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## Articles

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**Anna Borcuch**[1]

# PUBLIC FINANCE IN THE ERA OF CHANGING ECONOMY IN POLAND

**Abstract**
*Finance has always been under close scrutiny. Public finance is considered to play a particularly paramount role in world economies. Public finances are complex phenomena that are subject to assessment both within a given country, but also on the basis of an EU methodology (universal for Member States). The aim of this article is to conduct an extensive research on the significance and the development of public finance in the Polish economy over the years 2010 – 2020. The analysis shows that the statistical reference points to persistent imbalances in Poland's public finances, which manifest themselves in cyclical public deficits. Overall, both the level of income and expenditure in relation to GDP in Poland is at a moderate level in comparison with many European Union countries. The paper includes a critical analysis of the scientific literature and empirical data. This analysis is considered to be vital from the perspective of economic development of countries.*

**Keywords:** finance, public finance, public revenue, public expenditures, deficit, public debt.

**JEL classification:** E600, H600, H620

**Paper type:** Theoretical research article

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## Introduction

Nowadays, finance represents a major aspect of functioning of all entities in the economy. It occurs wherever money appears, so practically speaking in all processes taking place in the economy. There is a number of market economy entities which contribute to efficient and effective functioning of financial system in given countries or worldwide. The main entities are households, businesses, financial institutions, banks and the state. It has to be noticed that financial system of a country is determined by the efficiency of allocated funds. Undoubtedly, this subject appears to be important and still valid which is the reason why there is a great number of studies on this aspect. The field of studies related to finance is rapidly changing, which is mainly due to the socio-economic development of the whole world. The state is reckoned to be the main entity that stimulates the functioning of all entities in a market economy.

The purpose of this article is to demonstrate the importance and the development of public finance in the Polish economy over the years 2010–2020. Achieving this goal required answering the following research questions:

- How is the importance of public finances measured?
- Are public finances in Poland characterized by persistent imbalance?
- How are public revenues and expenditures in Poland compared to other countries?
- Is the value of public debt in Poland getting closer to the value of the convergence criterion contained in the Maastricht Treaty?

The article is composed of two parts substantively related to each other. The first part revolves around the theoretical approach to finance, while the second concerns the meaning of public finance in the modern economy and trends related to these changes. The article was written on the basis of Polish and foreign literature, applicable legal acts, and own research.

## I. Public finance in the field of financial sciences

Finance is considered to be one of the most frequently studied phenomena these days. It is perceived as the basic foundation of an efficiently and effectively functioning market economy. Financial phenomena apply to all economic processes in which money appears (Podstawka M., 2021, p. 18). There is a considerable numer of definitions of finance in the literature. The topic has been discussed by various authors, including M. Podstawka (2021, p. 18), A. Borodo (2019, p. 13), C. Kosikowski and E. Ruśkowski (2008, p. 15), D. Korenik and S. Korenik (2010, p. 13), S. Owsiak (2002, p. 21). Initially, the term “finance” was identified with public finance, which concerned tax burdens and spending of funds accumulated by the state. Along with the socio-economic development, the view on the term “finance” has evolved

(Podstawka M., 2021, p. 19). Lawrence J. Gitman (2015, p. 4) presents a novel approach to finance and he defines it as the art and science of managing money. According to M. Podstawka (2021, p. 18) finance concerns "the totality of monetary phenomena and processes related to the creation (issue), flow, accumulation and spending of funds". A number of researchers perceives finance in this way. A. Paździor (2014, p. 12) indicates that finance is a complex phenomenon, and it has not been exhaustively examined yet. One of the reasons of such situation is the fact that finance is marked with enormous diversity. In the subject nomenclature there is a division of finance according to the subjective criterion. According to this criterion there are:

- household finances;
- buisness finance;
- public finance;
- banking;
- financial market (Korenik D., Korenik S., 2010, p. 15-18).

The division of finance according to the subjective criterion makes it possible to classify financial phenomena due to the individuality of the entities that conduct business. A. Cenkier indicates that, the entity structure related to the financial system has not changed over the years, which is presented in Table 1.

**Table 1. Subjective structure of finance.**

| Subjective classification | Before the age of modern finance | The age of modern finance |
|---|---|---|
| Household finances | + | + |
| Business finance | + | + |
| Public finance | + | + |
| Finance of financial institutions | + | + |

Source: own analysis based on Cenkier A., *Finanse nowoczesne. Wybór refleksji*, Research papers of Wroclaw University of Economics and Business, Nr 533/2018, p. 61.

According to M. Podstawka (2021, p. 20), finance plays a subordinate role in relation to market economy entities. The following functions of finance are presented in the literature:

- allocative;
- redistributive;

- stabilizing;
- reconversion of ownership.

The state is considered to be the creator of these functions, whose task is to ensure the effective and stable functioning of the entire economy (Samuelson P.A., Nordhous W.D., 2021, p. 33). The main aim of the state is to ensure the security of its citizens, and so all entities operating in the real economy (Gwardyński R., 2021, p. 99). E. Ruśkowski (2018, p. 23-24) points out a number of differences between public nad private finance. They are presented in the table 2. The main distinguishing features are the purpose, organisation and management, as well as the nature of the operation. It has to be highlighted that all those features confirm a paramount meaning of public finance in the field of financial studies.

**Table 2. The character of public and private fianance**

| Feature | Public finance | Private finance |
|---|---|---|
| Purpose | meeting social needs | maximising profit |
| Organisation | separation of funds | fragmented |
| Management | centralisation | decentralisation |
| The nature of operation | compulsory, gratuitous | voluntary, non-gratuitous |

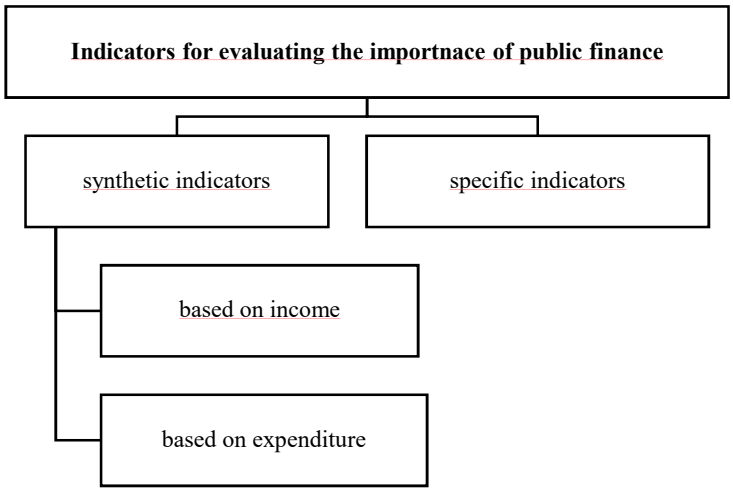
Source: own analysis based on Ruśkowski E., *Finanse publiczne i prawo finansowe. Instrumenty prawnofinansowe i warunki ich stosowania*, Temida 2, Białystok 2018, p. 23-24.

Public finance is a broad field that mainly concerned with the collection and distribution of public funds. Public finance is strictly regulated in the legal act. The main binding act in Polish law is the Public Finance Act of 2009. The basis of the state's budgetary economy is the Budget Act (Borodo A., 2019, p. 43).

According to E. Ruśkowski (2018, p. 25) public finance is a complex and dynamic term. The definition of public finance depends on the personal concepts of the authors. In the literature concerning the subject various approaches to defining were presented by Richard W. Tresch (2022, p. 3), David H. Rosenbloom, Robert S. Kravchuk and Richard M. Clerkin (2022, p. 20), Podstawka (2021, p. 138), A. Borodo (2019, p. 21), H. L. Bhatia (2018, p. 21), Carl S. Shoup (2017, p. 3), Ronald C. Fisher (2016, p. 1), Stephen J. Bailey (2004, p. 3-5), S. Owsiak (2002, p. 21). The significance of public finance depends on the level of:

- public revenue in relation to GDP;
- public expenditure in relation to GDP;
- public debt in relation to GDP (Ruśkowski E., 2018, p. 31).

**Figure 1. Indicators for evaluating the importnace of public finance**




Source: own analysis based on Czempas J., *Kilka uwag do mierzenia skłonności do inwestowania w jednostkach samorządu terytorialnego*, Economic Studies, University of Economics in Katowice, Nr 177/2014, p. 59.

The ratio of public expenditure to GDP is defined as socialisation index, while the fiscal indicator is the ratio of public revenue to GDP. E. Ruśkowski (2018, p. 31-32) indicates that, the importance of public finances has to be considered in relation to the ratio of public expenditure of the analyzed country to its GDP.

## II. Research methodology

The study will attempt to conduct own analysis of the importance of public finance in Poland in comparison to other countries. This empirical research can be divided into three main parts, which concern three aspects:

1. Analysis of statistical data related to public revenue.
2. Analysis of statistical data related to public expenditure.
3. Analysis of statistical data on public debt.

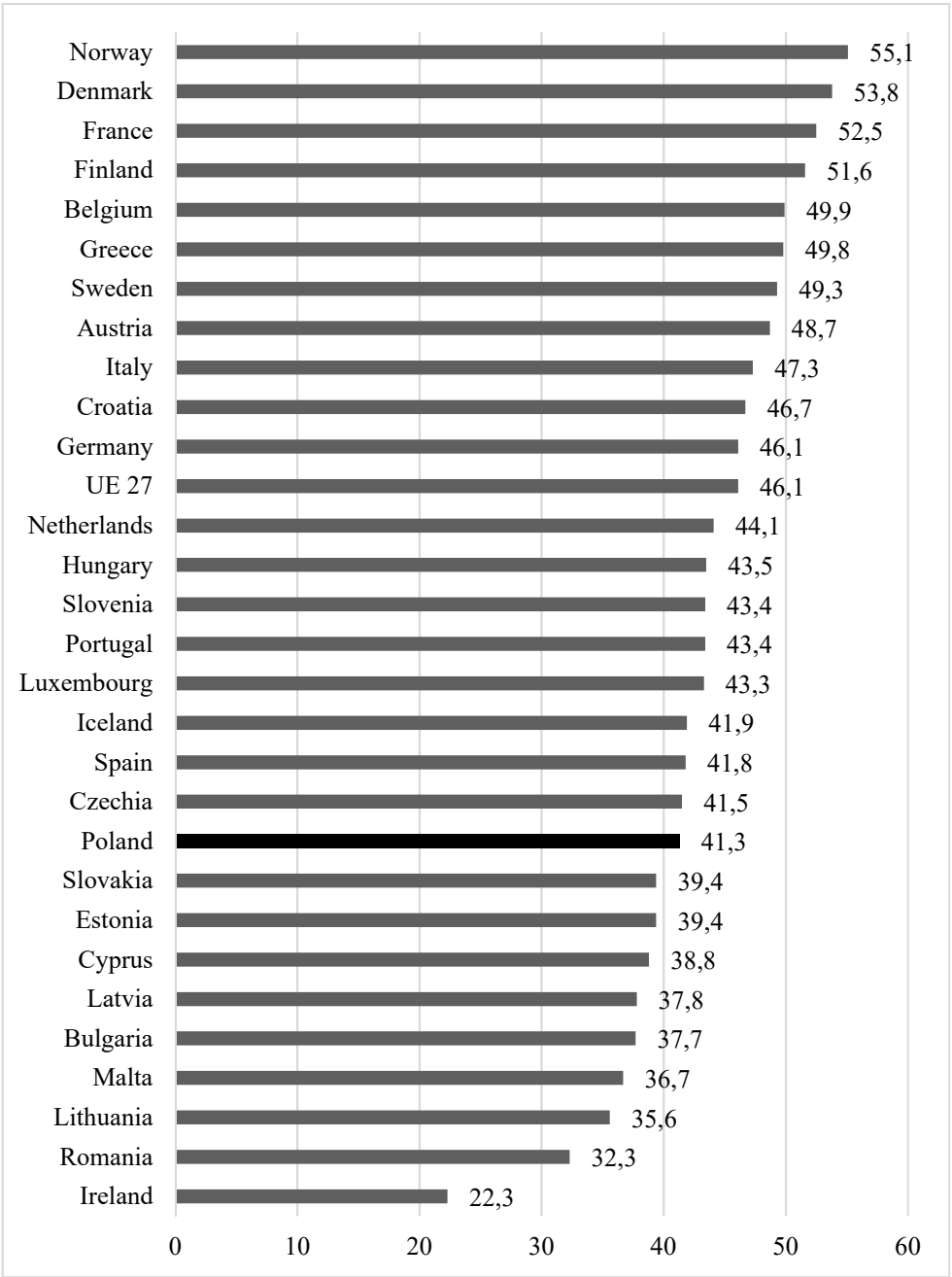
The aim of this article is to conduct an extensive research on the significance and the development of public finance in the Polish economy over the years 2010–2020. The data in this part of the work is taken from Eurostat and the Ministry of Finance.

