program (TASP)	The concept driving the Technion Autonomous Systems Program is to develop a research matrix with multidisciplinary teams that will define and develop principles and applications enabling autonomous solutions in various areas of human endeavor.
Technion Computer Engineering (TCE) Center	The Technion Computer Engineering Center is designed to lead worldwide computer engineering research and education, and to operate as a focal point for academic and industrial collaboration. The TCE Center provides the foundation and facilities for computer engineering research and education. Its unique model facilitates an unprecedented platform for industrial-academic collaboration and creates a novel eco-system beneficial to both.
Research Institutes	
National Building Research Institute (NBRI)	The research organization NBRI was opened in 1952 and is engaged in the promotion of advanced research of teachers of the Faculty of Civil Engineering and Ecology of the Technion.
Norman and Helen Asher Space Research Institute (ASRI)	ASRI was established in 1984. Its members are professors in multiple academic departments. The research and technical staff are involved in research and development of all aspects related to space technology and space science.
Solid State Institute (SSI)	The SSI Interdisciplinary Research Center offers its facilities and offers scientists from various faculties participation in projects for the study of solids and solid-state interfaces.
Stephen and Nancy Grand Water Research Institute (GWRI)	The Israeli national institute for research in the science, technology, engineering and management of water resources.
Transportation Research Institute (TRI)	TRI is a hub for the cooperation of teachers of various departments of the Technion in the field of transport.
Other Activities	

³⁵⁵ *Israel Institute of Technology*. Industry Guide to Technion. Haifa: Technion, 2014. [accessed 01.10.2020].

Available at: https://www.technion.ac.il/wp-content/uploads/2014/07/INDUSTRY-GUIDE-TO-TECHNION_L.pdf

³⁵⁶ Lorry Lokey Interdisciplinary Center. [accessed 01.10.2020]. Available at: <https://chemistry.technion.ac.il/lorry-lokey-interdisciplinary-center-for-life-sciences/>

Knowledge Center for Innovation	The Center was established in 2008 as part of the government's program to create "Infrastructure Knowledge Centers". The activities and projects of the center are aimed at connecting traditional industry with the latest technologies in three areas: research of innovations in industry, development of a knowledge base on innovations and activities that promote the support and application of inventions in production.
Research Authority	The Department helps scientists win grants from several dozen foundations ³⁵⁷ . Within the framework of the fund, there is also a human resources department. Under the auspices of the HR department, several programs are being implemented to attract young specialists: cooperation with ICore (centers of scientific excellence) to create interdisciplinary projects, participation in a job fair not only in Israel, but also in the USA (in Boston) to attract young professionals from MIT. Projects / programs "Career Advancement Chair" and "Leaders in Science and Technology" are created for recruiting new employees ³⁵⁸ .
AMIT's Grassroots Program	The program aims to provide newly established companies with all the necessary tools to commercialize their research by providing a comprehensive set of knowledge: experienced engineers, state-of-the-art equipment, intellectual property strategy, clinical research experience, experienced leadership, financial resources, business development guide, team recruitment support, regulatory guidance and subsequent capital investments.
Entrepreneur in Residence program (T3)	The program is designed to work collaboratively with entrepreneurs to identify applications for technology and create startups.

Source: developed by the author based on^{353- 359}

³⁵⁷ Israel Institute of Technology. Bridge: Technion. Technology. [accessed 16.11.2020]. Available at: <http://t3.trdf.co.il/overview>.

³⁵⁸ Technion R&D Foundation. About Research Authority. [accessed 16.11.2020]. Available at: <http://www.trdf.co.il/eng/About/>.

³⁵⁹ BENATUR, A., BARZANI, E., GETZ, D., DEHAAN, U., KATZ-SHAHAM, U., MI-TAL, S. *Entrepreneurship at the Technion. A background document for the formulation of a technical policy*. Haifa: Technion, 2017. 152 p. (Hebrew).

Organizational Structure and Research Authority Organizational Structure of Technion-Israel Institute of Technology

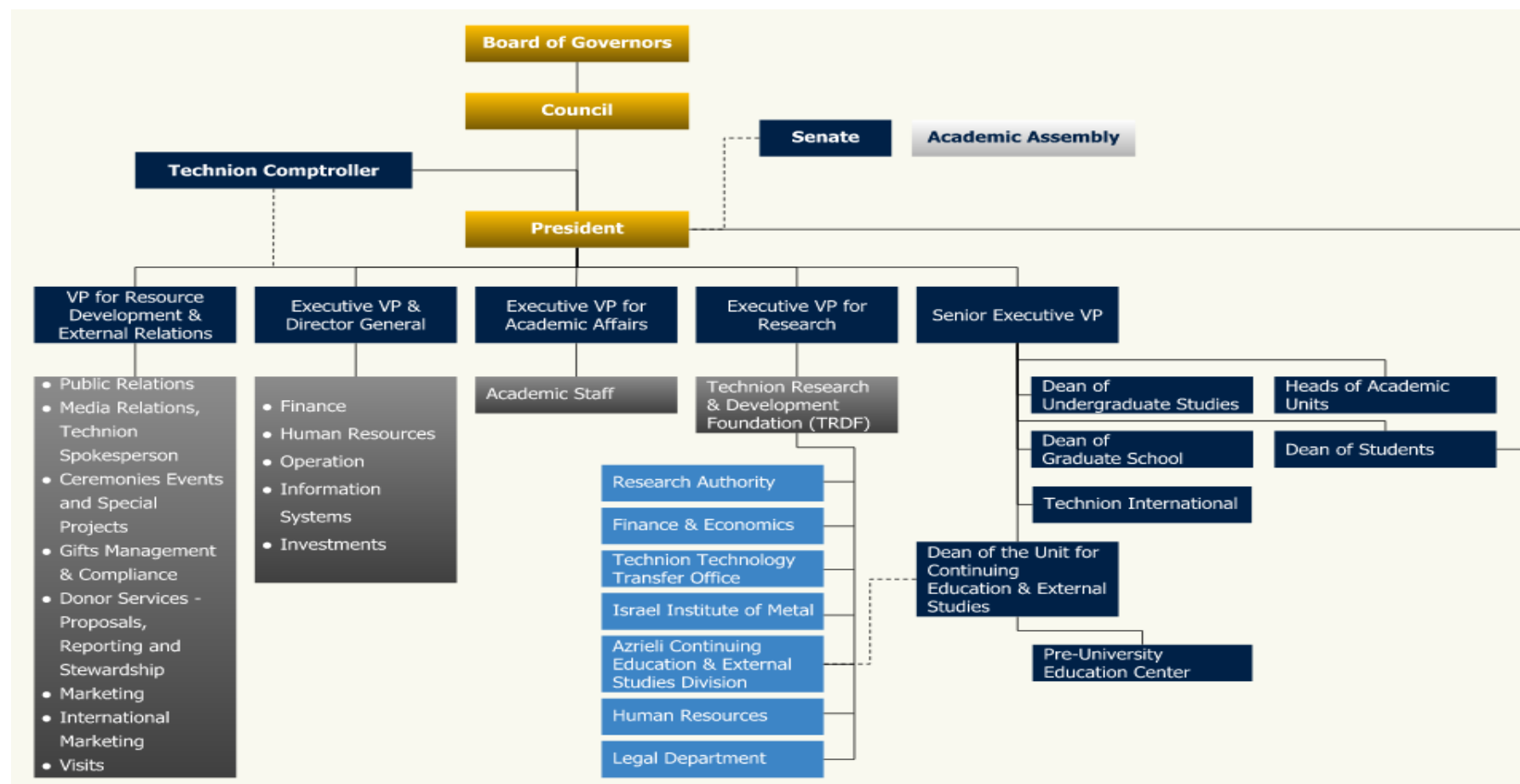


Figure 36.1. Organizational Structure of Technion-Israel Institute of Technology

Source:³⁶⁰

³⁶⁰ *Organizational Structure of Technion-Israel Institute of Technology*. [accessed 21.09.2021]. Available at: <https://www.technion.ac.il/en/organizational-structure-2/>

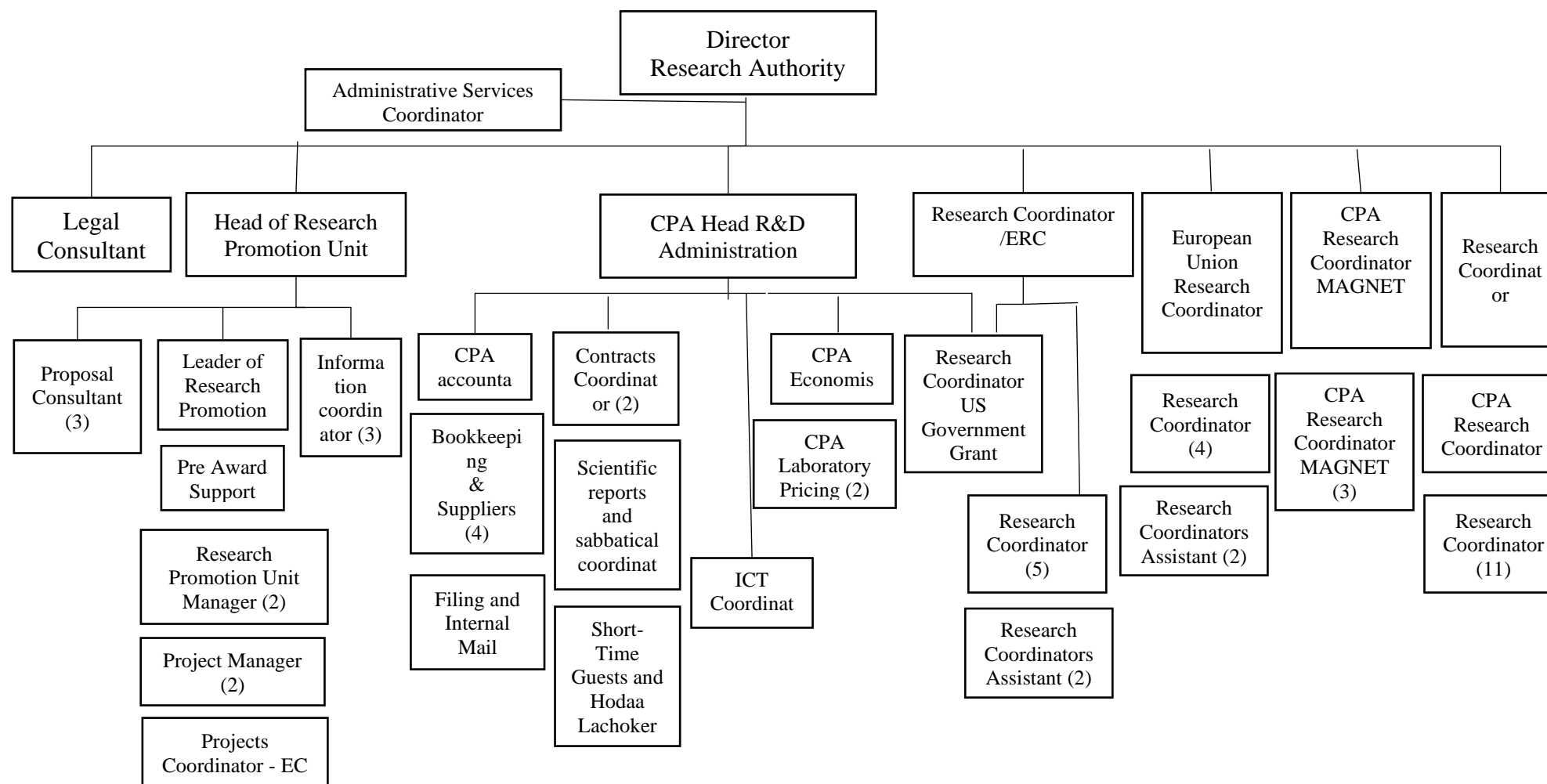


Figure 36.2. Research Authority Organizational Structure of Technion-Israel Institute of Technology

Source: ³⁶¹

³⁶¹ Research Authority Technion. Organizational structure. [accessed 17.09.2022]. Available at: https://www.ra.trdf.co.il/prdFiles/pages/sd_rgeneral_138518_doc_file_heb_1.pdf

Test to determine the level of development of the university's innovation ecosystem

Part 1. General information about the academic institution

In this section please share general details about your academic institution.

