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SWOT ANALYSIS OF INDIVIDUAL COMPONENTS WITHIN THE INNOVATIVENESS ECOSYSTEM

The article contains a qualitative assessment of the effectiveness of the individual components with in the innovativeness ecosystem. The aim of the study is to identify key performance indicators in the context of assessing the effectiveness of individual elements of the innovation network. A set of key performance indicators was developed for each of the six identified components of the innovativeness ecosystem in Northeastern Pennsylvania USA. The performance indicators were assessed using a qualitative method in the form of interviews with the key personnel and clients. The article also contains recommendations for managing an innovativeness network. The management of the innovativeness network needs to be based on leveraging strengths to maximize opportunities and minimize threats.

Keywords: SWOT analysis, innovativeness, entrepreneurship, innovativeness ecosystem, entrepreneurship ecosystem.

1. INTRODUCTION

Management of the innovativeness/entrepreneurship network is a very important part of the knowledge-based economy. The author of this article identified six components of innovativeness/entrepreneurship ecosystems. Each component of an ecosystem participates in the development and nurturing of the skills and attributes conducive to innovative behavior. The individual components of the innovativeness network complement each other. Their effectiveness can be assessed by assessing their key performance indicators and conducting a SWOT analysis. This information is needed to effectively manage an innovativeness/entrepreneurship network.

2. AIMS

The aim of the article is the identification of key performance indicators for assessing the effectiveness of the individual components of an innovativeness network. Identifying strengths and weaknesses of the different components of the innovativeness ecosystem allows for more effective management of the network by utilizing strengths to maximize

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opportunities and minimize threats. Equally important is to identify and assess weaknesses, so that they can be minimized. Minimizing weaknesses also minimize threats and increase opportunities. SWOT analysis can be effectively used for that purpose.

3. SELECTION OF THE RESEARCH SAMPLE

The data for this research project was collected using qualitative methods of assessment in the form of interviews with key personnel and clients of the individual components of the innovativeness network. Some data was also collected using statistical data and records from the individual components of the innovativeness/entrepreneurship

4. LIMITATION OF THE RESEARCH PROJECT

The assessment data for this project was collected in the Northeastern region of Pennsylvania which is a post-coalmining region similar to the Slask Region in Poland. This area was historically very prosperous and became depressed after the closing of the coalmining industry. Presently the region is in the process of restructuring and transferring to a knowledge-based economy. Northeastern Pennsylvania may not be a good representation of the entire country. To find a better representation of the entire country, some further research would be necessary in other regions as well.

5. LITERATURE REVIEW

Today, measures to improve production and organization as well as to introduce innovation-relevant ISO standards are essential if companies are to survive in a competitive and dynamically changing market. These measures can contribute to the achievement of economic, environmental and social objectives, which can, inter alia, contribute to the promotion of sustainable development (Hajduk-Stelmachowicz, 2014; Ostasz et al., 2020; Mentel, Hajduk-Stelmachowicz, 2020).

The literature review related to the role of the individual components of the innovativeness/entrepreneurship ecosystem has proven the importance of the process of the development of the skills and attributes conducive toward innovative behawior (Abreu, 2021; Granstrand et.al., 2020; Grebski and Grebski, 2018; Lee et.al., 2019; Malecki, 2018; Meng and Ma, 2018; Osterwalder et.al., 2019). The study highlights the following elements of the innovation and entrepreneurship ecosystem: Cultural and Ethnic Integration Center, Entrepreneurial Center, Business Incubator Center, Elementary and Secondary Schools, Higher Education Institutions, Local industry. To assess the effectiveness of the innovativeness network, measurable key performance indicators were developed. KPIs are an integral part of the world's best manufacturing practices known as World Class Manufacturing (WCM) (Piasecka-Gluszak, 2017). The KPIs indicate the extent to which the organization pursues operational, tactical or strategic objectives that are critical to its current and future success (Onyemeh et. al., 2016; Rolo et. al., 2014). The key performance indicators were developed following guidelines provided in the literature.(Badawy et.al., 2016; Key, 2018; Pourmohammadi et.al., 2018). After the key performance indicators were assessed, a SWOT analysis was used to identify the strengths, weaknesses, opportunities and threats (Friesner, 2011; Nyarhu and Agyapong, 2011). The main task of the SWOT analysis was to structure and synthesize the knowledge about the analyzed individual components within the innovativeness ecosystem. A literature analysis was also conducted