## III. The scope and role of public finance in Poland compared to other countries

The first part is devoted to the statistical analysis of public revenue in various countries. It is noteworthy that this statistical reference in 2020 indicates a differentiation of results. This indicator ranges from twenty-something to fifty-something percent of the gross domestic product. The data comes from Eurostat and the Ministry of Finance.

Figure 2 illustrates the size of the fiscal indicator (public revenue in relation to GDP). It is notable that the highest public revenues in relation to GDP in the surveyed countries in 2020 were: Norway (55.1%), Denmark (53.8%), France (52.5%), Finland (51.6%). On the other hand, the fiscal indicator was at the lowest levels in Iceland (23.2%), Romania (32.7%), Bulgaria (36.7%), Lithuania (37%), Malta (37%), Estonia (39%). Poland is ranked 10th out of 29 analysed countries. The fiscal indicator for Poland in 2020 was 41,3%. It is worth mentioning that this indicator in Poland in comparison with other countries was at a moderate level. In the European Union (EU 27), in 2020 the ratio of public revenue to gross domestic product was 46.1%.

**Figure 2. Ratio of public revenue to GDP in 2020 (in %)**

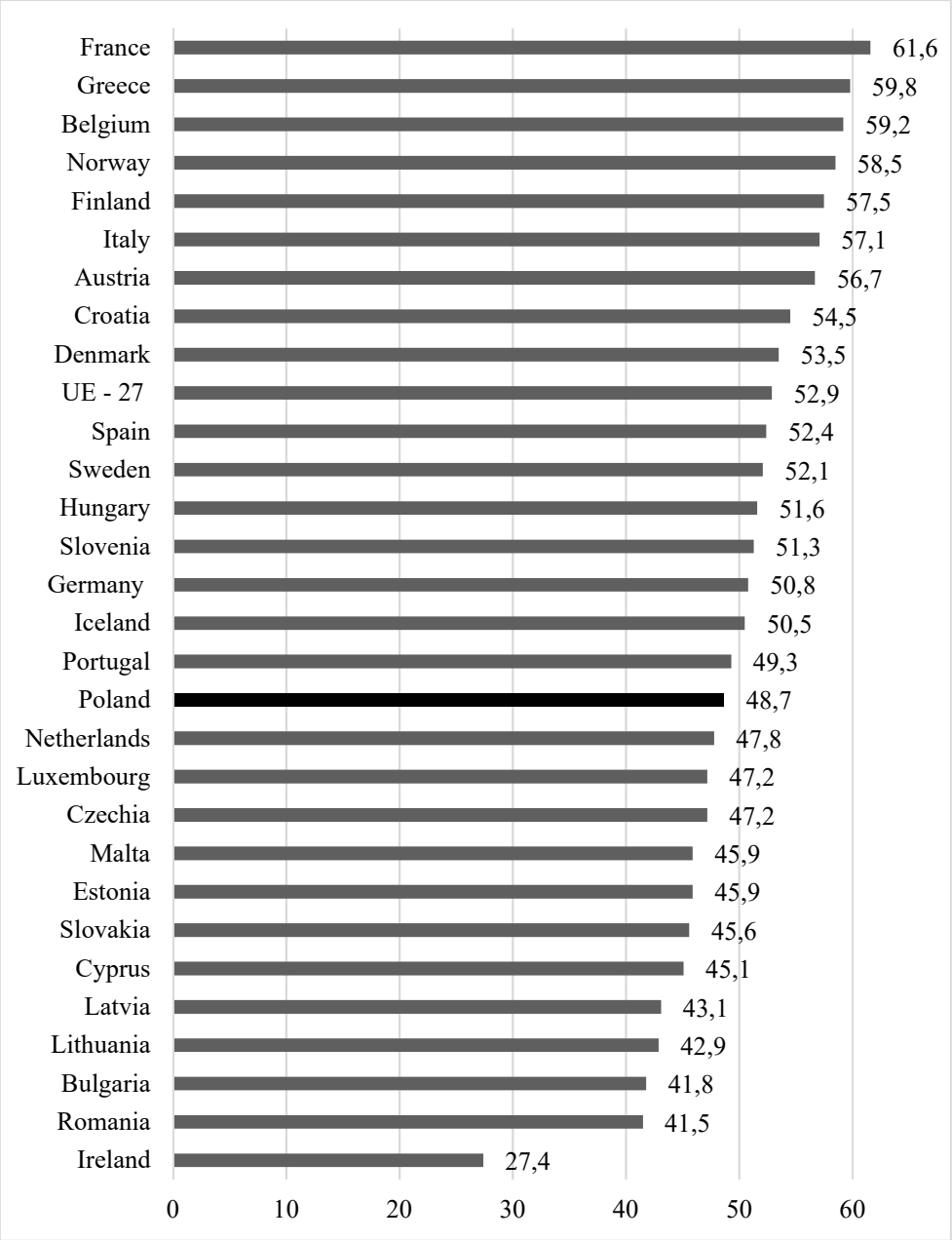



Source: own analysis based on Eurostat (access date: 02.01.2023).

A statistical analysis of the size of public expenditures in various countries will be presented in the further part of the study. Figure 3 presents the results of the research on the socialization indicator. It is to be noted that this statistical reference in 2020 indicates the diversity of results. This indicator ranges from twenty-something to almost sixty percent of the gross domestic product.

The greatest importance of public finance in the surveyed countries in 2020 was in: France (61.6%), Greece (59.8%), Belgium (59.2%), Norway (58.5%) %), Finland (57.5%), Italy (57.1%). On the other hand, the socialization rate at the lowest levels was in Ireland (27.4%), Romania (41.5%), Bulgaria (41.8%), Lithuania (42.9%) and Latvia (43.1%). Poland is ranked 14th out of 29 analyzed countries. The socialization rate for Poland in 2020 was 42.4%, which means that Poland is among the countries with a small scope of public finances.

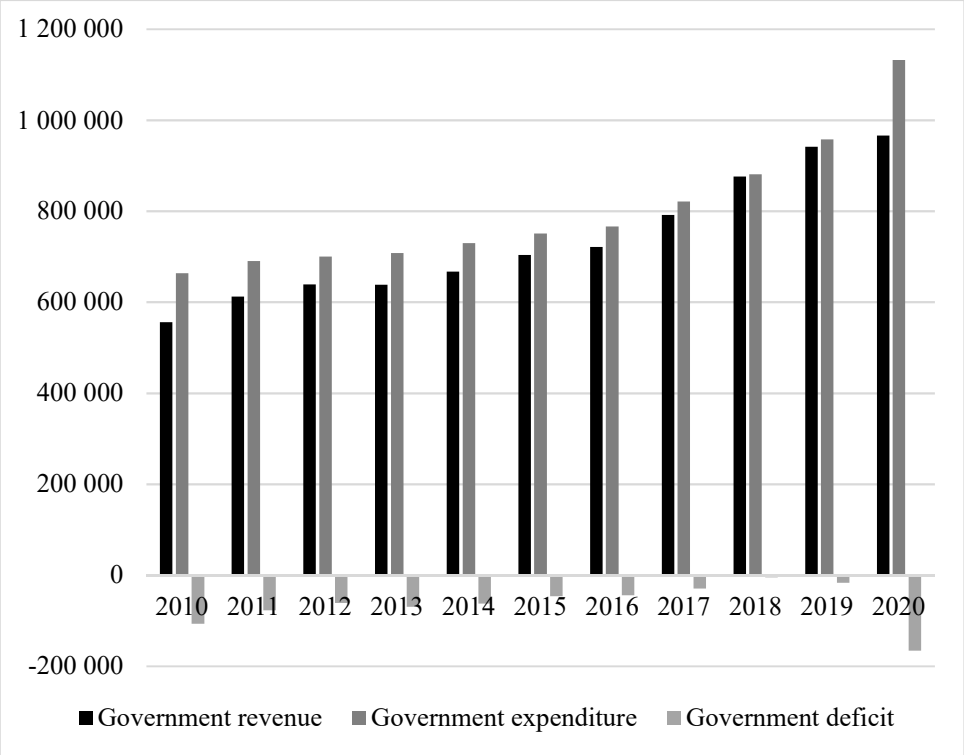
**Figure 3. Ratio of public expenditures to GDP in 2020 (in %)**




Source: own analysis based on Eurostat (access date: 02.01.2023).

S. Owsiak (2017, p. 189) indicates that Poland's public finances are characterized by a permanent imbalance. Figure 5 presents the development of public revenues and expenditures in Poland in 2010-2020. There is an upward tendency that shall be observed in relation to both public revenues and expenditures over the years. The major reason for this systematic increase is socio-economic development of the country. Nowadays, economies are a mechanism that has to satisfy the needs and preferences of all entities. Both income and expenses correspond to the periods for which they were planned. Economic progress forces the public finance of a given country to develop, which in turn affects the stability of the functioning of the economy. Along with the development of the country greater expenses are inevitable, and thus an urgent need for larger income. An efficient public finance system ensures the effectiveness of the entire economy. It has to be noted that in the years 2010-2020 a permanent imbalance becomes visible. The lack of balance was manifested in the occurrence of a recurrent public deficit, which in general contributes to the increase in public debt. From 2010 to 2018, there is a sustainable downward tendency in the public deficit. In the analyzed period, the highest deficit was recorded in 2020. This was mainly due to the outbreak of the COVID-19 pandemic. The outbreak of the pandemic has affected the lives of many entities. The restrictions significantly limited interpersonal relations, which resulted in slowing down most of the processes taking place in the economy. Limiting the functioning of many economic sectors resulted in a decrease in public revenues, which mainly come from tax revenues (primarily VAT). Therefore, the situation indicates that all changes in the economy are reflected in public finances.