1. Name of the academic institution
2. What is your role in the academic institution?
3. What is the total number of teaching staff in the academic institution?
4. What is the number of research staff in the academic institution?

Part 2. The ecosystem and innovation processes in the academic institution

1. Is there a collaborative system of innovation development in the academic institution (ecosystem of innovation)?

Yes

No

other

2. If the academic institution teaches subjects in the field of entrepreneurship, please indicate the names of the courses on the subject:

Entrepreneurship

Innovation management

Project management

Startup management

Other

3. Who teaches the basic disciplines of entrepreneurship?

Academic staff

External businessmen

Collaboration between academic staff and external business people

4. Entrepreneurship programs of the academic institution are in development:

The units within the academic institution

In collaboration with business consultants

In collaboration with the Ministry of Education

5. How is an innovative collaborative system managed?

Independently by the academic institution

Featuring business representatives

A special body created jointly by all participants in the ecosystem

6. Describe the level at which the innovation ecosystem processes in the academic institution are

In the initial stage of construction

Built-in

Developing

7. Here is a list of possible partners in ecosystem processes, which ones do you think take part in your academic institution in developing innovation processes?

Corporations

International companies

Famous Israeli companies

R&D organizations (public or private)

Scientific and industrial communities

Technology Transfer Companies (TTC)

Providers of facilities and resources for university infrastructure

Companies located near the university

Organizations of various industries and sectors

Government organizations (various ministries, the Israel Innovation Authority, tax authorities and more)

Local authorities

Universities and other colleges

Representatives of ventures and private investors

Activation accelerators

R&D funds

Entrepreneurship Center

Center for Entrepreneurship Education

Business schools

Public organizations

Student organizations

8. These are the means of communication that exist between partners of the ecosystem

Innovation centers / centers

Educational centers / centers

Educational clubs

9. The relationship between the participants in the innovation system of the academic institution develops on a basis

Double-sided official contract

Coordination on the basis of an informal agreement

Official contracts are concluded only with individual participants of the innovation ecosystem system

10. What do you think is the important component in managing collaborative innovation processes?

The quality of interaction between participants during the execution of large projects

To develop principles for the functioning of the ecosystem of innovation

Choose the type of innovation (product / technology / process)

11. What challenges does your academic institution face in the process of formulating and managing an innovation ecosystem system?

Economic

Manpower

Infrastructure

Insufficient dynamics of innovative activity of teachers and students

Lack of a common methodology for developing ecosystems of regional innovation

12. Has your academic institution built international collaborations with another academic-research institution?

Yes

No

13. Is there a startup community in the academic institution, and if so who are its partners?

Does not exist

Yes, students

Yes, businessmen

Yes, academic staff and researchers

14. Does the academic institution create new products / technologies / services: independently, participates in the production of new products / services in manufacturing plants?

Yes

No

15. How are collaborations between the academic institution and other factors expressed?

Project creation (average annual percentage of joint projects)

Teacher participation in business projects

Creating and supporting startups

Creation or participation in technopolis

Project financing

Providing internships for students and teachers

Granting corporate scholarships or other incentive payments to faculty and students involved in innovation development

16. How are collaborations between the academic institution and government manifested?

Opportunities to participate in state program competitions / innovative projects

Funding projects in the form of grants

17. How are collaborations with local companies reflected?

Lectures on entrepreneurship

Mentoring

Access to university infrastructure

Business Programs Competition for Students

18. What activities does the academic institution organize in order to attract partners for innovative entrepreneurship?

Idea contests

Master classes of innovators

Laboratories best practices

Conferences

Forums

19. Which of the following organizations / infrastructure facilities have been created in your academic institution?

Business incubator

Technology Park

Laboratories

Joint work center

Innovation Center

Technology Transfer Center

20. Is there an innovation center at the academic institution and if so, what is its purpose?
(Indicate in "Other")

Yes

No

21. Can you say that the organizational culture of your organization inspires innovation?

Yes

No

Source: developed by the author

The main and additional conditions for the emergence of an innovation ecosystem

Main Conditions	Additional Conditions
Availability of the venture industry and the main participants in the ecosystem (large universities, venture capitalists and a highly educated workforce)	Entrepreneur's freedom of action combined with limited financial support from the state
Having a critical mass of talented people	Geographical position
The presence of a market need (demand)	Presence of large corporations
Favorable for development business legislation and taxation system	Climate conditions
Availability of success stories	High authority of the region
Cultural aspects: - favorable business environment, - calm attitude to failures, - high status of technical specialists	Cultural aspects: - cultural and national diversity; - an opportunity to have an interesting leisure time; - liberal lifestyle; - presence of communities.
Availability of small business support programs	Self-implementation by the region examination functions
Availability of infrastructure (material and human)	
The system of material incentives for employees	
Time factor (life cycle)	
Territorial proximity of the investor and the investment object	
Focus on the advantages of the region	

Source: developed by the author based on ³⁶² ³⁶³ ³⁶⁴

³⁶² ISAAC, R. *From collective learning to Silicon Valley replication: the limits to synergistic entrepreneurship in Sophia Antipolis*. In: Research in International Business and Finance, 2009, nr. 23(2), p. 134-143. ISSN 0275-5319.

³⁶³ KUSHIDA, K. A strategic overview of the Silicon Valley ecosystem: Towards effectively "harnessing" Silicon Valley. In: Report submitted to the Stanford Silicon Valley-New Japan (SV-NJ) Project, 2015. 55 p.

³⁶⁴ FU, E., HSIA, T. *Universities and entrepreneurial ecosystems: Elements of the Stanford-Silicon Valley success*. In: Kauffman Fellows Report, 2014, nr. 5. [accessed 17.08.2022]. Available at: https://www.kauffmanfellows.org/journal_posts/universities-and-entrepreneurial-ecosystems-stanford-silicon-valley-success

Success Factors for the University of Massachusetts Ecosystem

Factors	Content
Resource base in science and engineering	Own investment system at early stages, startup community, community of venture capital and private equity investors, accelerators. The university is able to attract significant financial resources from the creation of spin-off companies for the development of advanced technologies. Development of a system of student clubs.
Business Interaction	Intensive interaction with the corporate sector (Google, Samsung, SANOFI, INTEL, NOVARTIS and others), including through business education. Contests as a meeting place for interested participants allow attracting attention and connecting investors and startups (Enterprise FORUM MIT, X-prize, MIT-\$100K, MIT IDEAS GLOBAL CHALLENGE).
Infrastructure quality	The university tries to create innovations that can be commercialized (64% of academics work in the field of applied sciences and engineering), looking for students and researchers with the highest potential. Within the ecosystem, there is the MIT-TLO Technology Licensing Office, CenterforMITentrepreneurship, which handles projects, MIT DeshpandeCenter is a center that grows entrepreneurs and (venture program club).
Organizational structures	The university has its own technology transfer platform, which is engaged in market research, identifying technology needs, prompting relevant departments to get the necessary results as soon as possible, assessing their prospects and securing intellectual property. Also today, the university has more than 60 interdisciplinary research centers, multiple entrepreneurial programs.
University Mission	The mission of the university is to receive new and improved knowledge, to educate students in science, technology and other areas, taking into account the needs that society currently demonstrates.
University corporate culture	Emphasis on the selection of highly qualified personnel in their areas of specialization; participants in research groups try to work autonomously, without resorting to the help of the university itself.
History and traditions	The formation of the university was influenced by the fact that it has always participated in the economic development of the country; always closely cooperated with the state in the creation of new revolutionary technologies; and a strong management core.
University location	The university is located in a region that is similar to an incubator for new commercial companies. It has all the resources for its successful development: scientific development initiatives, investment activity, professional level of the workforce. Massachusetts has a large concentration of high-tech workforce.

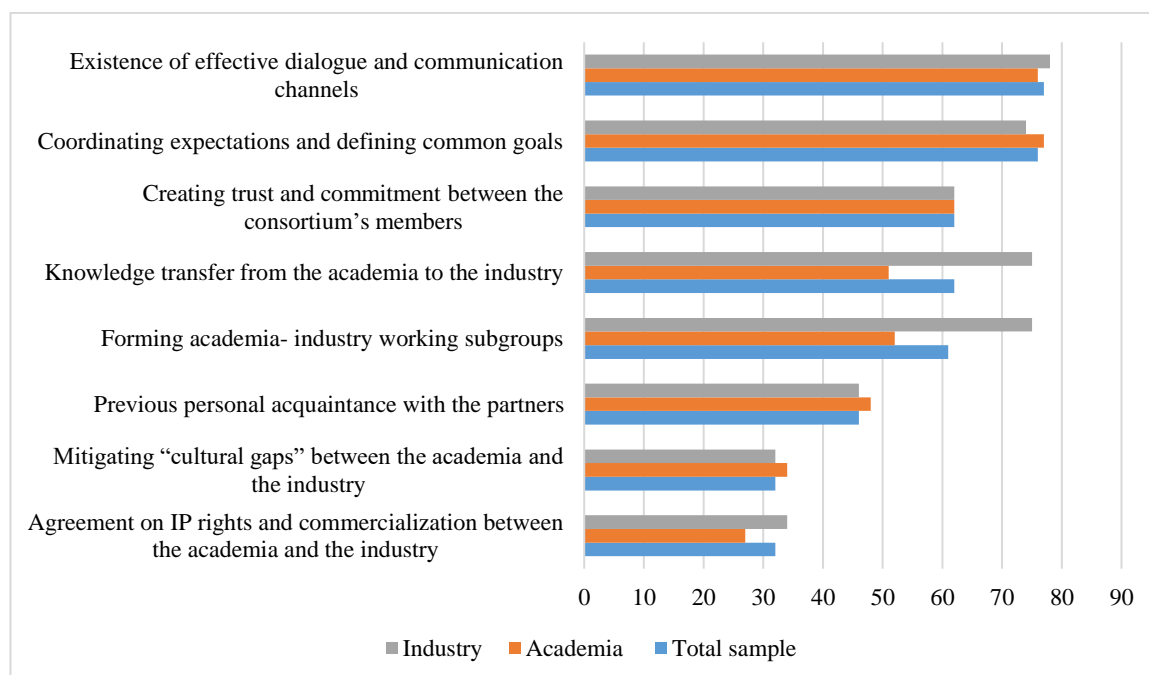
Source: developed by the author

Stakeholders as a collective entrepreneur of the innovation ecosystem and the innovation development process

Participants	Role in the innovation ecosystem
Academic organizations	Higher education institutions, research institutes and training centers that support the ecosystem by conducting primary research, promoting capacity building and encouraging the training of young innovators.
Entrepreneurs	Entrepreneurs stimulate innovation by creating companies that develop innovative solutions; participate in all stages of the innovation life cycle (from the design of ideas to their scaling); play the role of leaders and activists in the ecosystem. They are usually supported by other interested parties.
Government sector	Policy makers and regulators working in the innovation ecosystem in various fields (finance, trade, communications and technology), as well as other entities working with other partners such as international organizations and civil society groups.
Business Support Networks	Organizations within the ecosystem (innovation hubs, incubators, accelerators and entrepreneur support associations) that support entrepreneurs. They guide startup activities throughout the development life cycle, create a culture of support, and help shape the community. This group also includes the media and other organizations that promote innovators.
Financial entities	Investors include: philanthropist investors, seed funds, fundraising communities and platforms, venture capitalists, private equity investors, grant providers (such as NGOs), and targeted investors. They provide support at various stages of the startup life cycle (from the development of a prototype of a new company to the first public offering (IPO) of more mature companies). This category also includes entities that finance ecosystem building activities.
Private sector	Large, developed corporations and groups representing the interests of the private sector (chambers of commerce). Typically, these companies engage with the innovation ecosystem to explore opportunities to transform their traditional business models or provide services to other companies.