on the topic of interaction between the components of the innovativeness network.(Czerwinska-Lubszczyk et.al., 2020; Grebski and Grebski, 2019; Grebski and Grebski, 2016; Olkiewicz et.al., 2018; Kuzior et.al., 2021; Wolniak et.al., 2019).

6. EXPERIMENT AND DATA COLLECTION

To access the effectiveness of the individual components of the innovativeness/entrepreneurship network a number of key performance indicators were established. The performance indicators were divided into four categories.

- Social Indicators (Table 1),
- Organizational/Procedural Indicators (Table 2),
- Scientific/Technical Indicators (Table 3),
- Financial Indicators (Table 4).

Some of the key performance indicators apply simultaneously to a few components of the innovativeness ecosystem. The "X" in the tables indicates the correspondence of the indicator to an individual component of the innovativeness ecosystem. The numeral on the top of each table corresponds to the six components of the innovativeness network.

1. Cultural and Ethnic Integration Center.
2. Entrepreneurial Center.
3. Business Incubator Center.
4. Elementary and Secondary Schools.
5. Higher Education Institutions.
6. Local industry.

Table 1. Social key performance indicators

Social Indicators	1	2	3	4	5	6
Decrease in crime rate by adult population	X					
Decrease in crime rate by minors	X					
Decrease in unemployment rate	X					X
Percentage of female participants	X	X		X		
Percentage of participants from low-income families	X	X		X		
Percentage of minority participants		X		X		
Percentage of immigrant participants	X	X		X		
Number of new jobs created by startups			X		X	
Number of students finding internships at startups			X		X	
Number of graduates finding full-time jobs at startups			X		X	X
Unemployment rate	X					X
Average engineering salary					X	X
Average salary of skilled workers						X
Amount of grants received for cooperation with industry			X		X	X

Source: own study based on: (Grebski, 2021).

Table 2. Organizational/procedural key performance indicators

Organizational/Procedural Indicators	1	2	3	4	5	6
Annual number of clients	X	X	X			
Weekly hours of operation	X	X	X			
Number of full-time employees	X	X	X			
Number of volunteers	X	X	X			
Number of innovative projects evaluated annually		X	X		X	
Number of startups during incubation stage			X			
Number of companies in post-incubation stage			X			X
Number of high school students in a local school district				X		
Number of teachers in a local school district				X		
Number of institutions of higher education					X	
Number of Business and Engineering programs in the area					X	X
Number of Business and Engineering students in the area					X	X
Presence of industry-university cooperation			X		X	X
Number of micro and small companies in the area (0-50 employees)						X
Number of mid-size and large companies in the area (50^{+} employees)						X

Source: own study based on: (Grebski, 2021).

Table 3. Scientific/technical key performance indicators

Scientific /Technical Indicators	1	2	3	4	5	6
Annual number of English classes offered	X					
Annual number of professional development and training workshops	X	X	X		X	
Number of university faculty participating in the program	X	X	X			X
Number of volunteers participating in the program	X	X	X			
Number of entries in annual business plan competition	X	X				
Number of university students involved in applied research			X		X	X
Annual number of projects which evolve into startups			X		X	
Annual number of student projects for startups			X		X	
Number of high school students taking entrepreneurial courses				X		
Number of high school students taking dual enrollment classes				X	X	

Table 3 (cont.). Scientific/technical key performance indicators

Scientific /Technical Indicators	1	2	3	4	5	6
Annual number of Engineering and Business students involved in cooperation with industry			X		X	X
Number of university students finding employment with startup companies			X			X
Annual number of grants for industry-university cooperation			X		X	X
Number of research and development companies in the area			X		X	X
Number of business incubator centers in the region			X			
Number of entrepreneurial centers in the region		X				
Annual number of grants for technology transfer			X		X	X

Source: own study based on: (Grebski, 2021).