**Figure 4. Public revenues and expenditures in Poland in 2010-2020**

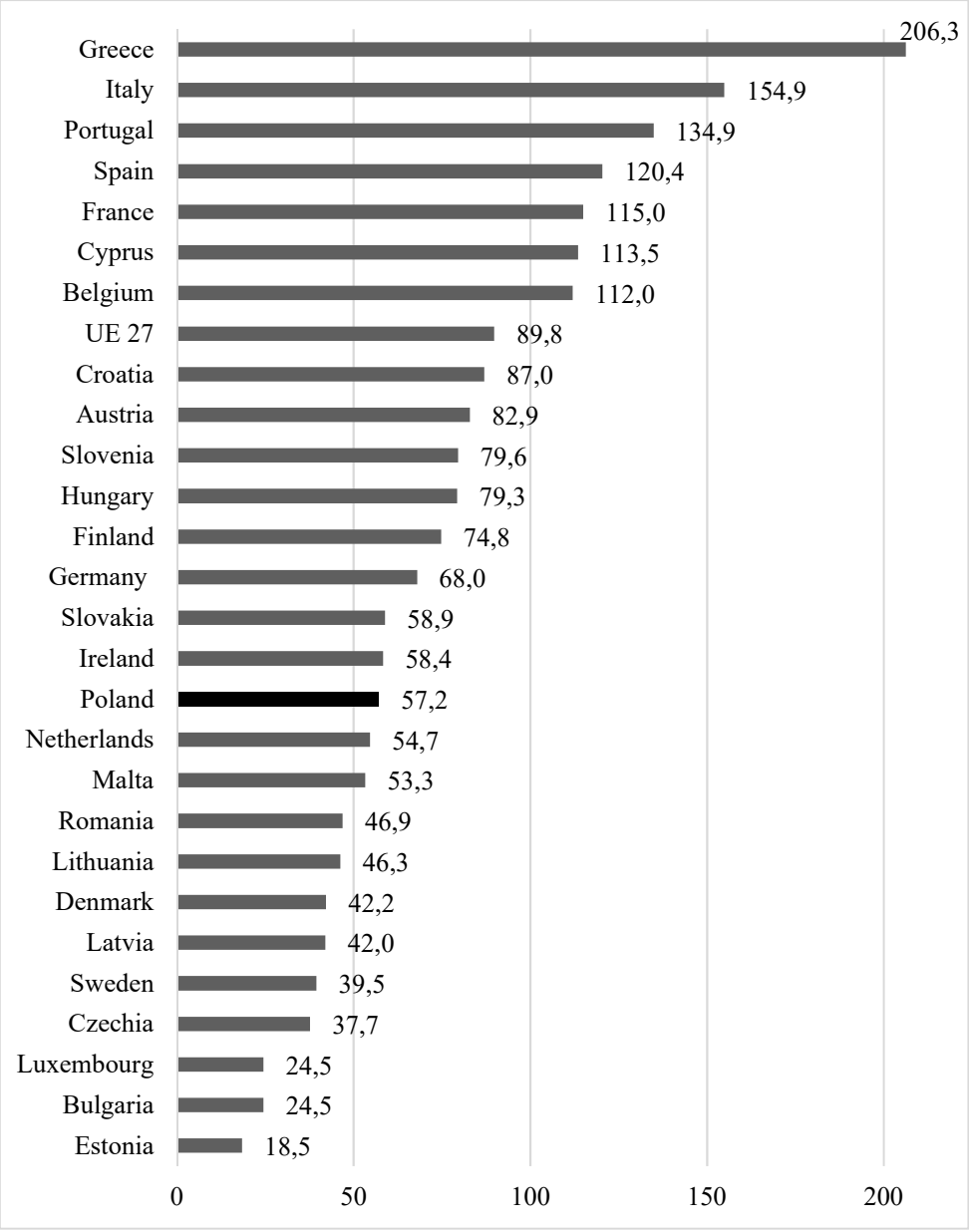



Source: own analysis based on Eurostat (access: 10.01.2023).

One of the main effects of recurrent public deficit is the increase in public debt. The study adopts the EU methodology - general government debt - to present the debt. E. Lotko and U. K. Zawadzka-Pąk (2018, p. 55) indicate that the ratio of general government debt to GDP is higher than the ratio of public debt to GDP, which is calculated using the national methodology. General government debt in relation to GDP in 2020 in selected countries is presented in Figure 5. The convergence criteria included in the Maastricht Treaty play an important role regarding public debt. This treaty is the basis for evaluating the fiscal policy of the European Union member states. In accordance with the provisions of the treaty:

- the public deficit should not exceed 3% of GDP;
- the ratio of public debt to GDP should be a maximum of 60% (Postuła M., Kawarska A., 2020, p. 115).

**Figure 5. General government debt in relation to GDP in 2020**



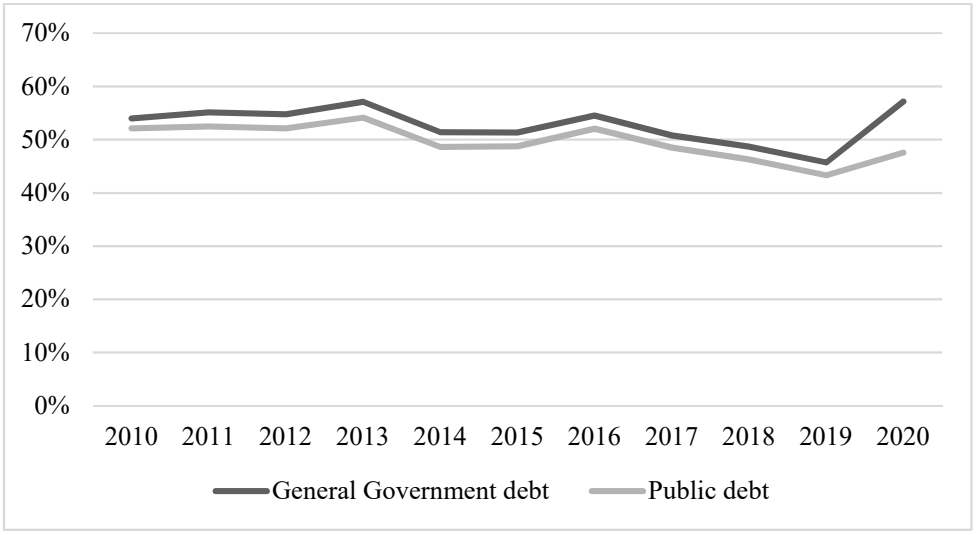

Source: own analysis based on Eurostat (access: 15.01.2023).

Comparing the size of the general government debt in relation to GDP in 2020, it needs to be noted that it is at a different level in the analyzed countries. The countries with the highest general government debt include:

Greece (206.3%), Italy (154.9%), Portugal (134.9%), Spain (120.4%), France (115%), Cyprus (113.5%), Belgium (112%). The countries with the lowest general government debt are: Estonia (18.5%), Bulgaria and Luxembourg (24.5%), the Czech Republic (37.7%) and Sweden (39.5%). The general government debt in relation to GDP in 2020 for Poland was at the level of 57.2%. The average debt of the EU-27 is 89.8%, which is 30 p.p. higher. with regard to the convergence criteria. Among the Member States, Greece has the highest coefficient, while Estonia has the lowest.

In Poland, the general government debt over the years 2010–2020 ranged from 45.7% to 57.2% of GDP. In the analyzed period, the values showed both an upward and a downward tendency. In 2020, the debt ratio was 57.2%, which means that the debt level is close to the reference value set out in the Maastricht Treaty. As a consequence, this may lead to difficulties in meeting the fiscal criterion in the future.

**Figure 6. Comparison of public debt and the general government sector in relation to GDP in Poland in 2010-2020**




Source: own analysis based on Ministry of Finance (access: 20.01.2023).

The comparison of the size of public debt and general government debt needs to be taken into consideration. Public debt in relation to GDP reached 47.6% in 2020, which is almost 10 p.p. lower than the general government debt to GDP ratio. In the period 2010-2019, this discrepancy was at a similar level, ranging from 1.9 to 3 p.p. Therefore, the existing differences in the assessment of the amount of debt, which depends on the methodology, may result in different assessments in the future. Discrepancies between individual methodologies should be unified. Harmonized methodology would

significantly improve the quality and credibility of the presented information. In addition, this aspect should be standardized for all countries.

**Conclusions**

Nowadays, the socio-economic development of the country plays an essential role. Undoubtedly, this development is determined by a number of financial phenomena. According to the secondary source literature there are various types of finances. The study focuses on the subjective approach, which distinguishes finances of households, enterprises, financial institutions and the state. Public finance is considered to be the foundation of well-functioning economies. Sustainable public finance creates a stable basis for economic growth and development. Thus, state finances are largely determined by macroeconomic stability.

The analysis of the literature of the subject and statistical studies allowed us to answer the research questions posed. As a result of the conducted research, it should be pointed out that the presentation of the size of public finances is done by means of the socialisation index and the fiscal indicator. Therefore, it is significantly determined by the socio-economic development of a given country. The fiscal indicator for Poland in 2020 was 41.3%, which means that Poland is in the group of countries with a relatively moderate level of public income. On the other hand, the index of socialisation for Poland in 2020 was 42.4%, which means that Poland is among countries with a small scope of public finances. The analysis of statistical data shows that there is a permanent imbalance in Polish public finances. This imbalance remains clearly visible in recurrent deficits, which are considered to be the cause of public debt. In the analyzed period, the highest deficit was recorded in 2020. The main reason for the negative difference between public revenue and expenditure was the outbreak of the COVID-19 pandemic, which was associated with the emergence of the economic crisis. Public debt to GDP ratio in Poland in 2020 was 47.6%, while the general government debt in relation to GDP was 57.2% (the level of debt indicates that the ratio of public debt to GDP is approaching the limits set by the Maastricht Treaty). Discrepancies between individual methodologies need to be unified. Harmonized methodology would significantly improve the quality and credibility of the presented information. From an economic point of view, a standardised methodology would result in an objective basis for historical and comparative analyses. The high level of the deficit in 2020 and the growing public debt make consolidation measures obligatory. Those actions result from the limitations of national and European regulations. The procedure of repairing public finances in Poland should primarily concern balancing the state budget. It would be reasonable to say that the public finance system determines the country's economic and macroeconomic stability, as it is the basis of the country's financial mechanism.

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ARTICLES

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**Andrzej Gumieniczek** [1]

# POSSIBILITIES OF USING CLUSTER SOLUTIONS IN THE POLICY OF REVITALISATION OF DEGRADED MUNICIPAL INFRASTRUCTURE IN UKRAINE

**Summary:** *This paper discusses the issues concerning the policy of revitalisation as the basis for planning and carrying out the social and economic reconstruction of Ukraine. It is crucial to consider the scale of destruction and degradation of urban tissue, as well as the migration which occurred in the wake of the military operations. As a result, it is necessary to devise a specific programme of revitalisation which would use innovative organisational and guarantee instruments on a macro-, meso-, and microeconomic levels.*

*The paper considers the factors which determine the aims of the municipal revitalisation policies, as well as their models, which include an analysis of degradation of urban areas as a step in the development of cities. The paper includes an examination of demographic factors, as well as those, which are associated with depopulation. In addition, the importance of urban infrastructure was highlighted in the process of revitalisation. Furthermore, the paper covers the analysis of literature regarding experiences in terms of using revitalisation clusters in degraded areas. The development of chosen clusters in cities in Western Europe was examined, having identified and evaluated basic conditioning factors of their use in revitalisation processes. Moreover, the importance of clusters was discussed, together with their possible use by establishing 'Key National Cluster' and, within its confines, 'Regional Key Clusters' in chosen*

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*oblasts in Ukraine according to their division into international areas of reconstruction. The scale of destruction and degradation of given areas of Ukraine was evaluated in terms of particular elements of revitalisation, together with the costs associated with reconstruction. This analysis covers the losses Ukraine experienced between July and December 2022.*

**Keywords:** revitalisation policy, urban revitalisation, cluster, systems analysis, modelling, degradation of Ukraine

**JEL Classification:** E000, H300

## Introduction

The aim of this paper is to introduce the roles of cluster structures in the development and revitalisation of cities, and to evaluate the possibility of using them to increase the efficiency and innovativeness of socioeconomic processes in Ukraine, drawing on the experiences of using “development clusters”. The analysis resulted in the identification of the factors which allow an effective cooperation within clusters on the international level in Ukraine. In the paper the assumption was made that because of the extreme extent of the damages to the municipal structures and the resulting migration, it is crucial that a dedicated systematic policy of revitalisation be followed, which would be based on organisational instruments taking the form of revitalisation clusters consisting of international entities. The main thesis presented in the paper was made under the assumption that the experience gained through the implementation of revitalisation and development clusters in cities in Western Europe in the period 2001-2022 can be used in the process of degraded urban units in Ukraine, which would result in an increased effectiveness of the above entities in terms of the socioeconomic development. The paper discusses the role of cities in stimulating economic growth and development as part of cluster initiatives and the importance of the idea of smart cities based on cluster infrastructures. The paper also contains the evaluation of the effectiveness of growth clusters in several European cities, as described in the literature, as well as, a given case of an innovative revitalisation cluster. On the other hand, the paper discusses the main problems associated with degradation of urban areas, including depopulation. Subsequently, the extent of destruction of urban areas in Ukraine was evaluated, together with the estimation of the costs of socioeconomic reconstruction. Taking into account the influence of innovative urban clusters which facilitate development, the paper includes the discussion of the possibility of using such clusters to improve the effectiveness of the revitalisation of the degraded oblasts and cities in Ukraine.

## 1. Importance of cities in initiating development and economic growth as part of cluster initiatives

In the theory of economics, the term economic growth coincides with economic development. The latter encompasses, apart from quantitative changes, changes that are qualitative in nature (Ziębicki, 2013). These primarily concern the socio-economic systems and the societal organisation. Since there are reciprocal dependencies between growth and development, it is assumed that growth is the fundamental condition that economic development occurs, consequences of which shape the standard and conditions of living for the inhabitants of a given region or country. Bigger cities are particularly important in initiating economic growth. Urbanised areas foster the development of knowledge, science, technology, and show potential for clustering. This is because of a substantial accumulation of ideas in a relatively small area. Therefore, the development of cities encourages development of highly valuable human capital (Dyr & Ziółkowska, 2017).