Source: developed by the author

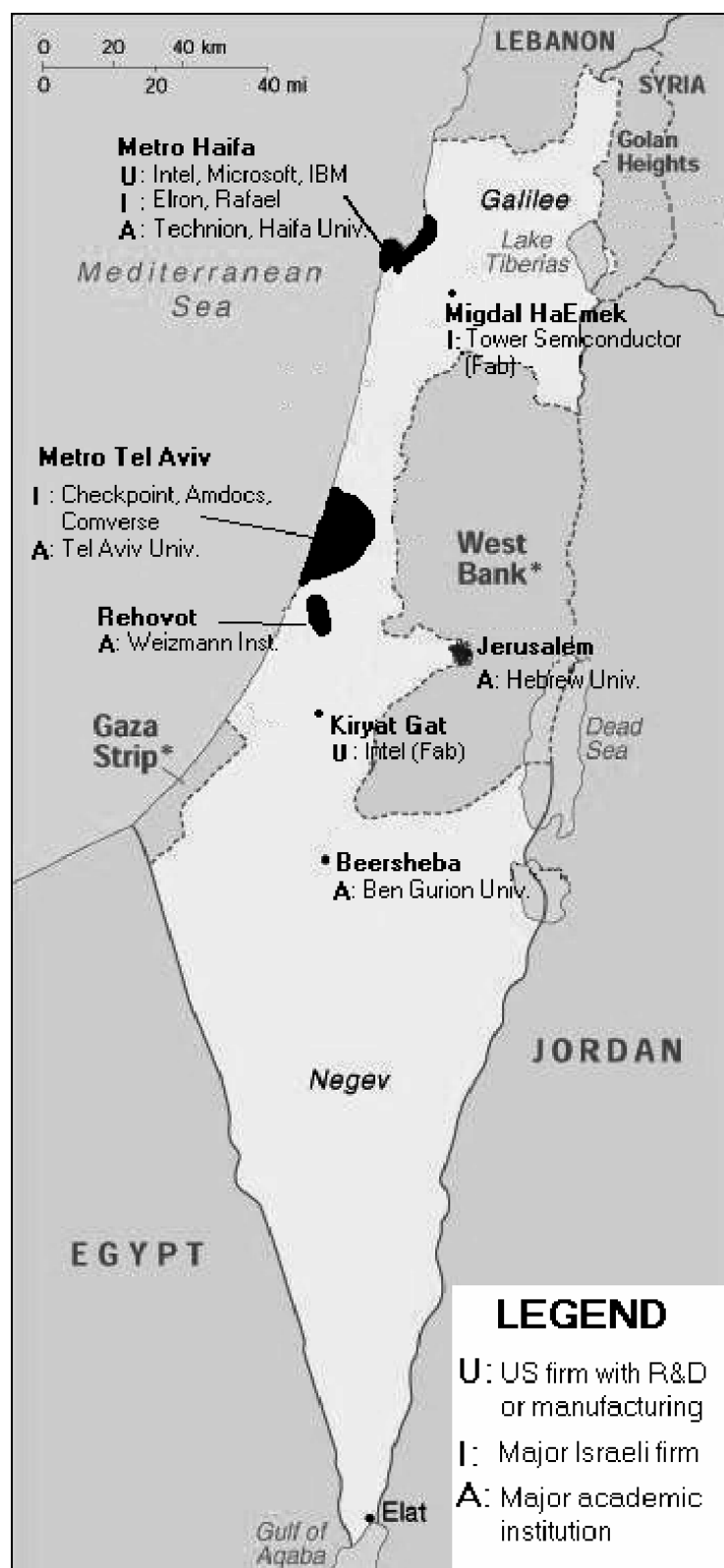
Main factors influencing the establishment of cooperation between science and industry in Israel



Source:³⁶⁵

³⁶⁵ LECK, E., GETZ, D., ZETCOVETSKY, I. *Research and Development Outputs in Israel: 2000-2020 Academy-Industry Cooperation Final Report*. Israel: Samuel Neaman Institute, 2021. 74 p. [accessed 07.05.2022]. Available at: https://www.neaman.org.il/EN/Files/Report_Patent%20report%202021%20Final%20with%20access.pdf

Geographic location of leading universities and their participation in the Silicon Wadi Israel project



Source:³⁶⁶

³⁶⁶ Кремниевое вади: как Израиль стал одним из центров глобального ИТ. [accessed 11.06.2022]. Available at: <https://habr.com/ru/company/ruvds/blog/677266>

Strategic guidelines for universities aiming for global and regional impact

Higher education institution	Place in the QS ranking	Strategy document	Key provisions of the strategic goal
Universities aiming for global impact			
Massachusetts Institute of Technology (USA)	1	University Strategy 2017	Global leadership in education and research to serve the world and society
Oxford University (UK)	2	Strategic Plan 2018–2024	Providing world-class research and education for the benefit of society at the local, regional, national and global levels
Stanford University (USA)	3	Long Term Vision for Stanford	Contribution to the development of society by solving urgent global problems
National University of Singapore (Singapore)	11	Global strategy of the National University of Singapore	Leading global university shaping the future
Yale University (USA)	14	Yale University Global Strategy 2019-2022	Global Leadership in Education and Research on Issues of Global Importance
Peking University (China)	18	Global Excellence Strategy	World-class university with Chinese characteristics
University of Hong Kong (Hong Kong)	22	Vision of the University for 2016–2025	World-class university with cutting-edge research and education in cutting-edge fields
London School of Economics and Political Science (UK)	49	LSE Strategy 2030	Leading Social Science Institute with the Most Global Influence
University of the Philippines (Philippines)	399	University of the Philippines Strategic Plan 2017–2023	Leading regional and global university for knowledge creation and community service
Hunan University (Korea)	414	Hunan University 2030	World-class global university contributing to the development of society
University of Stirling (UK)	471	Strategic Plan 2016-2021 and addition for 2021–2023.	A global leader in education, research, partnerships and sustainability through a commitment to innovation and the ability to transform people's lives
University of Eastern Finland (Finland)	521-530	Strategy 2030	A university focused on an interdisciplinary approach in education and interdisciplinary research in the framework of solving global problems
Universities aimed at regional influence			
ETH Zurich (Switzerland)	8	Strategic Development Plan 2021–2024	University contributing to the prosperity and well-being of Switzerland through the development of education, research and technology
University of Saskatchewan (Canada)	458	University plan until 2025	A university with great potential in research, teaching and creativity to create a sustainable future in Canada and around the world

Missouri University (USA)	476	Strategic Plan "Flagship of the Future"	Leading University for Successful Student Development, Benefiting All Missourians
Oregon State University (USA)	531-540	Strategic Plan 4.0 2019–2023 Transformation, Excellence and Impact	A leader in education, research, knowledge production, and innovation that drives prosperity in Oregon and beyond
Aberystwyth University (UK)	541-550	Strategic Plan 2018–2023	A university that contributes to the development of society in Wales and around the world
Hallim University (Korea)	561-570	Hallim University Vision 2030	Leading regional university in Korea with a global outlook
Howard University (USA)	561-700	Howard Forward 2024	Leading research university in the US that provides solutions to contemporary global issues affecting the African diaspora

Source: developed by the author based on ³⁶⁷

³⁶⁷ ШТЫХНО, Д. А., КОНСТАНТИНОВА, Л. В., ГАГИЕВ, Н. Н., СМЕРНОВА, Е. А., НИКОНОВА, О. Д. Трансформация моделей университетов: анализ стратегий развития вузов мира. В: Высшее образование в России, 2022, № 31(6), с. 27-47. ISSN 0869-3617.

Strategic Guidelines for Israeli Universities [developed by the author]

Higher education institution	Place in the QS ranking	Strategy document	Key provisions of the strategic goal
Hebrew University ³⁶⁸	198	Strategic Plan	Mission: To create an educated community capable of global transformation by encouraging holistic education, offering corporate skills, and promoting cultural development.
Tel Aviv University ³⁶⁹	255	Strategic Priorities	The mission of TAU is to advance research of the highest level and to equip tens of thousands of students every year with academic knowledge and critical thinking skills. The university also seeks to influence society in Israel and around the world in areas such as industry, culture and education.
Technion-Israel Institute of Technology ³⁷⁰	330	Strategic Plan for Undergraduate Studies	Main goal: to make the Technion competitive in the academic world, locally and globally. Objectives: to ensure the integration and development of advanced technologies and approaches both in education and research; encourage interdisciplinary discourse, learning, research and collaboration, and others.
Ben-Gurion University of the Negev ³⁷¹	471	Strategic Priorities	BGU research results have an impact on all of Israel and the whole world. The university's research centers maximize the use of resources and result in increased opportunities for academic and industrial collaboration, as well as an increase in publications and competitive grants.
Bar-Ilan University ³⁷²	477	Strategic Plan	Mission: striving to combine cutting-edge research with the best standards of academic teaching. Objective: Participation in conferences and research activities with leading strategic research centers around the world.
University of Haifa ³⁷³	701-750	Strategic Plan 'Multiversity'	The University has established strategic partnerships with distinguished institutions around the world that enhance the quality of our research and provide our students with a transformative experience.
Weizmann Institute of Science ³⁷⁴	-	Strategic Plan	Mission: To create an inclusive and fair campus environment for people of all genders, nationalities, religions, etc. Task: interdisciplinary approach to science, membership in the international corporation GMTO
Ariel University ³⁷⁵	-	Strategic Priorities	Priority in cooperation with international organizations

Source: developed by the author based on ³⁶⁸⁻³⁷⁵

³⁶⁸ Mission. Hebrew University. [accessed 17.08.2022]. Available at: <https://jewishus.org/about-page/>

³⁶⁹ Strategic Priorities. [accessed 12.07.2022]. Available at: <https://english.tau.ac.il/strategy#:~:text=The%20vision%20of%20the%20University,knowledge%20and%20critical%20thinking%20skills.>

³⁷⁰ Strategic Plan for Undergraduate Studies: vision, strategic plan, implementation and integration. Haifa: Technion-Israel Institute of Technology, 2022. 32 p.