Table 4. Financial key performance indicators

Financial Indicators	1	2	3	4	5	6
Annual cost of operating cultural and ethnic integration centers	X					
Annual amount of external grants supporting cultural and ethnic integration centers	X					
Annual budget of an entrepreneurial center		X				
Average cost of creating a new job at a business incubator center			X			
Annual budget of a business incubator center			X			
Tax incentives for startup in at incubation stage			X			
Annual level of subsidy for startups from the state			X			
Annual budget for a local school district				X		
Annual cost of education /student				X		
Average tuition cost/student at a university					X	
Average salary for Engineering graduates with a four-year degree					X	X
Grants received for cooperation with industry					X	X
Labor cost in the region						X
Tax incentives for companies in underdeveloped areas.						X

Source: own study based on: (Grebski, 2021).

All the key performance indicators listed in Table 1, Table 2, Table 3 and Table 4 were assessed. The assessment results are available. (Grebski, 2021) Based on the assessment results, a SWOT analysis was conducted as shown in Table 5, Table 6, Table 7 and Table 8 Grebski, 2021). Those tables include the strengths, weaknesses, opportunities and threats of the individual components of innovativeness/entrepreneurship ecosystem.

Table 5. Strengths of individual components of the innovativeness network

Strengths	1	2	3	4	5	6
Reaches wide variety of people	X	X		X	X	
Long hours of operation	X	X	X			
Variety of classes and workshops	X	X			X	
Large number of volunteers	X	X	X			
Large number of innovative projects		X	X			
Involvement of faculty and students			X		X	X
Creates new jobs			X			X
Evaluates business ideas		X	X		X	
Well-funded				X		X
Reaches diverse populations	X	X		X	X	
Partners with state agencies	X	X	X		X	
Internship opportunities			X		X	X
Presence of university programs			X		X	X
Presence of research opportunities			X		X	X

Source: own study.

Table 6. Weaknesses of individual components of the innovativeness network

Weaknesses	1	2	3	4	5	6
High cost of operation	X	X	X			
Too few full-time employees	X	X	X			
Dependence on external funding	X	X	X			
Shortage of well-educated workforce						X
High labor cost						X

Source: own study.

Table 7. Opportunities of individual components of the innovativeness network

Opportunities	1	2	3	4	5	6
Reaches many people	X	X		X	X	
Reduces unemployment	X		X			X
Reduces crime rate	X					
Focuses on minorities, females and immigrants	X					
Stimulus establishment of new businesses and startups	X	X	X		X	
Low cost of creating jobs			X			
Tax incentives for startups			X			
State subsidies for startups			X			
Creates internship opportunities			X		X	X
Creates entrepreneurial courses	X	X	X			
Dual enrollment opportunities				X	X	

Table 7 (cont.). Opportunities of individual components of the innovativeness network

Opportunities	1	2	3	4	5	6
Multidisciplinary entrepreneurial team building project.			X		X	X
Cooperation between university and startups			X		X	
Student projects done for industry			X		X	X
Mentoring students					X	
Student involvement in research activities			X		X	X
Tax incentives for businesses in undeveloped areas						X
Presence of a business incubator centers			X		X	X
Presence of cultural and ethnic integration centers	X					X
Industry-university cooperation			X		X	X
Grants for technology transfer					X	X

Source: own study.

Table 8. Threats of individual components of the innovativeness network

Threats	1	2	3	4	5	6
Limited funding	X	X	X			
Relying on grants and subsidies	X	X	X			
High operating cost	X	X	X			
Traditional approach to education				X		
Limited availability of grants	X	X	X			
Limited availability of financial aid to students					X	
Shortage of Engineering graduates						X
Shortage of qualified workforce						X

Source: own study.