Among numerous theories and models of economic development, those that pertain to manufacturing locations are the most important. Their originator is [Marshall, 1890], who formulated the idea of industrial districts, which are designated areas in which manufacturing plants are concentrated. The analysis of spatial placement of economic entities revealed that there are preferred areas which are especially advantageous. This is explained by the concept formulated by [Perroux, 1964], who coined the term ‘growth poles’. The role of growth pole of the so-called driving unit which provides the stimuli for other regions is occupied by an innovative enterprise or a group of such enterprises, with varying manufacturing potential, and which represent a dynamically developing economic sector. Such entities can be thought of as a driving factor or force as long as their size is sufficient to directly or indirectly influence the economy of a given region, they represent an innovative and dynamically evolving economic sector, and have multiple connections with other types of economic and social activity.

Entrepreneurial mobilisation, which is a result of the impulses generated by a growth pole, is realised through the so-called spread effects, the most important of which concerns knowledge and innovation. They are essential, but not sufficient on their own, in transforming a metropolitan area into a territorial growth pole. According to [Lasuen, 1969], their presence in a leading sector influences not only that sector, but also other branches of industry in a region. At the same time, it is noticeable that the inability to benefit from innovation in the entire region at a similar rate causes a concentration of the activities in selected cities, which become the growth poles. From these areas, which [Hirschman, 1958] called geographical growth centres, development is propagated into surrounding areas. As per

this idea, there are more opportunities for development in bigger cities. This is due to the fact that a concentration of consumers, employees and business entities in one place, together with formal and informal institutions which make a metropolitan area 'dense' and cohesive, encourages the production of external effects and magnification of scale effect. On the other hand, opportunities for development in small urban areas are scarce, and these areas primarily provide factors of production in relation to economic policy, which highlights the importance of developing large cities.

The theory of location production was developed by [Krugman, 1991], who is the author of new economic geography. Its premise is the necessity to treat several factors which influence regional development, for instance, spillover effect, economies of scale, effect of demand brought about by the external market, and business costs related mainly to transport. The consideration of the above causes the businesses to choose their location in close proximity to other entities. At the same time, they prefer to be located near sizable sales markets. The above conditions are found in big cities, in which or in close proximity to which numerous businesses operate. This positively influences the competitiveness of these areas and the standard of living therein.

In the models of new economic geography, spatially diverse distribution of employees (consumers) and businesses depends on the intensity of centripetal forces, which are advantageous for geographical concentration of activity, and centrifugal forces, which disperse the said activity. In the regions where centripetal forces dominate, the businesses are located unequally in space, and there are urban areas with particularly high concentration of business activity. In the remaining areas there are few businesses or there are no industrial entities. The primary factors which determine the occurrence of centripetal forces are a regional market which is characterised by a high demand, which greatly influences the size of businesses' income. On the other hand, centrifugal forces result from a lack of non-mobile factors of production and so-called non-exchangeable goods, such as, habitable structures, as well as numerous negative scale effects, which occur simultaneously [Niebuhr & Stiller 2002].

While presenting the idea of regional development, an emphasis was put on the theories which highlight the importance of cities. Apart from the ones included, there are numerous theories which indicate additional factors related to cities, which are beneficial for economic growth and development of countries and regions.

## 2. Degradation of urban areas as a step towards development of cities

Revitalisation is applicable in areas degraded to various extents, including those destroyed as a result of military activities. While assessing the degree of degradation, both the past and the future can be used as a point of reference. This assessment is done in relation to the potential of land, which is determined by the functional and spatial structure of a city. Additionally, the assessment of the potential of the land is carried out individually for each case. Degradation can be narrowed down to: physical degradation which concerns technical condition of buildings, functional degradation which concerns the process of functional transition occurring in an area, moral degradation which concerns the appearance of an area and the acceptance towards its function, compositional degradation of space which takes into account the extent of developing a compositional structure [Kaczmarek, 2011].

In a broad sense, municipal infrastructure is characterised by defined technical, economic and institutional features [Dziembowski, 1966]. The importance of infrastructural items' value in the total value of national assets (asset intensity) makes it necessary to incur financial outlays (capital intensity), which are related to the necessity of their development, refurbishment, replenishing and reconstruction. A lack of sufficient outlay leads to decapitalisation and progressive technical degradation. When it comes to material damage resulting from, for instance, warfare it can lead to a situation in which revitalisation of a city becomes very challenging or impossible. Degradation of urban areas leads to a loss of their socio-economic functions, which in turn results in a decrease in entrepreneurship, increase in unemployment, decreased quality of technical and social infrastructure, decreased accessibility of public services, and depopulation. Likewise, the said loss of socio-economic functions can be attributed to crisis situations, such as warfare and the destruction resulting from it.

## 3. Depopulation factor and demographic aspects of revitalisation

The term depopulation [Śleszyński, 2016] describes a decrease in population of a given area as a result of negative natural increase, caused by migration intertwined with natural factors. Human migration reduces the number of people in reproductive age, which results in a decrease in the number of births, while the death rate stays at the same level. The rate of migration depends on the internal factors in a given country. In a crisis or during a war it can be very high. In the wake of the conflict in Ukraine, it is estimated that the scale of internal and external migration in the period between February and December 2022 was 6-8 million people, according to the data gathered by the border authorities which registered the numbers of refugees.

Depopulation of an area has a negative impact, which encompasses various aspects. The demographic ones include a decrease in the number of inhabitants, an imbalance in the age and gender structure, and increased population ageing. The economic ones include decreased employment opportunities and a decrease in the number of skilled employees. The social ones include the fact that in Ukraine the majority of people aged 18-60 emigrated or were conscribed. The above aspects constitute the main reasons behind the halted development of cities [Szukalski, 2015].

The problems associated with the demographic situation in contemporary cities cause their economic, social and spatial degradation [Ciesiołka, & Jaroszewska, 2010]. A large population decline in cities and the associated phenomenon of shrinking cities constitutes a grave problem. When examining the causes of depopulation the most important aspects to consider are the demographic, economic, social and spatial ones. In addition, it is crucial to take into account those, which are conditioned by crisis situations, natural disasters or ongoing warfare. The negative impact of city degradation consists of an increase in the number of degraded areas, which are the properties whose technical condition does not allow for their inhabitation, an increased presence of degraded and dilapidated industrial areas whose function was lost and are no longer used, and the arised necessity to demolish degraded and dilapidated buildings which are unsuitable for refurbishment.

## 4. Main problems of revitalisation programmes

The identification of the problem of degradation and the specification of the area affected by it is the initial step in the process of revitalisation [Mironowicz, & Ossowicz, 2005]. In this step, financial and legal considerations are identified, as well as areas for revitalisation are designated, together with the entity responsible for revitalisation. Financing the majority of revitalisation processes is done using external funding and in this stage the preparation of appropriate documents needed to secure such funding is prepared. The economic aspects of revitalisation concern primarily its financing and effectiveness. In the processes of revitalisation the primary sources of funding are subsidies, debt, equity, fiscal and surety instruments, and public-private partnerships. The condition necessary to ensure the success of revitalisation is securing funding based on financial guarantees, without which financial institutions refuse to grant funding, making it crucial for investment realisation.

As far as the revitalisation of degraded cities and oblast areas in Ukraine is concerned, essential are international revitalisation clusters, in which funding is guaranteed by the involved countries and international institutions. The studies conducted in the countries in Western Europe demonstrate the importance of revitalisation clusters on a local, regional

and international level in enhancing the effectiveness of each respective entity in a cluster. This is because formalised structures of a cluster aid the entities, which increases the acceleration of effectiveness, when compared to the entities that are not part of a cluster.

## 5. Smart cities and cluster structures

The term ‘smart cities’ appeared in the 1990s as one of the ideas of regional development. It describes development of cities based on the technology of processing, gathering and transmitting information digitally using growth clusters. According to [Albino, 2015], smart cities are those in which information technology is intertwined with infrastructure, architecture, everyday objects and inhabitants with the aim to use them to tackle social, economic and environmental problems. On the other hand, [Chourabi, 2012] defines it as a city which combines physical and information technology infrastructure with business infrastructure, to use the collective intellectual potential of a city’s population, as a result of which the city becomes efficient, sustainable and well-adjusted. Additionally, the city uses technology together with city planning on the organisational level. The main reason for establishing smart cities is to digitise administrative, economic and mobility processes and create an environment which efficiently uses its resources and inhabitants’ abilities. The analysis of the development process of smart cities conducted by [Caragliu, 2009] confirms that the efficiency of cities depends not only on the availability of physical infrastructure and human resources, but also on the availability of information and communications technologies, which enhance the quality and accessibility of the said infrastructure.

[Russo, 2014] defined smart cities as those which try to address the civic challenges in terms of, for example, transport, sewage and waste management, energy, healthcare, safety and security. The above challenges are tackled using information and communication technologies, whilst relying on a partnership between multiple municipalities, which ensures a greater availability of services. As a consequence, smart cities constitute a paracluster vector for innovation in products, processes and services. [Porter, 1998] presented a novel idea of business localisation within clusters, which alludes to the theory of business districts. According to him, business location is a key factor of success. Businesses linked to each other, specialised suppliers, services providers, entities operating in related sectors and associated institutions (e.g., scientific, standards, business associations, etc.) operate within industry clusters. A crucial element of these clusters are urban areas, because they provide the means for business entities to connect, exchange experiences and cooperate. As a result, this leads to an increased productivity and competitiveness of these entities, as well as, the development of the areas in which these

entities operate. According to [Richter, 2015], smart cities are rudimentary in the development of clusters and stimulate this development. Knowledge creation and its consolidation, together with innovation management lie at the heart of smart cities. This is the reason why the introduction of smart initiatives increases the social and economic attractiveness and competitiveness of a city, which are supported by its technological infrastructure [Hajduk, 2016].

In a similar way, [Khatoun & Zeadally, 2016] highlight the fact that a smart city sets a goal to improve the standard of living of its inhabitants and optimise territorial, economic and environmental resources. According to [Kraus, 2015], an important aspect of smart cities is the geographical proximity of people who think alike. In these cities, clusters constitute a place where creative inhabitants can operate, which increases the competitiveness of these cities. In addition, through the cluster effect the pace of innovation implementation increases.

Smart cities support the emergence of clusters through the enhanced agglomeration effects and strengthen the clusters themselves. Furthermore, integrated urban strategies aim at associating the physical space in cities with the economic and social sphere. [Angelidou, 2015] identified the main factors which promote development. These are urban planning, public-private partnership, sustainable social development and education. A comparative analysis of relationships between smart cities and clusters indicates that they function at various geographical levels, such as, local, regional, national and European [Alaverdyan, 2018]. According to the analyses, smart cities constitute an organic system of subsystems [Harrison, Abbott & Donnelly, 2011]. In other words, they are an ecosystem, where products, services, businesses, people and societies cooperate to support the innovative ideas towards urban development [Cosgrave, 2017]. According to [Wang, 2015], [Corrigan & Joyce, 1997], and [Nalbadian, 2013], efforts to improve the interaction between cities and their inhabitants are key in the development of smart cities.

## 6. Research and analysis of the effectiveness of growth clusters in selected European cities.

On the European level, the idea of smart cities exists within cluster partnerships in some countries. The main clusters identified are Smart Cities Mediterranean Cluster and Smart City Tech. The former is a partnership between research groups, industries, innovative small and medium-sized businesses and civil society from 26 countries. The latter is a partnership between clusters with a defined aim of stimulating cooperation between cities and smart systems stakeholders. When focusing on the type of stakeholders involved, the Smart City Clusters involved are represented by scientific institutions (universities, research centres, institutions propagating science

etc.), industry (enterprises) and governmental organisations (regional and local governance).