³⁷¹ Strategic Priorities. Ben-Gurion University of the Negev. [accessed 12.07.2022]. Available at: https://in.bgu.ac.il/en/fohs/Pages/strat_process.aspx

³⁷² Bar-Ilan University website. [accessed 02.02.2022]. Available at: <https://www.biu.ac.il/en/science-and-research>

³⁷³ University of Haifa. [accessed 12.05.2022]. Available at: <https://magazine.haifa.ac.il/index.php/inside-6/43-example>

³⁷⁴ Research and discovery. Weizmann Institute of Science. [accessed 19.07.2022]. Available at: <https://www.weizmann.ac.il/pages/about-institute/research-and-discovery>

³⁷⁵ Ariel University website. [accessed 18.06.2022]. Available at: <https://www.ariel.ac.il/wp/en/>

Activities of the Israel Innovation Authority (IIA) to promote innovation dynamics in the country

Options	Content
Mission and vision	The IIA's mission is to promote innovation for Israel's inclusive economic growth, in particular by developing an effective entrepreneurial culture, promoting a strong technological infrastructure and building highly skilled human capital.
Activity	<p>IIA provides services under various programs in three main areas.</p> <ul style="list-style-type: none"> - Human capital: improving the skills of Israel's human resource, attracting new specialists to the country. • The Israel National Brain Gain Program is designed to encourage Israelis with international experience, especially in high-tech industries, to return to Israel. • The Coding Bootcamps Program increases the proportion of high-tech-skilled workers in the Israeli workforce. The program is targeted at skilled foreign workers and returning Israelis. -Infrastructure contributes to a more vibrant entrepreneurial culture. • The Innovation Labs Program funds technology-advanced innovation-model labs to encourage collaboration between tech entrepreneurs and industrial corporations engaged in new manufacturing technologies. • The Ideation Incentive Program (Tnufa) funds technology enterprises and encourages technology entrepreneurship in the pre-R&D phase. - Investments in R&D at all stages of technological development in all innovative industries. - Programs to support the development of innovation and creativity: <ul style="list-style-type: none"> • The Innovation Visas Program for Foreign Entrepreneurs allows entrepreneurs to stay in Israel for up to 24 months, during which they may receive support from the Tnufa program. • Multinational Corporations' R&D Centers encourages multinational corporations to establish R&D centers in the field of biotechnology and medicine, open representative offices and expand their presence in Israel. • The Global Enterprise R&D Collaboration Program ("single window") is designed for Israeli start-ups (with an annual income of no more than 70 million US dollars) wishing to cooperate with multinational corporations.
Achievements	In 2020, the IIA approved 615 requests submitted by new companies applying for support for the first time: 15 Infrastructure, 75 Growth, 120 Advanced Manufacturing, 82 Societal Challenges, 136 startups, 189 International. 179 entrepreneurs received support under the Tnufa program, and 135 companies received support under the Beginner Companies Program.
Management and resources	The IIA Council oversees the work of the Authority and determines the direction of activities. It is led by a CEO and is comprised of six major innovation divisions, each offering customized and comprehensive incentive programs. The divisions specialize in the following aspects: a) start-up; b) growth; c) technological infrastructure; d) advanced production technologies; e) international cooperation; and f) social challenges.

Source: developed by the author based on ³⁷⁶

³⁷⁶ *Activities of the Israel Innovation Authority's Divisions*. [accessed 17.08.2022]. Available at: <https://innovationisrael.org.il/en/reportchapter/activities-israel-innovation-authoritys-divisions>

Level of fear of failure to open a new business, GEM 2018/2019

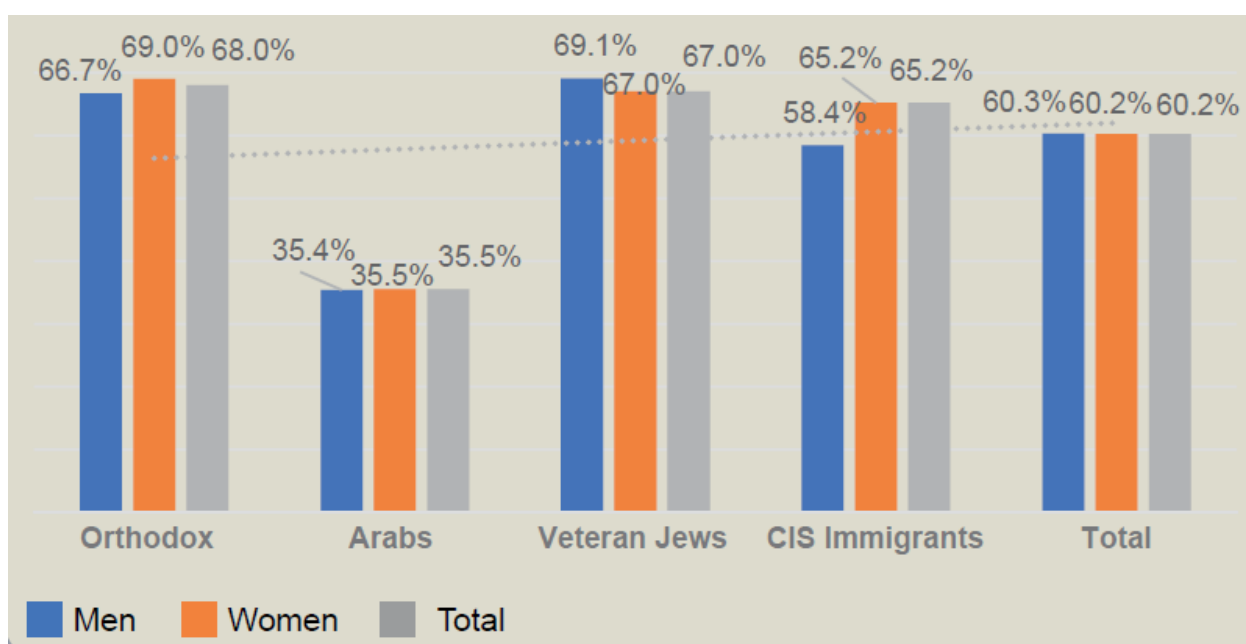


Figure 46.1. Fear of failure as a deterrent to start a new business in the non-entrepreneurial population of Israel

Source:³⁷⁷

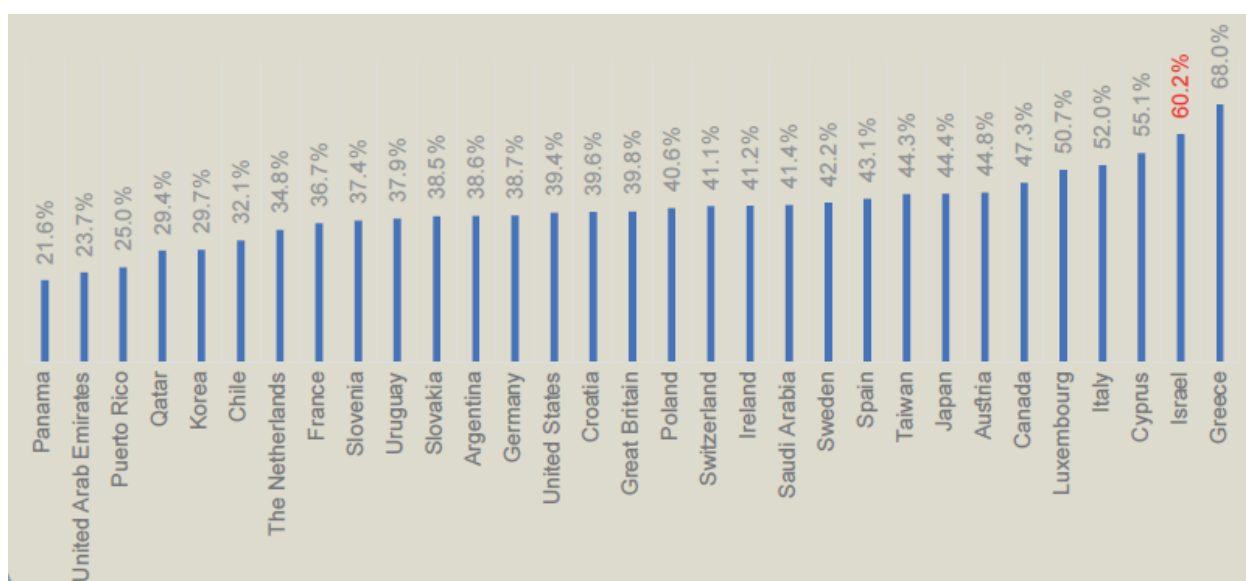


Figure 46.2. Fear of failure that prevents entrepreneurship in developed countries

Source:³⁷⁸

³⁷⁷ MENIPAZ, E., AVRAHAMI, Y. *Entrepreneurship Report, Israel, GEM 2018/2019*. Beer Sheva: Ben Gurion University, 2019. 50 p.

³⁷⁸ Idem. MENIPAZ, E., AVRAHAMI, Y. *Entrepreneurship Report, Israel, GEM 2018/2019*. Beer Sheva: Ben Gurion University, 2019. p. 26.

Self-assessment of entrepreneurial skills and abilities for starting a new business

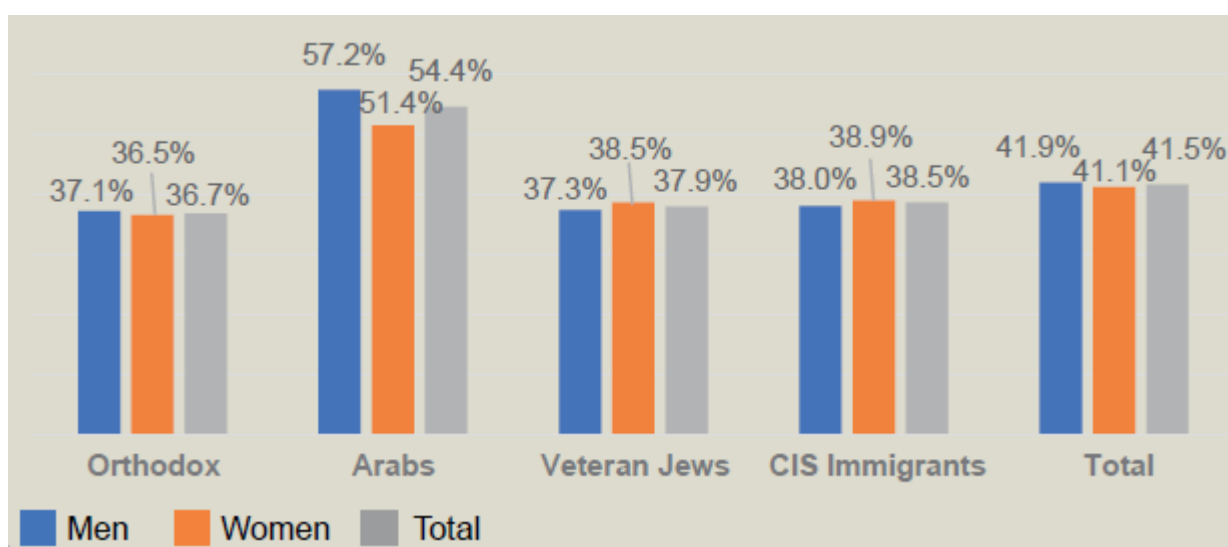


Figure 47.1. Self-perception of skills and capabilities to start and manage an independent business in the population in Israel