Based on the strengths of the individual components of an innovativeness network, recommendations have been made to maximize the opportunities and minimize the threats. Those recommendations are included in the conclusions.

7. CONCLUSIONS

All the components of the innovativeness network need to cooperate with each other and complement each other. The recommendations based on the SWOT analysis are as follows:

1. Cultural and Ethnic Integration Centers
   - Expand hours of operation including evening and weekends to accommodate the adult population.
   - Accommodate a wide variety of populations including students from elementary schools, high schools and universities as well as the adult population.
   - Charge a small fee for courses and other services to lower the dependency on grants.

2. Entrepreneurial Center
   - Expand training workshops focusing on innovativeness and entrepreneurship.
   - Continue to focus on high school and college students as well as the adult population.
   - Sponsor an annual business plan competition to stimulate the establishment of new businesses in the region.
   - Focus on underrepresented groups (females, minorities and immigrants).
   - Establish small charges for participation in the workshops to minimize the dependency on grants.
3. Business Incubator Centers (BIC)
   - Continue to offer entrepreneurial workshops for the general public.
   - Get more Business faculty and students involved with clients at the BIC.
   - Provide services in evaluating business ideas to the general public as well as high school and college students.
   - Provide internship opportunities for Engineering and Business students as well as faculty.
   - Use tax incentives to accumulate some operating capital to lower the dependency on grants.
4. Elementary and Secondary Schools
   - Modify the curriculum to focus on the development of creativity and innovativeness.
   - Offer entrepreneurial courses in the curriculum.
   - Promote dual enrollment opportunities.
5. Higher Education Institutions
   - Link every capstone design project to the need of a local industry.
   - Promote involvement of Engineering and Business students with an Entrepreneurial Center, Business Incubator Center and local industry.
   - Provide more students with internship opportunities.
6. Local Industry
   - Maintain ongoing cooperation with faculty and students at local universities.
   - Get involved in research and development as well as technology transfer.
   - Provide scholarship opportunities for Engineering and Business students at the local universities.

REFERENCES

Abreu, A. (2021). *Innovation Ecosystems: A Sustainability Perspective (Special Issue)*, Sustainability. Access on the internet: https://www.mdpi.com/books/pdfview/book/4049

Badawy, M., Abd El-Aziz, A. A., Idress, A. M., Hefny, H., Hossam, H. (2016). *A Survey of Exploring Key Performance Indicators. „Future Computing and Informatics Journal", 1*(1–2).

Czerwinska-Lubszczyk, A., Grebski, M., Jagoda-Sobalak, D. (2020). *Cooperation of Universities with Business in Poland and the USA-Perspective of Scientific Environment.*

„Management Systems in Production Engineering", 28(1). DOI: 10.2478/mspe-2020--0007.

Friesner, T. (2011). *History of SWOT Analysis.* Marketing Teacher Ltd. Access on the internet: https://researchgate.net/publications/288958760_History_of_swot_analysis

Granstrand, O., Holgersson, M. (2020). *Innovation Ecosystems: A Conceptual Review and a New Definition,* Technovation, 90–91, 102098. https://www.sciencedirect.com/science/article/pii/S0166497218303870.

Grebski, M. (2021). *Management of Entrepreneurship Networks in Poland and the United States: A Comparative Analysis.* Monograph, Toruń, Poland: Wydawnictowo TNOiK.

Grebski, M., Grebski, W. (2016). *Keeping Technical Education Aligned to the Needs and Expectations of Industry. „Management Systems in Production Engineering", 22*(2).

—— (2018). *Building an Ecosystem for a New Engineering Program. „Management Systems in Production Engineering", 26*(2).

—— (2019). *Project-based Approach to Engineering Technology Education. „Production Engineering Archives", 25*. DOI: 10.30657/peas/2019.25.11.