The role of clusters in urban development was researched by [van den Berg, 2001], who carried out an analysis of growth clusters in European cities in 9 regions of the EU and compared their growth dynamics. They based their analysis on economic activity and demonstrated organisational solutions deployed in cities. Their aim was to examine urban regions in a comprehensive way and embed the functioning clusters in the economic, cultural, administrative and political structure of a given urban area. This is indicated by the tendencies in the urban policy in terms of investing in development and cooperation with industry, especially in innovative sectors [Nijkamp, 1999]. The literature contains studies devoted to compiling experiences concerning growth clusters and results of international comparative studies. [de Graff & Boekema, 2002] illustrated how large urban areas can benefit from quickly developing sectors, for example, biotechnology, medical services, tourism, information technology, media industry, as well as, construction industry. To conduct the study one cluster from each city was selected. The studies sought to explain the processes behind the emergence of clusters in cities. The clusters analysed were located in the following cities: Amsterdam (The Netherlands), Eindhoven (The Netherlands), Helsinki (Finland), Leipzig (Germany), Lyon (France), Manchester (The United Kingdom), Munich (Germany), Rotterdam (The Netherlands) and Vienna (Austria). [van den Berg, Braun & van der Meer, 2001] analysed various types of clusters. The above frame of reference allowed an analysis of clusters in an urban context and a systematic overview of clusters of different sizes and structures. For each city, the available raptors and studies were carefully examined, and in-depth interviews with key representatives were conducted to establish strategic links with other organisations. Evidence was collected which pointed to the presence of formal and informal structures, joint facilities or projects in a growth cluster in an urban area. Included in the analysis was the influence of general conditions (accessibility, quality of life and cultural aspects) on the functioning of a cluster. Interviews with the politicians were held which pertained to identification and evaluation of clusters and urban strategies. The empirical analysis included an examination of aspects of several clusters: the importance of scale, the role of large companies as stimuli for cluster development, the level of strategic interaction among cluster participants and the state of creating new networks. It was claimed that an important aspect is the size of a cluster and its association with the geographic market in its area. The bigger the cluster, the higher the level of specialisation (‘uniqueness’) in the cluster and the greater the cluster’s market reach. It was confirmed that all the developed clusters operated

on an international market. To sum up, large clusters are more important and have more advantages than small ones, for example, a large cluster entails a division of labour and specialisation, as well as, a large, specialised labour market. Furthermore, a large cluster generates a transfer of knowledge, which allows an improvement of 'cluster products', which in turn may stimulate demand and accelerate the pace at which this demand grows, allowing the city to develop. Clusters can provide many advantages thanks to the presence of the so-called 'cluster drivers', which are large organisations with a dominant position which act as knowledge sources as well as providers of all types of spin-offs. The results of the studies of the factors of city development confirm that the functioning and the dynamics of cluster development are dependent on the general economic situation and spatial conditions found in a city, as well as, cultural variables.

At the same time, relations between strategic participants of clusters in the development of cities and European regions are on the level of the international economy, in which the participants operate on a competitive market, where they use new opportunities for growth. The study attempted to analyse and compare the development of different types of growth clusters, which are located within a network of specialised organisations in urban areas. The notion of a cluster promoting local interactions and innovation demonstrates its usefulness and the inclinations towards abandoning traditional economics. Based on the conducted analysis, [van der Berg, 2001] confirmed that despite the appearance of global networks, many networks have a strong local dimension.

## 7. Case study: innovative revitalization cluster

An innovative revitalization cluster called "Lublin Region Culture Cluster – strengthening socio-economic potential of culture-forming and tourist environments of the Region" operated in the Lublin Voivodeship in 2006-2012. It has been described in the article "Good examples of implementing Regional Innovation Strategies in Poland" by the Polish Agency for Enterprise Development (PARP, 2009). The main goal of this project was to create a cooperation network between organisational units of the local governments, research and development institutions, non-governmental organisations and entrepreneurs in urban areas. This cooperation occurred in the Local Programmes of Revitalization of historic urban complexes. The research on the above cluster was conducted by [Gumieniczek, 2018], who focused on the 196 enterprises operating in the above-mentioned cluster (the study group) and 79 enterprises operating outside its structure (the control group). The participating entities were described as micro and macro enterprises with 5-50 employees, that were economically active in the areas of culture, construction and tourism. The statistical analysis showed that the percentage

of enterprises in which efficiency increased was higher among those which were part of a cluster than those that remained outside the cluster. Additionally, it was shown that the percentage of enterprises implementing innovations was higher among enterprises that were part of a cluster than those that were not. On top of that, the percentage of enterprises in which efficiency increased as a result of implementation of these innovations was higher inside the cluster than among enterprises remaining outside it. The enterprises concentrated in the cluster implemented process, product, organisational and marketing innovations, achieving higher efficiency. Thus, it was confirmed that formal cluster structures allowed a greater acceleration of efficiency when compared to the enterprises outside the cluster structure.

Growing urban competition in Europe has become a big challenge for cities. In order to use their potential optimally, however, the idea of cluster structures could be implemented. For example, networking could be used to optimally distribute resources among market participants. This could be done by supporting cluster institutions, investing in cluster-specific infrastructure or supporting informal networks. In addition, the cluster-oriented policy is a way of binding the active structures to the particular region, which promotes its stabilisation.

The use of the cluster approach is the most effective mechanism for a holistic development of economies in countries as well as for developing their regions [Kowalski & Marcinkowski, 2012]. The cluster structures support the development of countries by mobilising the network resources of territorial organisations and ensuring the competitiveness of countries within the global economy. The European Commission determines that 24% of the existing clusters are global leaders, 37% are national leaders, and 24% are the economic entities with a strong competitiveness. Clusters in Europe support regional development and stimulate innovation. Countries which participate in clusters benefit from an increased potential of their regions and a diversification of regional economy [European Commission, 2021]

Effective cooperation within international clusters should be preceded by an analysis of the conditions, assumptions and prospective directions of the said cooperation between participating countries and regions. Economic development is especially accelerated by innovative clusters. An innovative cluster highly increases competitiveness, by bringing together the research centres, industrial enterprises, state administration bodies, public organisations and universities which initiate the transfer of knowledge, technology and innovation. [Solvell, 2003] defines the cluster initiatives and activity as an organised effort to intensify development and competitiveness in the region where the cluster companies, government and the scientific communities are involved.

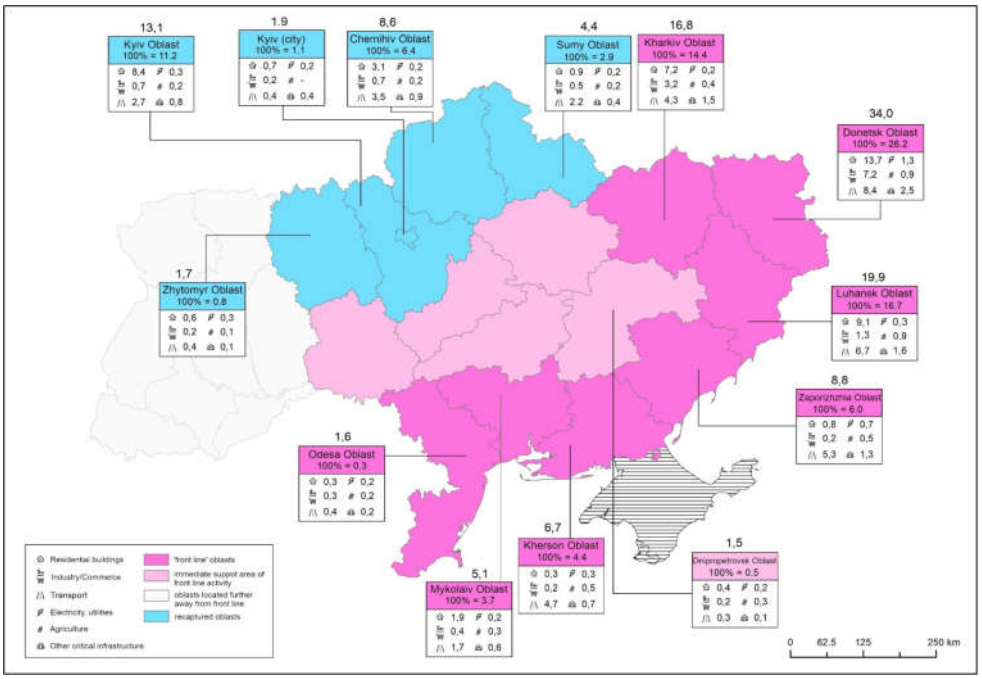
The [European Commission, 2021] defines the innovation clusters as concentration of independent enterprises, newly established innovative companies, small, medium and large enterprises and research organisations operating in a specific sector, region, which were created to stimulate innovative activity through promoting relations between entities, exchange of knowledge and experience, as well as through transfer of technology, networking and information sharing. [Chesbrough, 2014] indicates that the role of the external partners of the company is constantly becoming more important in the innovation process.

Internationally competitive clusters are called world-class. In a given country, such clusters should be nominated as the key national clusters. The development of these national and key regional clusters should be stimulated by supporting them, including a dedicated support for internationalisation, promotion, research and development, production infrastructure and development of human capital. At the same time, particular regions should specify priorities within their own development policy by identifying the key regional clusters that would define their specialisation.

## 8. Synthetic assessment of the scale of damage, degradation and costs of social and economic restoration of Ukraine

The analysis was based on the report by the Kyiv School of Economics from August 2022 included in the special report by Bank Pekao S.A. from October 2022 [Bank Pekao S.A., 2022] as well as on the European Commission data published at the end of August 2022 [European Comission, 2022]. The summarized data from these reports are presented in Figure 1 and Figure 2. In particular, the infrastructure of urban areas in Ukraine was damaged and degraded, with the losses amounting to $115 billion. The report indicated that the highest level of degradation concerned urban infrastructure and buildings, and these losses were estimated at $47.8 billion. The second biggest damage concerns the transport infrastructure, where losses were estimated at $35.1 billion. This was followed by the damage to the industry and business services which amounted to $9.7 billion, education - $4.4 billion USD, agriculture - $4.3 billion, vehicles - $2.7 billion, trade - $2.1 billion, culture, religion, sport and tourism - $2 billion, energy sector - $1.8 billion, health services - $1.6 billion, media - $1.3 billion, administrative buildings - $0.9 billion, digital infrastructure - $0.6 billion, social services - $0.2 billion, and financial sector - $0.02 billion. In addition, the cost of restoring the damaged buildings and infrastructure outside main urban areas is estimated at $198 billion. These reports set the costs of rebuilding and modernising the economy of Ukraine at $480 billion and the costs of socio-economic reconstruction at $750 billion.

**Figure 1. The costs of revitalising the particular sectors of the economy in the oblasts and cities in Ukraine expressed in USD billions**.



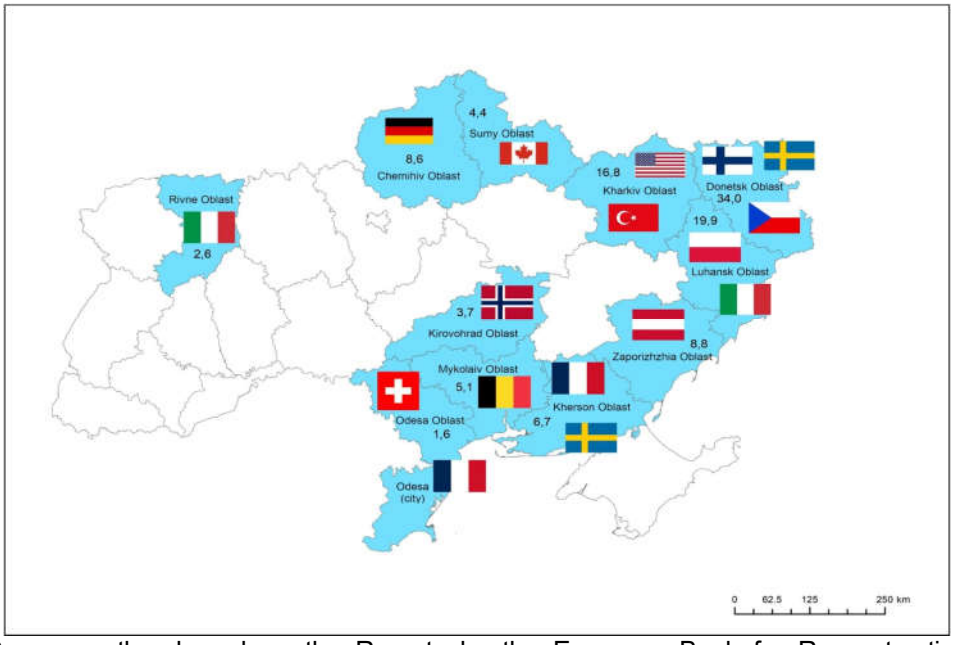

Source: author, based on the report entitled 'Reconstruction of destroyed or damaged buildings along with the necessary modernisation and the provision of funding needed to resume the activity of the entities from different sectors' by the Kyiv School of Economics from August 2022 included in the special reports by [Bank Pekao S.A., 2022] and by [European Comission, 2022].