Source: ³⁷⁹

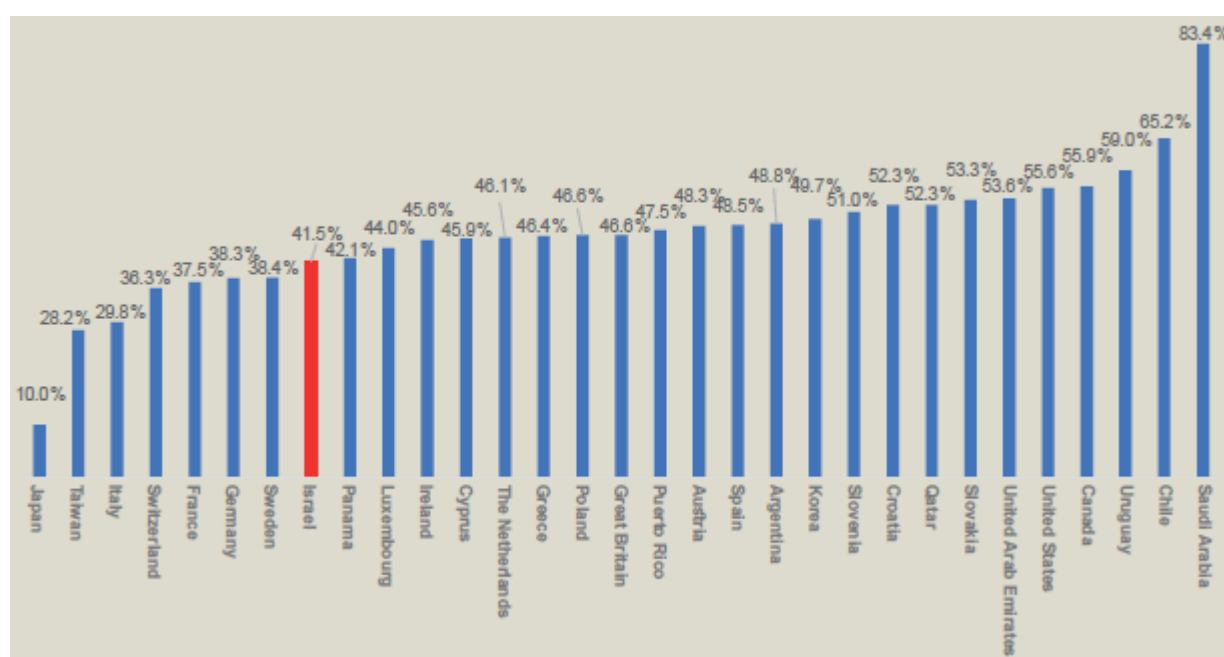


Figure 47.2. Self-perception of skills and capabilities to start and manage an independent business in the non-entrepreneurial population in developed countries

Source: ³⁸⁰

³⁷⁹ MENIPAZ, E., AVRAHAM, Y. *Entrepreneurship Report, Israel, GEM 2018/2019*. Beer Sheva: Ben Gurion University, 2019. 50 p.

³⁸⁰ Idem. MENIPAZ, E., AVRAHAM, Y. *Entrepreneurship Report, Israel, GEM 2018/2019*. Beer Sheva: Ben Gurion University, 2019. p. 34.

The composition of the methods for managing the formation and development of the university's innovation ecosystem

Methods for managing the formation of UIE	Management methods UIE development
<ul style="list-style-type: none"> - identification of potential innovative participants (KPI system); - phased formation of the UIE (system approach, analogy method, block, modeling, etc.); - systematization of the goals of forming the UIE ("Target of goals", the SMART method and others); - identification of interrelations and interdependencies within the elements of the UIE (diagram (map) of stakeholders); - organization of search and attraction of new UIE participants (interview method, questioning, exhibitions, presentations, forums, communities and others); - development of a support system for innovative entrepreneurship, innovation, entrepreneurial initiatives of UIE participants, incl. university staff and students (programs on entrepreneurship and innovation management, partnerships, consortiums, joint projects); - organization of events and platforms for interaction between UIE participants (forums, exhibitions); - formation of the process of integration of university departments into the UIE (in educational, scientific and entrepreneurial areas); - drawing up a methodology for selecting promising projects, incl. students' projects (peer review, present value method, criteria list method, etc.); - organization of support in attracting R&D financing (fundraising, interaction with investors, competitions, acceleration programs); - cooperation with innovative infrastructures (calculation of the commercial potential of projects, business planning); - formation of teams for the Coordinating Center and project executors (recruitment methods, personal participation of management, involvement of informal leaders, business experts); - formation of a common vision and culture in the UIE (replication of "success stories", "calendar of joint events" and others) 	<ul style="list-style-type: none"> - analysis of requests from the external environment (SWOT-analysis, PEST-analysis and other marketing tools); - development of the UIE development strategy (Boston Matrix, Porter's competitive analysis, Ansoff Matrix, strategic maps); - organization of interaction between university scientists and interested participants (exhibitions, presentations, forums, communities, etc.); - cooperation with organizations innovation infrastructure (consultations in the preparation of business start-up development plan and strategy); - organization and implementation of financing of promising projects (fundraising, interaction with investors); - organization of internal document flow (models of contracts); - technologies for negotiating with UIE participants and stakeholders (variation method, compromise method, integration method and balancing method); - promotion of information on the innovation market (market map, viral marketing, tenders, etc.); - procedures for negotiating contracts and resolving conflict situations with UIE participants (negotiations, coordination and integration mechanisms, compromises, and others); - development of the necessary culture of change (the minimum number of management levels, informality and self-government, loyalty, involvement, and others); - promoting connectivity and ensuring the sharing of the knowledge base and the network (integration, mobility, statistics, expert systems, information security, network analysis)

Source: developed by the author

Comparative characteristics of behavioral models of participants in innovative interaction

Compare parameter	Behavior Model			
	"Autonomy"	"Partnership"	"Full consensus"	"Separation of functions"
Implementation of strategic management	university, enterprise	university, enterprise	university, enterprise	university, enterprise
Implementation of operational management	CC	CC, university, enterprise	university, enterprise	university, enterprise
Head of CC	invited manager	representative of the university / representative of the enterprise	representative of the university / representative of the enterprise	representative of the university / representative of the enterprise
Advantages	minimal time spent on making a managerial decision, low probability of conflict	the ability of the university to directly influence the activities of the CC	cooperation potential	competent decision in solving problems
Disadvantages	inability to directly influence the activities of the CC	considerable time spent on coordination	conflicts in making managerial decisions	time costs for the coordination of management decisions and actions; conflicts in making managerial decisions

* CC – Coordinating center

Source: developed by the author

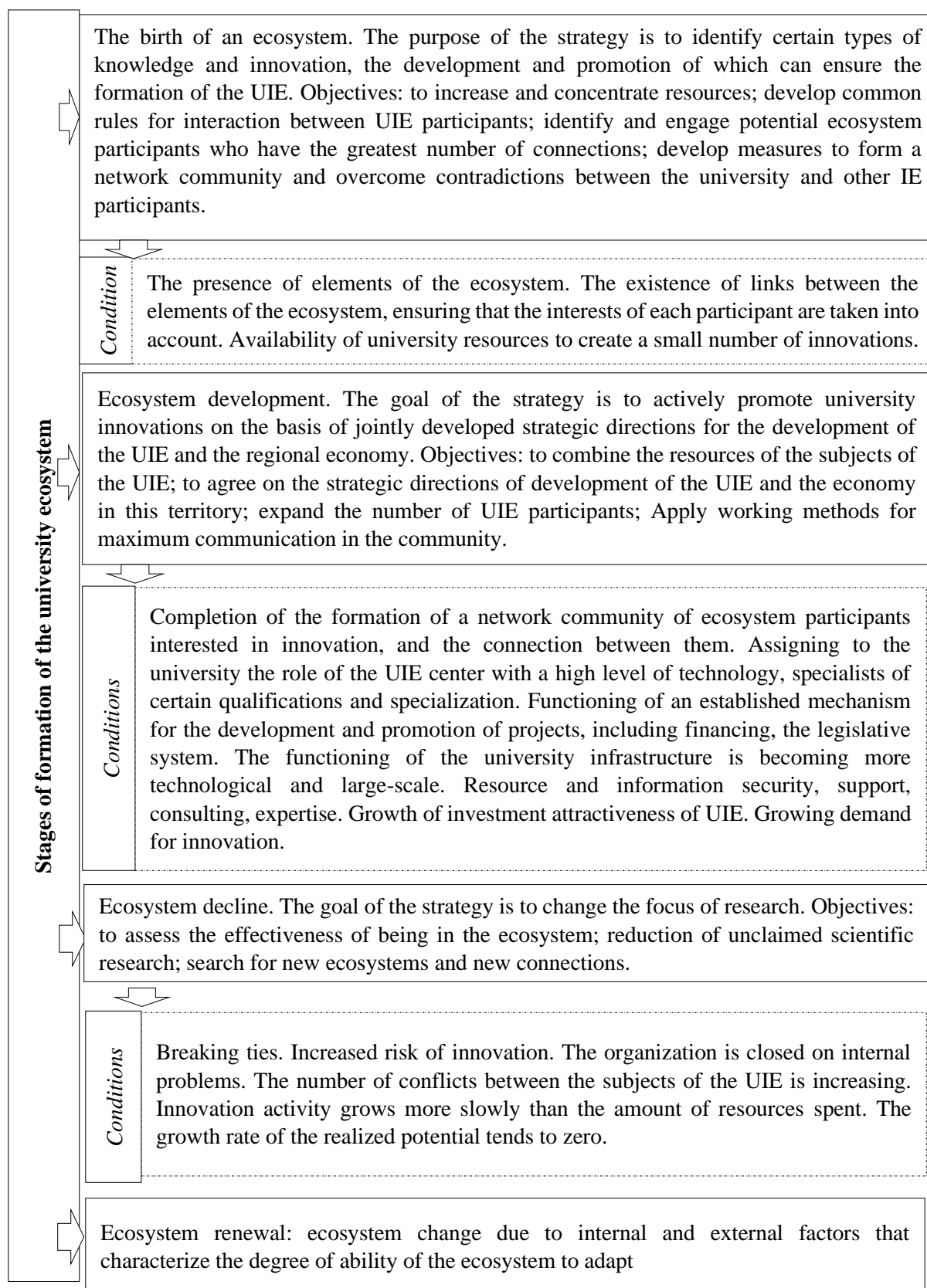
The main elements of the university's strategy for two scenarios of formation and development of the university's innovation ecosystem

Elements	First scenario (UIE creation)	The second scenario (integration into the UIE)
Mission of the University	development of an effective model for the preparation of students competent for innovative learning, motivated to research, design, technological development and entrepreneurship of researchers in accordance with the priorities of the development of the Israeli economy, the trends of international technology markets, the tasks of the emerging ecosystem.	generation of new knowledge and innovations that will ensure integration into the national innovation system through research and successful innovation.
Vision	a research university competitive in the world in terms of quality, flexibility and competitiveness of educational formats, distinguished by the quality of research, entrepreneurial initiative and commercialized result of intellectual creativity of researchers and students, based on an innovation ecosystem.	a research university distinguished by the quality of research, entrepreneurial initiative and commercialized result of intellectual creativity of researchers and students, capable of contributing to the development of the national innovation system.
Purpose of the university	training of highly qualified specialists in the field of innovative economy based on interdisciplinary knowledge, acquisition of sustainable leadership among leading universities through the creation of an ecosystem for the transformation of fundamental knowledge, exploratory and applied scientific research into new products and services.	increasing the level of integration of the university into NIS and increasing the level of innovative activity and efficiency of its innovation activities.
Strategic directions	<p>1. Development of the university as a center for the formation of research competencies, the development of conditions for the generation of knowledge and the development of innovations.</p> <p>2. Development of the university as a leader in scientific research and commercialization of innovations in a certain field and related fields;</p> <p>3. Development of academic entrepreneurship, in particular entrepreneurial education, dissemination of entrepreneurial thinking and skills among people of all professions and ages, increasing the influence of the university on the economy and social life.</p> <p>4. Improving the efficiency and transparency of governance through partnership.</p> <p>5. Development of the university's infrastructure to provide the IESU with personnel, scientific and technical, educational, financial, image and other components.</p>	<p>1. Formation and development of an integrated system for the implementation of innovative projects and development programs based on improving the exchange of information, financial and other flows in order to realize the mutual interests of NIS participants.</p> <p>2. Development of the university through the expansion of ties between universities and various clusters and regional ecosystems that are part of the NIS.</p> <p>3. Enhancing the role of the University through participation in economic and political forums and committees as experts and advisors, as well as through membership in the boards of companies, public organizations and associations.</p> <p>4. University development through cross-collaboration in</p>

		commercialization projects, licensing agreements, patents, as well as academic spin-offs and startups.
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Source: developed by the author