Hajduk-Stelmachowicz M. (2014). *Znaczenie strategii proekologicznych w kontekście budowania przewagi konkurencyjnej przedsiębiorstw. „Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, Zarządzanie strategiczne w teorii i praktyce"* 2014, nr 366.

Key Performance Indicators for University Research Centers, 2018. Access on the internet: https://www.odu.edu/content/dam/odu/offices/research/docs/Research%20Center%20KPI%202018.pdf.

Kuzior, A., Grebski, M., Grebski, W. (2021). *Marketing of an Academic Program: Case Study of an Engineering Program. „Marketing and Management of Innovations", 1*.

Lee, Y. M., Moon, H. C., Yin, W. (2019). *Innovation Process in the Business Ecosystem: The Four Cooperations Practices in the Media Platform. „Business Process Management Journal", 26*(4). https://www.emerald.com/insight/content/doi/10.1108/BPMJ-11-2019-0473/full/html.

Malecki, E. J. (2018). *Entrepreneurship and Entrepreneurial Ecosystems. „Geography Compass", 12*(3). Access on the internet: https://onlinelibrary.wiley.com/doi/epdf/10.1111/gec3.12359.

Mentel, U., Hajduk-Stelmachowicz, M. (2020). *Does standardization have an impact on innovation activity in different countries?* „Problems and Perspectives in Management", *18*(4).

Meng, Y., Ma, Y. (2018). *Innovation Ecosystem Analysis 1986–2017: A Citation-Based Literature Survey. „American Journal of Industrial and Business Management", 8*(11). Access on the internet: https://www.scirp.org/journal/paperinformation.aspx?paperid==88796

Nyarhu, K., Agyapong, G. (2011). *Rediscovering SWOT Analysis: The Extended Version.* „Academic Leadership Online Journal", *9*(2). Scholars.fhsu.edu/cgi/view-content-cgi?articles=16666.content=acj.

Olkiewicz, M., Wolniak, R., Grebski, M. E., Olkiewicz, A. (2018). *Comparative Analysis of the Impact of the Business Incubator Center on the Economic Sustainable Development of Regions in the USA and Poland. „Sustainability", 11*(1). DOI: 10.3390/su11010173.

Onyemeh N. C., Lee C. W., Iqbal M. A. (2016). *Key performance indicators for operational quality in the oil and gas industry a case study approach*. IEEE International Conference on Industrial Engineering and Engineering Management.

Ostasz, G., Czerwińska, K., Pacana, A. (2020). *Quality management of aluminum pistons with the use of quality control points.* Management Systems in Production Engineering.

Osterwalder, A., Viki, T., Pigneur, Y. (2019). *Why Your Organization Needs an Innovation Ecosystem,* Harvard Business Review. Access on the internet: https://hbr.org/2019/11/why-your-organization-needs-an-innovation-ecosystem.

Piasecka-Głuszak, A. (2017). *Implementacja world class manufacturing w przedsiębiorstwie produkcyjnym na rynku polskim. „Ekonomia XXI wieku", 4*(16).

Pourmohammadi, K., Hatam, N., Shojaei, P., Bastani, P. (2018). *A Comprehensive Map of the Evidence on the Performance Evaluation Indicators of Public Hospitals: A Scoping Study and Best Fit Framework Synthesis. „Cost Effective Resource Allocation", 16*, 64. DOI: 10.1186/S12962-018-0166-Z.

Rolo A., Pires A. R., Saraiva M. (2014). *Supply chain as a collaborative virtual network based on larg strategy. „Advances in Intelligent Systems and Computing", 280*.

Wolniak, R., Grebski, M., Skotnicka-Zasadzien, B. (2019). *Comparative Analysis of the Level of Satisfaction with Services Received at the Business Incubators (Hazleton), PA USA and Gliwice, Poland. „Sustainability", 11*(10). DOI: 10.3390/su1102889.

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