## 9. The use of clusters in improving the effectiveness of revitalization of the degraded oblasts and cities of Ukraine

The reconstruction of Ukraine encompasses the entire territory, with the greatest damage being caused by the warfare in the so-called front oblasts and the neighbouring ones, while the oblasts far from the war front have a lower scale of degradation. The proposed revitalization policy, which includes the reconstruction of urban infrastructure in the oblasts in Ukraine assumes the creation of international clusters. According to the concept from (Figure 2) individual oblasts were assigned to respective countries, whose role is to supervise and support the reconstruction processes. It is an innovative proposal from the organisational perspective, as it assumes the creation of a "National Key Cluster" and "Regional Key Clusters" with a participation of international entities to guarantee funding for reconstruction, which would enable and accelerate the implementation of socio-economic recovery of oblasts (regions) and cities of Ukraine. Adopting such an

assumption will enable the development and the restructuring of the economy at regional level, as well developing a new level of international relations.

**Figure 2. The International project encompassing the National Key Cluster and the Regional Key Clusters shown on a map with the Oblasts, along with the estimated costs of reconstruction expressed in USD billions: Rivne – (Italy), Chernihiv – (Germany), Sumy – (Canada), Kharkiv – (USA, Turkey), Donetsk – (Chech Republik, Finland, Sweden), Luhansk – (Poland, Italy), Zaporiztzhia – (Austria), Kherson – (France, Sweden), Kirovohrad (Norway), Mykolaiv – (Germany), Odesa – (Switzerland), Odesa (city) – (France).**




Source: author based on the Reports by the European Bank for Reconstruction and Development, the European Investment Bank and the Organisation for Economic Cooperation and Development, included in ["Lugano Declaration", 2022] and by [European Comission, 2022].

The Lugansk oblast was selected for a detailed analysis of the estimated reconstruction costs. It will be managed by a consortium of countries, i.e. Italy and Poland, as a part of the planned "Regional Key Cluster". This region was chosen for the analysis, because the Polish economy is planned to be involved in the process of reconstruction and the resulting benefits are estimated at 3.6-3.8 GDP, which is the equivalent of obtaining PLN 170 billion over the period of 10 years, based on the special report by [Bank Pekao S.A., 2022]. A detailed analysis showed that the reconstruction

of the Lugansk oblast requires an expenditure of $19.9 billion and is the second-highest reconstruction cost after the Donetsk oblast which amounts to $34 billion. The costs associated with the reconstruction rose from $15.9 billion to $19.9 billion between June and December 2022 (an increase of 25.15%). The damage to the housing infrastructure was estimated at $7.9 billion and increased to $13.7 billion (73.41%). Damage to the industrial and commercial structures increased from $0.8 billion to $1.2 billion (50%). As for the transport infrastructure, the costs were estimated at $5.5 billion and saw an increase to $8.4 billion (52.72%). The damage to the energy sector and utilities amounted to $0.1 billion and increased to $0.3 billion (200%). In agriculture the change was from $0.6 billion to $0.9 billion (50%). Finally, in the remaining services these costs rose from $1.0 billion to $1.3 billion (30%).

Additional problems which hinder the creation of international cluster structures are some internal conditions in Ukraine, which have been described shortly in Table 1.

**Table 1. The internal problems of Ukraine impacting the implementation of international clusters.**

| Problem area | Description |
|---|---|
| Political | The political situation in Ukraine is currently very unstable, due to the military conflict with Russia. In this situation, the government is not taking the necessary action towards the preparation and adoption of normative legal acts concerning stimulating the development of cluster structures. |
| Economic | The economic conditions for the implementation of a cluster policy are currently exceptionally unfavourable due to the ongoing crisis and war in Ukraine. However, there is no alternative policy for effective restoration of the economy. In other words, the development of cluster structures in oblasts and regions of the country seems to be the only way to ensure effective refurbishment of the economy of Ukraine. |
| Financial | High level of monopolisation of the Ukrainian economy and the political influence of the oligarchs on the governmental institutions make the financial policy and economy unfit for a cooperation between science and industry, mainly due to the lack of interest in such activities. |
| Social | The level of social capital in Ukraine is low, as is the level of transparency and trust between potential cluster participants and local, regional and national authorities. |
| International | A national policy of establishing international cooperation between clusters in Ukraine and foreign partners is unsatisfactory and is currently conducted mainly on a personal level. |

**Summary**

The adoption of a comprehensive revitalisation policy including innovative organisational instruments and guarantees is necessary for an effective revitalisation of destroyed urban infrastructure in Ukraine. An identification of specific issues in each region is necessary to specify areas where particular problems occur. While doing so, social issues, such as depopulation, must be identified and taken into account not only to tackle them, but also allow for social participation in the process of revitalisation. Based on the analysis of the effects of cluster implementation in the urban areas of Western and Central European countries and their impact on socioeconomic development of the said areas, the implementation of clusters for the revitalisation of the degraded regions of Ukraine was proposed.

Despite the limitations and problems indicated in this paper, it can be assumed that the hypothesis and the thesis have been positively verified.

The main thesis presented in the paper was made under the assumption that the experience gained through the implementation of revitalisation and development clusters in cities in Western Europe in the period 2001-2022 can be used in the process of degraded urban units in Ukraine, which would result in an increased effectiveness of the above entities in terms of the socioeconomic development.

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# THE CONCEPT PRE-INCUBATION IN THEORY AND PRACTICE

**Abstract**

*The concept of business pre-incubation is described in a residual way in the literature. The few articles defining what business pre-incubation is describe it as a service that enables an entrepreneur to test his or her business idea in real market conditions. The aim of this article will be to try to define and structure the concept of pre-incubation by pointing out its basic features, as well as to identify good practices for corporations that would decide to create a corporate incubator along the lines of the one described below. The objectives of the article will be achieved through an analysis of a pre-incubation project carried out at the end of 2021 and the beginning of 2022. The analysis will be carried out from the point of view of its participant, and through information from the organisers of this project in order to maintain a multi-faceted and broad view of the problematic of the concept of pre-incubation. By analysing existing definitions, listing the basic characteristics of pre-incubation and placing them in a real-life example, the conceptual and theoretical gap that exists in the science of about innovation, and the practical features of such a model of cooperation from the point of view of enterprises will be indicated.*

**Keywords:** Pre-incubation; Innovation; Innovation Management; Innovation Processes; Startups; Entrepreneurship

**JEL Codes:** M13, O31

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## 1. Conceptual structuring and definition of pre-incubation

In order to get a closer and deeper insight into how pre-incubation is perceived so far, it is necessary to delve into the proposed definitions, According to one of them, pre-incubation is "a proactive activity to check whether innovative ideas have business potential." (Mwandosya, Apiola, & Lahde, 2016) The concept of a pre-incubation recipient does not appear in the above definition. Key in this definition is the indication of the processivity to which the idea is subjected. It is checked for business potential. The activities that are undertaken for the said checking are not outlined. A characteristic feature of this definition is its broad outlining of the subject, and the object of pre-incubation. The only restrictive criterion is that the pre-incubated idea must have an innovative feature. Two conclusions can be drawn from the above, namely that an already existing product or service cannot be pre-incubated. The business solution must be at the concept stage, and it must be innovative, i.e. propose a new, previously unknown solution (Mwandosya, Apiola, & Lahde, 2016).

Researchers associated with the Technical University of Valencia, and the university's StartUPV incubator, point out that pre-incubation, as a business development tool, is primarily dedicated to students, and that the main area of activity within the pre-incubation stage concerns the search for business opportunities, the refinement of technology, and the development of a business model (Griol Barres, Márquez Gómez, Giménez Carbó, & Gómez Martín, 2022). Here, in turn, the main audience is shown as a student who has an idea that needs to be adjusted to a level where this idea will solve a specific problem and consequently meet consumer demands. Furthermore, the role of pre-incubation at this stage is to simultaneously develop a business plan through which the idea will develop a profitable business model.

Putting these two definitions together, it is important to note how broadly defined the recipient of pre-incubation is. What they have in common is that it is usually a young entrepreneur (both in terms of age and in terms of running their own business) and that pre-incubation is subject to an idea being developed and tested in relatively safe conditions. This testing can take place within professional business incubators, inside specially dedicated teams within companies, as well as within student incubators set up at universities. It is, however, impossible to pre-incubate an entire functioning enterprise, as the purpose of pre-incubation in a broader context is to create a product or service, as well as the processivity going on around it. A developed enterprise has all these characteristics so it is impossible to preincubate such entities. One can therefore conclude that in the preincubation process it is not the experience of the entrepreneur or the team that is important, but the idea around which the process environment is built.

The pre-incubation and creation of the business model itself takes place in multiple stages. Several sub-stages of business idea creation have been

listed in the literature. These sub-stages will later be placed in the context of the eponymous corporate-student incubator.

The various stages of creating a business model are (Yoganandan & Vignesh, 2017):

- information gathering,
- analysis of the business environment,
- analysis of the practicality of implementation,
- creation of a multi-pronged business strategy,
- preparation of a pre-incubation report,
- evaluation and control of activities.

The above stages help to outline the basics of pre-incubation. None of these stages would be possible without having a business idea. Pre-incubation starts with having an idea, as it is the business idea that is the subject of pre-incubation, not the entrepreneur or any other entity. The second cut-off point is the end of pre-incubation. This can be considered as the creation of the first business model for the idea. This idea does not have to be profitable; it can be subject to numerous modifications in relation to the current market situation. This stage is already carried out as part of the incubation process. The literature indicates that the recipient of incubation, i.e. the next process after pre-incubation, is already the entrepreneur (Rudawska, 2020), who must have his or her own business, as it is the main object of incubation next to the support in creating an innovative product or service (Przybył & Grudzień, 2011).

## 2. Definition of pre-incubation versus student pre-incubation programme

In view of the above considerations, the proposed definition of pre-incubation is as follows: pre-incubation is the process during which a business model for an innovative solution to a market-embedded problem is developed around an idea for an innovative solution to a market-embedded problem, under controlled conditions. Two aspects are key in the proposed definition: the controlled conditions and the market-embedded problem. The entrepreneur aspect is deliberately omitted, as an idea is pre-incubated regardless of the specific characteristics of the entrepreneur. An idea tested inside a large-scale corporation can be pre-incubated as well as a student idea. Restricting the definition with the notion of entrepreneur would considerably narrow the concept of pre-incubation itself. More important than who is the recipient of pre-incubation is what competences of the originator will be strengthened through the pre-incubation process (Rudawska, 2020).

Another point is the controlled environment. Using the definition quoted earlier, there is no company at the pre-incubation stage, so strategy development and early testing must take place in as safe an environment

as possible. Purpose-built business incubators or academic incubators, on the one hand, and corporate incubators for enterprise innovation, on the other, can serve as safe environments. Equally important is the market-embedded problem. By this term is meant the solution to a problem, the solution of which will bring the greatest added value to the customer. This value brought to the customer will then be a source of growth for the future enterprise (Ries, 2017). A definition outlined in this way, together with the indicated characteristics, should be put into a concrete practical example.