**Goals and objectives of the university's strategy as the creator of the innovation ecosystem
(first scenario) at the stages of the life cycle**



Source: developed by the author

Strategic goals and objectives of the university as a participant in the existing innovation ecosystem (according to the second scenario) at the stages of the life cycle

Stage	Stage characteristics	Goals and objectives of the university
Initial stage	Availability of an existing IE and a network of interaction of participants. The role of the orchestrator is realized by one of the participants of its original composition. The university begins to interact with those participants who have the greatest number of connections and are leaders in this community.	The goal of the strategy is to gain legitimacy in an already established ecosystem. Objectives: to gain recognition of the university's actions as acceptable and useful in order to become an actor in this ecosystem; audit resources to promote their innovations; identify and stimulate the degree of interest of regional business structures in the acquisition of competencies, innovative solutions of the university.
Stage of development	A sharp increase in the number of people wishing to join existing IE members as connections grow. IE is growing and has further prospects in terms of its potential. A variety of activities of the companies located in it. Each individual organization plays a specific role and occupies a place in the ecosystem, i.e. has its own niche. In a mature ecosystem, each of the participants is interconnected with the others (sometimes through several stages of the relationship), the innovation process is debugged, acts independently and does not require interventions.	The purpose of the strategy is to develop mechanisms for interaction between intra-university institutions of knowledge generation and institutes of commercialization and a complex of institutions of the innovation ecosystem. Objectives: to identify priority areas of innovative developments of a cross-sectoral nature on the basis of analysis and audit of existing scientific projects at the university; to coordinate the strategy of the university with the strategy of ecosystem development; adapt, streamline and synchronize all actions with interdependent network participants; development of a comprehensive program of innovative development.
Stage of decline	Destruction of immediate elements and connections in the ecosystem. At the same time, the potential of the region is limited, therefore, there is no confidence in the successful innovative development of the territory..	The purpose of the strategy: the search for new areas of research or a new ecosystem for the commercialization of scientific developments. Tasks:

Source: developed by the author

Assessment of the university innovation ecosystem based on the BSC

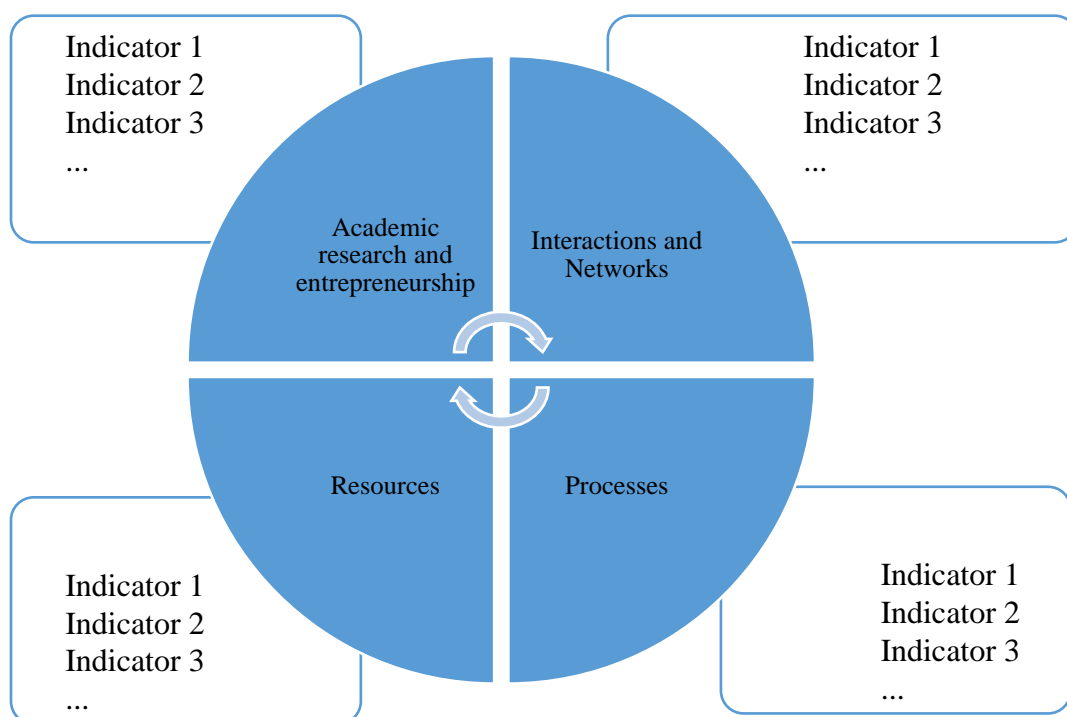


Figure 53.1. Functional components of the university innovation ecosystem based on BSC

Source: developed by the author

Table 53.1. Characteristics of the strategic aspects of the functional components of the university innovation ecosystem

Strategic aspect	Content
Academic research and entrepreneurship (I_{ARE})	
Accumulation and sharing of knowledge	The purpose of this aspect is the publication activity of scientists and researchers, which can be used by both UIE members and other communities.
Development of an innovative product/service	The purpose of this aspect is to organize the process of developing an innovative product (service) in the form of new or improved products / services through the implementation of university projects or joint projects with business structures.
The contribution of the university to the innovative development of the region	This aspect is planned to be achieved by obtaining patents and other intellectual property registered at the university, creating spin-offs and startups.
Recognition of university achievements	To achieve this goal, the university needs to become a world-class self-developing entrepreneurial innovative university.
UIE financial results	The purpose of this aspect is to profit from the commercialization of developments and license fees.
Interactions and Networks (I_{IN})	
Integration of UIE members into regional and/or national IE	The aim of the UIE members is to co-create new value by attracting new members/stakeholders.
Interaction of the university with local authorities, business structures in the field of research and entrepreneurship	The purpose of this aspect is the cooperation and interaction of the university with local authorities, business structures in the field of research and entrepreneurship.
University interaction with alumni	The purpose of this aspect is to attract university graduates for direct participation in the innovation ecosystem or financial assistance.
Interaction of UIE participants within the university	The purpose of this aspect is to attract university staff to participate in the UIE, the development of activities related to innovation.
Entrepreneurial/innovation culture	To achieve many of the goals of the UIE, the university must develop a corporate culture shared by the majority in favor of values relevant to the ecosystem, focused on joint development (co-evolution, collaboration), flexibility and stability, teamwork.
University technology transfer network	In order to commercialize technology, successful technology transfer mechanisms are being created that serve the interests of universities and society and do not involve government intervention. The university in this system assumes the function of the organizer of network interactions between the participants of the innovation ecosystem.
Processes (I_P)	
Providing UIE participants with a platform for collaboration	The processes carried out at the platforms for cooperation create an opportunity for the joint accumulation of knowledge and the exchange of knowledge and become a kind of hub for innovative solutions.
Establishing an effective UIE management system	The development of institutional innovations and the management system aims to create a new form of cooperation between a higher education institution and various UIE member companies. To achieve this goal, a system for regulating the relationship between functional departments, projects and management is needed.
Development of information and analytical system	The purpose of this aspect is to create a single information space for digital interaction, including the development of information services and platforms, the introduction of intelligent digital technologies, the

	development and maintenance of digital products and services, as well as the training of specialists competent in the field of the digital economy.
Resources (I_R)	
Ensuring the availability of funding for new knowledge and research	The purpose of this aspect is the financial support of scientific research from various sources.
Reducing the cost of new knowledge and research	For each project to create innovations, it is necessary to find the optimal amount of costs that will ensure profit from the commercialization of developments and license fees.
Providing the UIE with human resources	The purpose of this aspect is to motivate and select employees with a high level of professionalism to participate in the UIE.
Development of production and technical systems for the process of commercialization of scientific research	The goal of a successful innovation ecosystem is to build the right infrastructure for research and commercialization.

Source: developed by the author

Comparative characteristics of the application of BSC in business and higher education

Business		Higher education	
Functional components	Main content	Functional components	Main content
Finance	Indicators characterize the economic viability and profitability of the business, the capitalization of the company	Academic research and entrepreneurship	Indicators characterize the contribution of academic entrepreneurship to the economic development of the region/country, as well as the creation and development of new firms (spin-offs)
Clients	Indicators allow you to study the client and all points of interaction with him.	Interactions and networks	The indicators make it possible to study business partners, the required level of business and social ties, contacts, interest and trust of UIE participants, the presence of “soft” UIE variables (social capital, cultural values).
Processes	Indicators characterize the processes that are most important for solving the problems identified in the previous two directions, as well as assess the work of various departments of the company.	Processes	The indicators characterize the process of developing innovations at the university, which is gradually moving into the process of commercialization; allow taking into account the methods of supporting innovation through innovation policy at various levels of management, the availability of resource providers, etc.
Personnel training and development	Indicators make it possible to assess the effectiveness of the work of personnel after training and advanced training.	Resources	The indicators make it possible to assess: the provision of the university with various resources (financial and human capital); the provision of the process of commercialization of scientific research with production and technical systems.

Source: developed by the author

Indicators for assessing the development of the university's innovation ecosystem for the functional component "Academic Research and Entrepreneurship"

Strategic aspect	Indicators (X_{ARE})
Accumulation and sharing of knowledge	Total number of scientific publications and citations
	Share of articles in Scopus and Web of Science journals in the total number of publications
	Total number of grants received in the reporting year (per 100 researchers)
	Number of educational programs on entrepreneurship and innovation
	Volume of R&D per one university researcher
	Number of firms using university developments
	Mobility of researchers
Development of an innovative product/service	The share of projects for the development of new products / technologies / services in the total number of university projects
	Number of new products / technologies / services created jointly by the university and business structures
The contribution of the university to the innovative development of the region	The share of patents received by the university in the number of applications filed
	Number of patent applications filed and issued by the university
	Number of patents and other intellectual property objects registered at the university
	Number of license agreements
	The number of spin-offs and startups formed at the university and their results
	Share of university startups created in the total number of startups in the region/country
	Number of registered new firms per 1,000 residents of the region
Recognition of university achievements	University rankings
	Place in the top 100 most innovative universities
UIE financial results	University income from the commercialization of developments
	University income from royalties
	The share of the university's income from royalties in income from research and development

Source: developed by the author

Indicators for assessing the university innovation ecosystem for the functional component

"Interaction and Ecosystem Networks"