For the purposes of this article, this example will be the pre-incubation programme (https://csv-student.pl/program-preinkubacji), co-organised by the Foundation for Shared Value Creation by Students, and the Polish white goods manufacturer. The idea of the programme was based on the cooperation between corporate managers and students. on real business problems faced by the company. According to one of the programme's organisers, Marcin Bielicki, PhD it was primarily intended to create a space for learning project activities, rather than for learning how to find and diagnose problems. In addition, the programme was intended to "respond to business challenges aimed at solving a real, existing problem in the market." (https://odpowiedzialnybiznes.pl/aktualności/grupa-amica-stawia-na-preinkubacje/). Organisationally, the programme was based on a stage-gate innovation model and the methodology of the individual teams was to use Design Thinking tools. The people taking part in the programme were divided according to their personality predispositions examined beforehand using a specialised tool under the guidance of experts. The teams thus selected designed and tested their solutions, in collaboration with the managers assigned to each problem and team. The projects were evaluated after a certain period of time within the individual gates and some of them were rejected. The entire programme was quoted from the participant's point of view. At this stage, it is important to note how this project fits into the definition proposed earlier. The first aspect will be to look at the lack of inclusion of the word entrepreneur in the previously proposed definition and how the activities in the pre-incubator relate to this theory. According to the Polish Entrepreneurs' Act (The Entrepreneurs' Act of March 6 2018) an entrepreneur can be defined as a person who "is a natural person, a legal person or an organisational unit that is not a legal person, to which a separate act grants legal capacity, performing business activity." Also key to the full picture is the concept of economic activity. According to the aforementioned Act, it is "an organised profit-making activity, performed on its own behalf and in a continuous manner". Continuity of activity is of particular importance here. Pre-incubation as a process is not a continuous activity, its limit is the creation of a viable business model for the proposed idea. In addition, during the pre-incubation process, the idea may undergo dynamic changes, so its earning potential is severely limited.

The aim of pre-incubation is to develop a model as well as entrepreneurial attitudes (Bielicki & Weinert, 2021).

In this spirit, the eponymous pre-incubation programme was carried out, which, in terms of entrepreneurship, provided a source of knowledge for both the participants (who were students) and the senior managers. The cooperation, and the project activities, did not create a new entrepreneur, but provided a basis for further learning and development of entrepreneurship. The learning aspect was particularly emphasised with respect to the students. In addition to practical involvement in project activities, a series of training courses was conducted in parallel, whose topics included introducing participants to the Design Thinking methodology (https://press.amica.pl/releases/726025/preinkubacja-studencka-w-grupie-amica-na-polmetku). Given the above, pre-incubation only indirectly focuses on the creation of entrepreneurs, and focuses more on the creation of attitudes and personal know-how, and in parallel the business development of the pre-incubated idea.

The idea of solving a market-embedded problem is another point within the definition. The issue of the idea is central to the concept of pre-incubation, as it is the idea that is the object of pre-incubation, while the subsequent stages of business development focus on the development of the product or service, and the business itself. The viability of the idea itself, and the exploration of the preferences of potential consumers, is the subject of the first three activities mentioned above, i.e. gathering information, analysing the economic environment, and analysing the practicality of implementation. Each of these tasks is aimed at refining the idea itself

as much as possible, as further activities in the pre-incubation process depend on the quality and precision of the idea. In the programme mentioned earlier, the ideas were identified by the company itself, so the participants acted on real problems. The identification of problems depended in this particular case from the analysis of trends, and the company's analysis of its competitors' activities. This is a natural direction, as innovation itself, according to the literature, must include the element of "novelty", i.e. the absence of previous similar solutions, as well as the ability to implement the innovation into market conditions, i.e. practical implementation into everyday business life (Grandstand & Holgersson, 2020).

The last part of the definition is the controlled conditions under which pre-incubation is carried out. This is an essential element, as the pre-incubated idea is not a finished product and all processes and necessary know-how are only just being developed. Controlled conditions are understood in a broad sense, as they can be both professional technology incubators, but also incubators established inside mature companies that test internal innovations created for the corporation. This is not a closed catalogue of institutions that provide controlled conditions for development, however, due to the specificity of the case described, these three types of institutions

will be developed. Technology incubators, and technology parks of all kinds, are an important point of business creation, because in addition to the development of the innovative idea itself, they support the creation of new forms of scientific cooperation between business and universities, contribute significantly to the development of various forms of industry, thereby supporting the development of regions, and raise the level of corporate culture (Hunjet, Ivetić, & Kozina, 2018). The programme described here is representative of a corporate incubator, however, enriched with elements derived from the philosophy of 'open innovation', which involves companies opening up to the outsourcing of innovation processes and extensive cooperation (Chesbrough, 2003). In the described case, the controlled conditions served as the operating within the space created by the company and the organisers. All ideas were tested and fine-tuned with the help of the management in order to eliminate costs for both the company and the participants as much as possible while maintaining the professional nature of the event. This also confirms that the incubator does not have to be a separate professional institution in every case, but that places operating in a similar way can also be set up after the space inside the company has been set aside after separation of the space within the enterprise.

In addition to the definitional aspects, it is important to note how the programme described fits into these six stages of pre-incubation. For the purposes of the programme and due to its specificity, some of the stages were reduced or modified and some were given more emphasis. This does not change the fact that participants went through each stage learning from it.

The first stage mentioned is information gathering. It is understood in two ways, i.e., information includes both information concerning the market, competition, know-how or requirements of potential clients, as well as information not directly related to the subject of pre-incubation. It can include, among other things, information on how to run the business, which necessary formalities to complete, how to negotiate contracts concluded with the company, etc. Information presented in this way fits in with information in this way fits in with the indirect aim of pre-incubation, which is to develop entrepreneurial attitudes, thereby simultaneously developing the idea and its creator. Participants in the pre-incubation programme collected information according to a given scheme. They received information about the market and the problem from the managers who looked after the project, as well as from their own research into the environment. Soft information, i.e. any knowledge about operating methodologies, was provided by the Foundation, whose experts provided training on operating methodologies, as well as personal creativity development, product approach development or training on problem solving and logical thinking. This phase was conducted

practically throughout the programme, and by the length of the programme was one of the most comprehensive one.

The next stage is the analysis of the economic environment. This concept refers to a direct analysis of the economic environment in which the business, based on the pre-incubated idea. This mainly concerns issues of potential competition, potential suppliers of the necessary materials, information on who is the right and who is a side target group. There can be many channels for gathering this information including the internet, the professional press, colleagues and associates, and networking. One source of information can also be pre-incubation for the originator. It is this way that was adapted by the described programme. Managers provided their teams with a baseline of the economic environment before the teams started the actual work, but any specific issues were sought out by the teams. The model used here is modified from the regular information search, as basic information about the market and the problem was presented to the participants at the very beginning of the struggle, no preliminary research was required from them, so the procedure was relatively simplified compared to standard incubator activities.

The third stage is practicality of implementation, i.e. assessing whether the idea is suitable for practical application in business life. This analysis can have many dimensions, e.g. it can concern the drawing up of preliminary versions of a cost analysis for the launch of the product/service, so production costs, marketing costs or team maintenance costs. If it is a more complex product/service, it may concern the technical possibilities offered by potential suppliers and whether it is possible to create this product fully on one's own. This issue in the pre-incubation programme was reduced to the creation of initial cost estimates, as projects in which the company would be interested would be developed through the creation of appropriate cost estimates and creating the right business models for the solution.

This fact connects to the next three points, which together will constitute the business model and its control of the idea refined in the earlier steps. The first step is the design of the business strategy. This moment, and the strategy and model that is created, is a crucial step for the emerging company. According to researchers, having a business model is an attribute of a genuine company (Massa, Tucci, & Afuah, 2016), which, apart from the product, has an idea for its development, sales or marketing. The choice of a company's business model and the development of its strategy should be as precise as possible, as having and managing multiple business models at once can lead to the models undermining each other at the expense of the product (Porter, 1996). This step was the first of six that was almost completely ignored in the development of projects in the pre-incubation programme. The main idea of the programme was to test potential solutions under controlled conditions and the development of its participants,

and the creation of appropriate models and strategies would be addressed by the company.

The same was true for point five, the creation of the report. The summary contains the individual steps that the initiator needs to take in order to market the idea in accordance with the previously developed strategy. This point is a bridge between design and testing and the actual implementation. Successful implementation depends on three main factors: a strategic approach to innovation within the company, the business environment in which the innovation will develop and the characteristics of the innovation itself (Johnson, 2001). These features are listed in no particular order, as even the best environmental conditions for innovation development can be undermined by insufficient or no innovation policy in the company. As in the previous point, this point too was not particularly emphasised as far as the pre-incubation programme was concerned. Due to its R&D nature, implementation details were not a target activity envisaged in the programme.

The last feature cited is the evaluation and control of activities. This point is essential, in the creation of innovations of any kind, as the dynamics of any innovation require continuous evaluation of the actions already taken and ongoing modification of the strategy adopted. The technology industry in particular is characterised by high volatility and changes in innovative solutions. Data shows that large companies can change their innovation strategies even at monthly intervals (Yoganandan & Vignesh, 2017). This stage was used differently in the pre-incubation project than described. The checks on the progression that the actors made in their projects focused on the information and initial solutions that the teams proposed, not on the progress of the market implementation of the solutions.

## 3. Final conclusions

Summarising the previous considerations, the specificity of pre-incubation can be understood in a in a broad way. This is conducive to the modification of processes depending on the demand that the pre-incubation recipient makes. Depending on who this recipient is, pre-incubation can be carried out in different ways. Other needs are those of a student, whose main objective, apart from developing an idea, is to learn the basic market know-how of the business, and others are those of a large corporation, for which the most important thing is to test the market for the profitability of the innovation and the return that the investment can bring. It is also possible to combine the individual features and create syncretic solutions tailored in detail to the needs of the company. A representative of tailored pre-incubation is the cited pre-incubation programme, which brings together the business world and the academic world through a third sector organisation. In addition to the flexibility of matching, pre-incubation is characterised by a group of constant

features. The first feature is the development of the idea, which is the main feature of any pre-incubation programme, since, regardless of who carries out the pre-incubation and who is the recipient, the main objective of pre-incubation will be to develop the idea at the seed stage of investment. Another of the main features is that the whole process is carried out under controlled conditions. The idea that is the main object of pre-incubation is not the actual company, and all the measures taken are aimed at creating the entire institutional background, headed by a business strategy and a business model.

The aim of the article was to attempt to define and structure the concept of pre-incubation. The objective was achieved through the analysis and synthesis of existing definitions. The main outline of the definition involved expanding the model provided by G. Yoganandan and T. Vignesh through the enrichment of practical analysis for each of the previously proposed points. This analysis was based on the pre-incubation program, by incorporating its individual stages into the already highlighted points. Additionally, the model incorporated elements of definitions proposed by other authors. Limitations in the article creation primarily pertained to the lack of a larger number of definitions in the global literature. Therefore, the article represents an attempt to extract common characteristics from available definitions and synthesize them into a single definition.

**Table 1. The provided definition, after being divided into individual stages, is presented as follows:**

| Stages | Groups of interest | Barriers | Best practices |
|---|---|---|---|
| Information gathering | Originators; | Time; Money; People; | Diversification of sources of information; |
| Analysis of the business environment | Originators; Pre-incubator; Incubator; Customers | Competition; Macroeconomic environment | SWOT Analysis; Trends Analysis; Using broad number of data |
| Analysis of the practicality of implementation | Originators; Pre-incubator; Incubator; Customers; Capital Providers | Technology; Suppliers of materials | Testing the product on a target customer |
| Creation of a multi-pronged business strategy | Originators; Pre-incubator; Incubator; Customers; Suppliers; Capital Providers | Lack of business model for a new product; uncertainty | Recognising the strengths of the product and showing what problems it can solve |
| Preparation of a pre-incubation report | Originators; Pre-incubator; Incubator; Customers | - | Precise describing successes to date |
| Evaluation and control of activities | Originators; Pre-incubator; Incubator; Customers; Suppliers; Capital Providers | Lack of data; Subjectivity of indicators; Difficulties with risk assesment | Creating clear evaluation criteria; putting emphasis on finances and customer experience |

Source: *own development*

Outlined in this way, pre-incubation offers the possibility of creating a similar programme in enterprises. Good practice to set up such a programme relates primarily to establishing close contacts with local universities or with organisations that deal with innovation or cooperation with students. Another of the phases of starting cooperation concerns the ongoing identification of problems that are possible solvable through the use of pre-incubation and, in a later phase, the production and testing of the finished product within the organisation. Some of the identified problems can be delegated in parallel to the students collaborating with the company as part of the pre-incubation programme. A collaborative model designed in this way broadens the optics to new, out-of-the-box solutions that can be proposed by the students. This opens up a number of opportunities for the enterprise, as in addition to the innovation process, the enterprise simultaneously trains the students and gives them an insight into

its organisational culture thus increasing the chances of attracting young talent and further development.