Strategic aspect	Indicators (X_{IN})
Integration of UIE members into regional and/or national IE	Total number of UIE participants
	Share of UIE member firms involved in university R&D in the total number of UIE members
	The share of firms that are members of the UIE with which contractual relations are formalized in the total number of enterprises in the region
	Number of involved participants/stakeholders per year
	Number of meetings with participants/stakeholders
	Share of major contributors in total IE organizations
Interaction of the university with local authorities	The number of university employees participating in the activities of commissions, advisory councils and other structures of local authorities in the field of entrepreneurship
	The share of open events to promote innovation in the region, provided for in the innovation policy of the university, in the total number of events
	Number of events to create information portals (platforms) on the development of innovations in the region
Interaction of the university with business structures in the field of research	Number of firms participating in the UIE
	Number of projects and research conducted by the university in collaboration with other organizations in the ecosystem
	The share of the number of joint projects / research conducted with UIE participants in the total number of projects / research of the university
	Number of joint scientific publications
Interaction of the university with business structures in the field of entrepreneurship	Share of joint scientific articles in the total number of publications of university scientists
	Number of lectures on entrepreneurship delivered at the university by representatives of local firms
	Number of new educational programs with joint participation of business representatives
	The share of enterprises that are practice bases with which contractual relations have been formalized in the total number of enterprises in the region
Interaction of the university with business structures in the field of entrepreneurship	The share of the number of students from UIE member organizations in the total number of students who have studied at the university in advanced training or professional retraining programs
	Number of alumni participating in the UIE
	Number of graduates currently working as a director (shareholder) of the company
	Number of student/teacher consultations on entrepreneurship and innovation by university staff
Interaction of UIE participants within the university	The share of joint events related to supporting the creation and growth of start-ups in the total number of university events
Entrepreneurial/innovation culture	The number of events to promote cultural values provided for in the innovation policy of the university
University technology transfer network	Number of university departments involved in technology transfer
	Number of technology transfer branches

	The share of innovations transferred by Technology Transfer Company for commercialization in the total volume of distribution of innovations
	The share of university developers of innovations in the total number of participants in the commercialization of innovations

Source: developed by the author

Indicators for assessing the university innovation ecosystem for the functional component**"Processes"**

Strategic aspect	Indicators (X _p)
Providing participants with a platform for collaboration UIE with a for	Number of projects to create sites for joint research
	Number of specific places (sites) where UIE participants can contact
	Share of university sites for joint research
	Number of sites for entrepreneurship learning (hubs)
Establishing an effective UIE management system	Percentage of innovation project managers (projects involving at least two organizations) in the UIE governing body
	Percentage of university representatives in the governing body of the UIE (e.g. Council)
	The share of the administrative staff of the university involved in the development of innovative and entrepreneurial activities in the total number of staff
	The share of decisions in the field of innovation made by the university management in the total number of management decisions
	The share of decisions in the field of innovations made by university departments in the total number of management decisions
Development of information and analytical system	Availability of an electronic library
	Availability of an IT system and other means or methods of communication to collect information and disseminate knowledge among employees (for example, knowledge bases)
	The share of IT - systems, services and services used in the innovation process, in the total number of communication tools
	Availability of IT systems that support the processes of making managerial decisions in the field of innovation

Source: developed by the author

Indicators for assessing the university innovation ecosystem for the functional component

"Resources"

Strategic aspect	Indicators (X_R)
Ensuring the availability of funding for new knowledge and research	Share of government funding in total R&D funding
	Share of private organizations in total R&D funding
	Share of alumni donations in total R&D funding
	Share of donations by other stakeholders in total R&D funding
	Share of funds in total R&D funding
	Share of domestic funding in total R&D funding
	Share of funding for laboratories, business incubators in total funding
	Share of private funding for university infrastructure development projects in total external funding
Reducing the cost of new knowledge and research	Share of university spending on basic research in total R&D funding
	The share of costs for applied innovative research of the university from the received R&D funding
	The share of the university's R&D costs in the total funding of the university
	The costs of social marketing of ideas of co-evolution, collaboration, innovative entrepreneurial culture within the ecosystem
Providing the UIE with human resources	Number of university staff and students as participants in the UIE
	The share of university employees in the total number of UIE participants
	The share of employees employed in R&D in the total number of faculty
	Percentage of university staff with advanced degrees participating in the UIE
	Number of undergraduate and graduate students performing research and development
	Number of teachers of educational courses on entrepreneurship and innovation
	The share of university employees who improved their qualifications under the university's programs for training innovative personnel for the internal needs of the university and supporting innovative processes, in the total number of employees
	The share of trained and advanced innovation-oriented personnel for small and medium-sized innovative businesses according to university programs to the total number of graduates
	The share of employees and students who opened startups in the total number of employees and students of the university
Development of production and technical systems for the process of commercialization of scientific research	Number of university infrastructure development projects that received external funding per 100 researchers
	Number of innovation infrastructure facilities: technopark, incubators, etc.
	Number of R&D centers established jointly with enterprises
	Number of established joint laboratories/innovation facilities

Source: developed by the author

The system of complex indicators of the development of the university innovation ecosystem based on BSC for a conditional example

Functional components (subindexes)	Simbol	Name of indicator
Academic research and entrepreneurship (I_{ARE})	$X_{ARE\ 1}$	Share of articles in Scopus and Web of Science journals in the total number of articles
	$X_{ARE\ 2}$	The share of projects for the development of new products / technologies / services in the total number of university projects
	$X_{ARE\ 3}$	The share of patents received by the university in the number of applications filed
	$X_{ARE\ 4}$	Share of university startups created in the total number of startups in the region/country
	$X_{ARE\ 5}$	The share of the university's income from royalties in income from research and development
Interactions and Networks (I_{IN})	$X_{IN\ 1}$	Share of UIE member firms involved in university R&D in the total number of UIE members
	$X_{IN\ 2}$	The share of UIE member firms with which contractual relations are formalized in the total number of enterprises in the region
	$X_{IN\ 3}$	The share of the number of joint projects / research conducted with other UIE members in the total number of projects / research of the university
	$X_{IN\ 4}$	The share of open events to promote innovation in the region, provided for in the innovation policy of the university, in the total number of events
	$X_{IN\ 5}$	The share of joint events related to supporting the creation and growth of start-ups in the total number of university events
Processes (I_P)	$X_{P\ 1}$	Share of university sites for joint research
	$X_{P\ 2}$	The share of university representatives in the governing body of the UIE
	$X_{P\ 3}$	The share of decisions in the field of innovation made by the university management in the total number of management decisions
	$X_{P\ 4}$	The share of IT - systems, services and services used in the innovation process, in the total number of communication tools
Resources (I_R)	$X_{R\ 1}$	Share of government funding in total R&D funding
	$X_{R\ 2}$	The share of the university's R&D costs in the total funding of the university
	$X_{R\ 3}$	The share of employees employed in R&D in the total number of faculty
	$X_{R\ 4}$	Percentage of university staff with advanced degrees participating in the UIE
	$X_{R\ 5}$	Share of private funding for university infrastructure development projects in total external funding

Source: developed by the author

**An example of calculating the integral development index UIE of a separate university
using the BSC method**

I_k		$\chi_i, \%$	$\dot{\chi}_i$	I_f^k	f_k	I_{IEU}
I_{ARE}				0,61	0,35	
	$X_{ARE\ 1}$	7	0,29			
	$X_{ARE\ 2}$	74	0,64			
	$X_{ARE\ 3}$	20	1			
	$X_{ARE\ 4}$	30	0,76			
	$X_{ARE\ 5}$	75	0,38			
I_{IN}				0,36	0,12	
	$X_{IN\ 1}$	45	0,4			
	$X_{IN\ 2}$	28	0,2			
	$X_{IN\ 3}$	68	0,8			
	$X_{IN\ 4}$	55	0,4			
	$X_{IN\ 5}$	46	0,5			
I_P				0,76	0,14	
	$X_{P\ 1}$	28	0,5			
	$X_{P\ 2}$	27	0,7			
	$X_{P\ 3}$	65	0,82			
	$X_{P\ 4}$	85	1			
I_R				0,77	0,39	
	$X_{R\ 1}$	9	0,33			
	$X_{R\ 2}$	81	1			
	$X_{R\ 3}$	60	0,67			
	$X_{R\ 4}$	82	1			
	$X_{R\ 5}$	82	0,83			
						0,66

Source: developed by the author

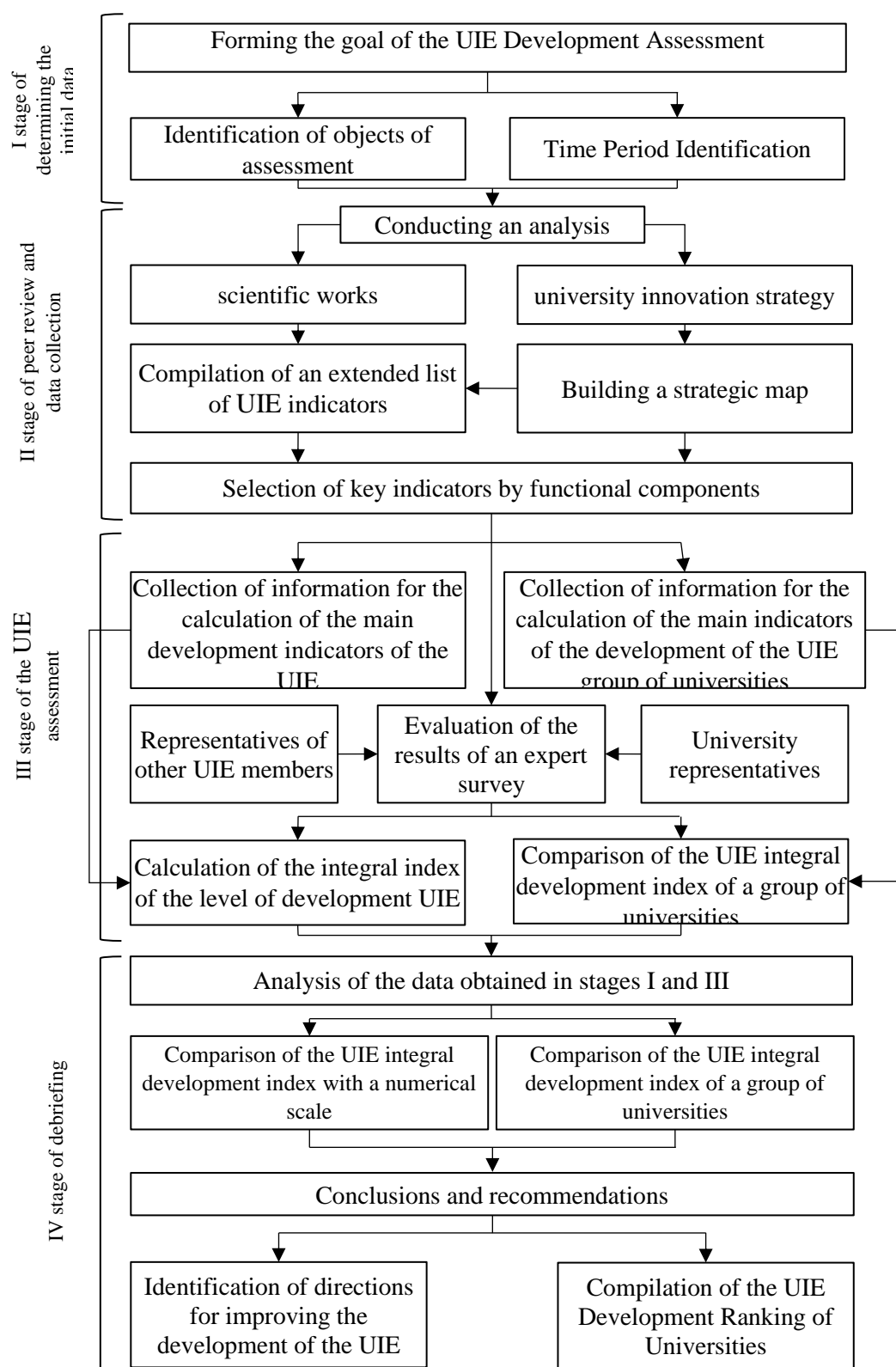
**Indicators for calculating the UIE integral development index of a group of universities
according to the BSC methodology**

		University 1	University 2	University 3	University 4	University 5
$X_{ARE\ 1}$	%	10	12 (<i>max</i>)	8	5 (<i>min</i>)	7
\dot{X}_l		0,71	1	0,43	0	0,29
$X_{ARE\ 2}$	%	79 (<i>max</i>)	65 (<i>min</i>)	70	67	74
\dot{X}_2		1	0	0,36	0,14	0,64
$X_{ARE\ 3}$	%	30 (<i>max</i>)	18	15 (<i>min</i>)	16	20
\dot{X}_3		1	0,2	0	0,07	0,33
$X_{ARE\ 4}$	%	35 (<i>max</i>)	25	18	14 (<i>min</i>)	30
\dot{X}_4		1	0,52	0,19	0	0,76
$X_{ARE\ 5}$	%	80 (<i>max</i>)	76	72 (<i>min</i>)	73	75
\dot{X}_5		1	0,5	0	0,13	0,38
$I_{f_j}^{ARE}$		0,94	0,44	0,20	0,07	0,61
f_{ARE}		0,35				
$X_{IN\ 1}$	%	60 (<i>max</i>)	55	40	35 (<i>min</i>)	45
\dot{X}_1		1	0,8	0,2	0	0,4
$X_{IN\ 2}$	%	30	27 (<i>min</i>)	32 (<i>max</i>)	29	28
\dot{X}_2		0,6	0	1	0,4	0,2
$X_{IN\ 3}$	%	70 (<i>max</i>)	66	67	60 (<i>min</i>)	68
\dot{X}_3		1	0,6	0,7	0	0,8
$X_{IN\ 4}$	%	70 (<i>max</i>)	45 (<i>min</i>)	64	65	55
\dot{X}_4		1	0	0,76	0,8	0,4
$X_{IN\ 5}$	%	50 (<i>max</i>)	45	44	42 (<i>min</i>)	46
\dot{X}_5		1	0,38	0,25	0	0,5
$I_{f_j}^{IN}$		0,72	0,28	0,53	0,24	0,36
f_{IN}		0,12				
$X_{P\ 1}$	%	25	20 (<i>min</i>)	36 (<i>max</i>)	21	28
\dot{X}_1		0,31	0	1	0,06	0,5
$X_{P\ 2}$	%	30 (<i>max</i>)	25	28	20 (<i>min</i>)	27
\dot{X}_2		1	0,5	0,8	0	0,7
$X_{P\ 3}$	%	70 (<i>max</i>)	50	58	42 (<i>min</i>)	65
\dot{X}_3		1	0,29	0,57	0	0,82
$X_{P\ 4}$	%	80	70 (<i>min</i>)	78	75	85 (<i>max</i>)
\dot{X}_4		0,67	0	0,53	0,33	1
$I_{f_j}^P$		0,74	0,20	0,73	0,10	0,76
f_P		0,14				
$X_{R\ 1}$	%	10	9	11 (<i>max</i>)	8 (<i>min</i>)	9
\dot{X}_1		0,67	0,33	1	0	0,33
$X_{R\ 2}$	%	79	70 (<i>min</i>)	77	76	81 (<i>max</i>)
\dot{X}_2		0,82	0	0,64	0,55	1
$X_{R\ 3}$	%	70 (<i>max</i>)	65	58	40 (<i>min</i>)	60
\dot{X}_3		1	0,83	0,66	0	0,67
$X_{R\ 4}$	%	80	65 (<i>min</i>)	79	70	82 (<i>max</i>)
\dot{X}_4		0,88	0	0,82	0,29	1
$X_{R\ 5}$	%	84 (<i>max</i>)	72 (<i>min</i>)	76	74	82
\dot{X}_5		1	0	0,33	0,17	0,83

I_{fj}^R		0,87	0,23	0,68	0,20	0,77
f_R		0,39				
I_{IEUj}		0,86	0,31	0,50	0,14	0,66

Source: developed by the author

Algorithm for assessing the development of the university's innovation ecosystem



Source: developed by the author

DECLARATION ON ASSUMING THE RESPONSIBILITY

Exhibits

By signing below, I certify personal responsibility that the materials presented in the doctoral thesis are the result of independent scientific research and processing. I am aware that otherwise I will be punishable fully of the law.

Name: Israeli Milana

Signature:

Date:

CURRICULUM VITAE



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EDUCATION

2018 - 2022
Ph.D studies at the International Free University of Moldova
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2000-2004
Master of Science in Philosophy
University of Haifa, Israel

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University of Haifa, Israel

PROFESSIONAL ENHANCEMENT

*Courses / Workshops /
Seminars*

2014-2022
Training in the field of pedagogical product development, trends
and principles future-oriented pedagogy, design thinking,
inventive creative thinking, educational product development
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*Ministry of Education - Experiments and Initiatives R&D
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PROFESSIONAL EXPERIENCE

Internship

2012 - 2016
Program for training managers in the education system
University of Haifa, on behalf of Avni Rasha Institute, Israel
2010-2021
Ministry of Education - Experiments and Initiatives R&D
Division, Israel

- Pedagogical Manager
- Positions: Haifa district representative on behalf of the Experiments and Initiatives R&D Division
- Expert and consultant in the field of educational product development, future trends and expansion of developments in the system.
- Main supervisor of the innovation developments in Haifa district and other districts.

List of scientific papers published by the author on the theme of thesis:
"Evaluation and management of innovation ecosystem in higher education institutions in Israel"

1. Articole în reviste științifice

1.1. în reviste din alte baze de date acceptate de către ANACEC (cu indicarea bazei de date)

1. DREIHER, D., ISRAELI, M. Innovation as the key to improvement in healthcare and education. In: Economic Series, Vol. 13(22), Issue 4, 2022, p.309-318. Indexată în bazele de date: Index Copernicus, DOAJ, CEEOL, ECONBIZ, OAJI, RePEc. <http://anale.spiruharet.ro/economics/issue/view/150/229>
2. ROSHKA, P.I., BLAGORAZUMNAYA, O. N., ISRAELI, M., DREIHER, D. Innovation as an element of the development of healthcare and education in Israel. In: Modern engineering and innovative technologies, Nr.24 (2), 2022, p. 39-47. Indexată în bazele de date: IndexCopernicus. <https://www.moderntechno.de/index.php/meit/issue/view/meit24-02/meit24-02>

1.2. în reviste din Registrul Național al revistelor de profil (cu indicarea categoriei)

1. BLAGORAZUMNAYA, O., ISRAELI, M. Innovative culture as one of the directions of innovative activity of the university. In: EcoSoEn, Nr. 3-4 (Anul 2/2019), p. 45-54. Indexată în bazele de date: IBN https://ibn.idsi.md/ro/vizualizare_articol/89358/datacite
2. ISRAELI, M. National Innovation System of Israel: features and structure. In: EcoSoEn, Nr. 1-2 (Anul 3/2020), p. 155-164. Categoria B. Indexată în bazele de date: CEEOL, DOAJ, IBN, INDEX COPERNICUS, Munich Personal RePEc Archive (MPRA), Academia.edu. https://ibn.idsi.md/ro/vizualizare_articol/105623
3. LAPUȘIN, R., ISRAELI, M. Assessing the rating of innovative activities of higher educational institutions: on the example of Israel. In: Journal of Research on Trade, Management and Economic Development, Volume 7, Issue 1(13), 2020, p.59-70. Categoria B. Indexată în bazele de date: IBN, DOAJ, INDEX COPERNICUS, OAJI. https://ibn.idsi.md/vizualizare_articol/106849
4. ISRAELI, M. The mechanism for management the innovative ecosystem of the university. In: EcoSoEn, Nr. 1-2 (Anul 5), 2022, p. 54-59. Categoria B. Indexată în bazele de date: CEEOL, DOAJ, IBN, INDEX COPERNICUS, Munich Personal RePEc Archive (MPRA), Academia.edu. https://ibn.idsi.md/vizualizare_articol/160085
5. BLAGORAZUMNAYA, O., ISRAELI, M. Analysis of the factors of the external and internal environment of the innovation ecosystem of universities. In: EcoSoEn, Nr. 3-4 (Anul 5), 2022, p. 19-25. Categoria B. Indexată în bazele de date: CEEOL, DOAJ, IBN, INDEX COPERNICUS, Munich Personal RePEc Archive (MPRA), Academia.edu. https://ibn.idsi.md/vizualizare_articol/168843

2. Articole în lucrările conferințelor și altor manifestări științifice

2.1. În lucrările manifestărilor științifice incluse în BDI

1. ISRAELI, M. Management aspects of the university's innovative ecosystem. In: IXth International Scientific and Practical Conference "Actual problems of the development of vertical integration of the education system, science and business: economic, legal and social aspects", Voronezh Institute of Economics and Law December 29, 2020, p. 10-16.

2. ISRAELI, M. The university's innovative ecosystem: management aspects. In: Materials of the XXVI International Scientific - Practical Conference "Education: tradition and innovation" Prague, April 29, 2021, p. 44-48. Indexată în bazele de date: eLIBRARY.ru
3. ISRAELI, M. Methodological approaches to assessment of innovative ecosystems of higher educational institutions. In: Материалы VIII ежегодной научно-практической конференции "Университетская наука – региону", Пятигорск, 30 апреля 2021, p.13-24. Indexată în bazele de date: eLIBRARY.ru
4. ISRAELI, M. Methodology for assessing the innovative ecosystem of the university. In: Материалы международной научной интернет-конференции "Тенденции и перспективы развития науки и образования в условиях глобализации", Переяслав-Хмельницкий, 23 декабря 2021, p.47-49. Indexată în bazele de date: Україніка Наукова, Джерело, <https://drive.google.com/file/d/1Ww3ueffzQ5CeVEor7MCiGtMM5jVx14F3/view>

2.2. în lucrările manifestărilor științifice incluse în Registrul materialelor publicate în baza manifestărilor științifice organizate din Republica Moldova

1. ISRAELI, M., BLAGORAZUMNAYA, O. The innovative ecosystem of Israel's universities as a vector of sustainable development. In: The International Scientific Conference „The modern paradigms of the national and global economy development”, Chisinau, Moldova October 30 – 31 2020, p.33-38. Indexată în bazele de date: GRID, ORCID, Google Sholar, IBN. https://ibn.idsi.md/sites/default/files/imag_file/33-38_17.pdf

Certification

I, Limor Harary, Head of Innovation and Technology Department at Gordon Academy. Studied very carefully the Ph.D. thesis by Milana Israeli:

«Evaluation and management of Innovation Ecosystem in higher education institutions in Israel».

Mrs. Israeli has developed and proposed a mechanism for managing the innovation ecosystem of higher educational institutions, including a set of such elements as: goals, objectives, management principles, subject, object, coordination center, methods, ways of interaction of elements, conditions and factors of functioning of the mechanism and the results of the mechanism.

And in my opinion each part of her methodology can be used in our innovation center as well. So I decided to implement some aspects of the mechanism of the innovation ecosystem that Mrs. Israeli has developed in our institution.

Sincerely,

Limor Harary,

A handwritten signature in black ink, appearing to read 'L.N. Harary', is written over the printed name.

Head of Innovation and Technology Department

Gordon College of Education