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# CLIMATE POLICY RELEVANT SECTORS IN THE POLISH COMMERCIAL BANKS

**Abstract**
*The aim of the study is to estimate credit exposures and their changes in commercial banks' portfolios in terms of sectors important for climate policy, which exposes them to the risk of transition in Poland in 2013-2022. The research concerned the analysis of changes in the structure of the loan portfolio in terms of sectors relevant to climate change (CPRS) broken down by groups (green, black, brown, dirty), industries (fossil fuels, utility-electricity, production, manufacturing, transportation, agriculture), and types of activity divided into sections. The CPRS methodology was applied (Battiston), which is used in EiOPA, ECB, EBA. The share of green exposures of the entire banking sector in 2013-2022 increased (to 49%) and the share of dirty exposures decreased (to 51%). Due to the link between the sections, the three pillars of industries with the greatest risk to transformation among the CPRS were: buildings, transportation and manufacturing.*

**Keywords:** Credit portfolio, CPRS, transformation risk

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**JEL Classification:** G210, Q500, Q540, Q590

**Paper type:** Empirical research article

## Introduction

Climate policy in the real sphere of enterprises and households is treated as a wide range of ESG (*environmental, social and corporate governanc*e, ESG) relations. The ESG risk in financial institutions, including the banking sector, is understood as the risk of negative financial effects of the impact of ESG factors on customers and counterparties or balance sheet positions of banks.

Directly exposed to ESG risks in banks are loan portfolios of enterprises operating in high-emission industries, i.e. emitting greenhouse gases (GHG). Climate risk management (*climate-related risk)* is supported by all committees functioning in a bank. The effect of banks' activities in the area of ESG is also the promotion of corporate social responsibility (CSR) activities.

The changes introduced in connection with the implementation of Basel IV in the EU (Regulation (EU) No 575/2013 of the European Parliament and of the Council, Directive 2013/36/EU of the European Parliament and of the Council) imposed on banks the obligation to proceed with climate risks in the risk management system. The ESG climate risk is also treated as a challenge for financial stability. The European Systemic Risk Board *(ESRB*) and the European Central Bank (ECB) are actively involved in analysing and monitoring the impact of climate risk on the financial system, identifying it as one of the main systemic risks in the European Union (EU). These risks also require banks to develop appropriate strategies and change business models to minimise climate risks.

The aim of the study is to estimate credit exposures and their changes in commercial banks' portfolios in terms of sectors important for climate policy in Poland in 2013-2022.

## 1. Review of literature

In view of the adoption of the *Paris Agreement*, which crowns the 21st UN Climate Change Conferences, and the commitment to achieve carbon neutrality by 2050, EU bodies are taking several legislative actions, including those addressed to banks (Council Decision (EU) 2016/1841 of 5 October 2016).[2] The *European Banking Authority (EBA*) focuses

[2] The Paris Agreement on climate change is the first universal and legally binding global climate agreement. It was signed on 22 April 2016 and ratified by the European Union on 5 October 2016.

on how risks related to climate change, legal regulations and reputational risks will affect and manage financial and non-financial risks at bank level.

Currently, legal regulations regarding the ESG can be found, among others, in the SFDR Regulation (*Sustainable Finance Disclousure Resolution*), the EU Taxonomy or the TCFD Guidelines (*Task Force on Climate – Realated Financial Disclousures*). Since May 2020, the European Central Bank (ECB) guidelines on climate-risk disclosures have been in force. In March 2021, the Regulation on sustainability-related disclosures in the financial services sector entered into force, and from June 2022, ESG risk disclosures are part of the so-called third pillar disclosures under CRR 2. As of 30 June 2021, the guidelines for granting and monitoring loans (EBA/GL/2020/06) became applicable to financial institutions.

In the case of the report and opinion published by the EBA on 1 March 2021, a methodology for calculating a new efficiency indicator in banks' operations, i.e. *the green asset ratio (GAR),* was proposed. This measure is intended to determine whether the operations of a given bank qualify as environmentally sustainable within the meaning of the relevant provisions of Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment. The proposed ratio reflects the share of assets related to the financing of environmentally sustainable investments in the total balance sheet exposure of an institution (taking into account specific inclusions).

The EBA documents also propose performance indicators relating to environmental sustainability in the context of a bank's off-balance sheet activities, its trading book and income from non-lending activities or asset management. The transitional period for banks' adaptation to the new requirements should end in December 2022 or June 2024, depending on the type of indicator. During this time, starting from January 2022, banks are obliged to publish the information specified in the documents.

The literature on ESG and climate risk is extensive (Table 1). The climate risk can affect the financial system and the real economy through two risk channels (types). *The physical risk* includes the economic costs and financial losses resulting from the increasing severity and frequency of extreme weather events caused by the climate change. *The transition risk* is related to the costs generated by the need to adapt the economy to a more sustainable and low-carbon development path. In opinion Monasterello and Battiston (2020, pp. 52-72), there are several reasons why the risk of transfer is revealed, e.g. if the transition is late and sudden (ESRB, 2016) and thus "disordered" (NGFS, 2019).

**Table 1. ESG and climate risks and interactions with other risks**

| Risk type | Physical risk<br><br>– severe weather events and long-term changes in weather patterns can contribute to: | Transition risk<br><br>– new climate regulations, technologies and market sentiment can contribute to: |
|---|---|---|
| Credit | Decrease in the value of collateral, which in turn increases credit risk through higher LGD. | The emergence of the so-called "stranded" assets in industries with high $CO_2$ emissions, which in turn increases the probability of default default (through lower debt sustainability) and LGD (through lower collateral value). |
| Market | Impairment of assets and growth in volatility of e.g., commodities and/or FOREX. | The emergence of "stranded" assets in industries with high $CO_2$ emissions, which cause a sudden need to reassess e.g., equity and/or the bond market. |
| Operating | Destruction of real estate (e.g., bank branches), data center and operations. | Increase operational risk, e.g., by outsourcing selected activities or processes. |
| Other | Macroeconomic shocks increasing liquidity risk. | Negative impact on the reputation of an institution, e.g., in connection with the so-called "green washing". |

Source: The author's own compilation.

In view of the financial risk, including losses in assets and disruptions in the supply chain as a result of weather outbreaks (Adrian *et al.,* 2022; NGFS, 2020; Oswald *et al.* 2020; Riksbank, 2019; Xu *et al.*, 2018; Nordhaus, 2017), weather phenomena may also generate losses for insurance institutions, i.e. financial risk in terms of underestimated costs of paying compensation for losses caused by floods, storms and droughts, as well as lending institutions (banks) and asset managers related to asset impairment or bankruptcies of borrowers caused by climate change (IMF, 2022; Bank of England, 2021; Kalkuhl *et al.* 2020; Monasterolo, 2019; NGFS, 2019; Hsiang *et al.* 2017; OECD, 2015).

Research into estimating banks' exposure to climate risk mostly uses two identification approaches: carbon dioxide ($CO_2$) emitters and carbon-intensive industries (according to NACE), such as Battiston *et al.* (2017). The initial stage of assessing the level of climate risk often involves surveys addressed to financial institutions[3]. Battistion *et al.* (2022)

[3] Empirical research on the ESG risk in the financial sector, including towards banks, is at its preliminary stage. These studies focus, inter alia, on transition risks for corporate clients (enterprises) in the face of difficulties in obtaining data from individual customers

emphasize that low-carbon transition policies are expected to affect economic sectors in very different ways (IPCC, 2014, 2018, 2022). For instance, there is a consensus that achieving the Paris Agreement climate target requires the electricity sector to expand and the fossil fuel sector to shrink. However, differences are also expected within these sectors depending on specific climate mitigation scenarios and the technology used to produce energy and electricity.

The slow process of upgrading the building infrastructure used by businesses and households to achieve lower energy intensity sustains increased transition risks, which over time culminate in an increase in financial risk (Battiston, et al. 2019; ESRB, 2016).

According to Monasterolo (2020), the climate transition risk refers to the risk associated with a disorderly low-carbon transition in which changes in the values of financial assets (respectively, negative for fossil fuels and positive for renewable energy technologies) cannot be fully anticipated or hedged by market players. There are several reasons for the lack of anticipation, including climate policy uncertainty; a late-and-sudden alignment to climate targets (e.g. 2 degrees C) due to the complexity of the policy process; incomplete markets (e.g. insurance); a deep uncertainty of future climate impacts on technological developments and social dynamics.

Moreover, Battiston *et al*. (2022) underline that, however, the same activity can be carried out with different technologies (e.g. coal-fired power plants or wind turbines). In the context of climate policies, the specific technologies used in the production process are very relevant because they are associated with very different levels of GHG emissions and transition risk. Financial institutions hold securities and loans associated with firms and these data typically come with the classification of firms in terms of their NACE codes or other similar economic classification systems. However, ISIC (International System of Industrial Classification), NACE (Statistical Classification of Economic Activities in the European Community) or NAICS (North American Industrial Classification System) economic classifications were not designed to disclose climate-relevant information and do not provide an identification of the activities that are exposed to the climate transition risk and could become "carbon stranded assets". Therefore, a specific use of NACE codes is required to identify sectors relevant to the climate policy. The main assumptions for mapping these sectors according to Battiston *et al*. (2022) are presented in Table 2-3.

(households). It is easier to obtain data from companies than from individuals. Similarly, the transition risk is monitored more often than the physical risk due to problems with data to estimate the latter.

Moreover, attempts to link economic activities with their emissivity can be found, among others, in process-ased Integrated Assessment Models (IAM). According to Weyant (2017) and Krey (2014), these models are widely used to generate possible future trajectories of output of economic activities based on their energy technology (e.g., fossil fuels or renewables). Recently, IAM trajectories have been used to inform climate financial valuation adjustment and climate financial risk assessment in climate stress tests. The first approach to use the trajectories of IAM in the climate stress-tests of financial institutions was developed by Battiston *et al.* (2017). Since 2020, process-based IAM have been used by the NGFS to build climate mitigation scenarios (NGFS, 2020, 2021) which are recommended for use by the financial industry and by financial supervisors in their climate stress test exercises (Allen *et al*., 2020, Clerc *et al*., 2021, Alogoskoufis *et al*., 2021, Vermeulen *et al.*, 2021).

The participation of banks in financing business activities through various types of loans and the management of assets of climate-sensitive customers identifies banks as participants in ESG issues. Therefore, banks' lending policies require the financial supervision of ESG risks (EBA, 2021; NGFS, 2020a, 2020b, 2020c).

From the point of view of financial stability, the ESG risk can be assessed as part of management. The standard is insurance against fortuitous events, assets and fixed assets securing financial liabilities. This applies to mortgage loans for real estate placed against collateral to protect against a fall in the value of this pledge or to guarantee the payment of compensation (ECB, 2022; ESRB, 2020; Giuzio *et al.* 2019; ECB, 2019).

## 2. Sectors Relevant to Climate Policy (CPRS)

An important method for determining exposure by groups, sectors, and sections sensitive to climate change is the *Climate Policy Relevant Sectors* (CPRS) method developed by S. Battiston and I. Monasterelo (2017), improved at the turn of 2019-2022, and used in the studies of EiOPA (2018), ECB (2019), and EBA (2020).

To identify the CPRS, guidelines have been prepared for the qualification of various operations according to the economic activity codes (NACE) (at the level of classes and subclasses), covering some different levels of disaggregation (Table 2).

**Table 2. Levels of disaggregation for CPRS**

| Groups (four) | CPRS Main | Individual sections | CPRS (dis-aggregation) |
|---|---|---|---|
| • black (fossil fuels);<br>• brown (electricity + manufacturing + transportation),<br>• brownish (agriculture + buildings),<br>• dirty (black + brown + brownish),<br>• green | • CPRS1-fossil-fuel,<br>• CPRS2-utility-electricity,<br>• CPRS3-manufacturing,<br>• CPRS4-buildings,<br>• CPRS5-transportation,<br>• CPRS6-agriculture | CPRS2 (NACE Rev2 level) | Granular |

Source: Battiston *et al*. (2022)

The CPRS classification is widely used by practitioners and policymakers, based on the use of a classification of economic activities that is reproducible and comparable across portfolios and jurisdictions (Table 3).

**Table 3. The list of sectors relevant for climate policy by code classification**

| CPRS sectors | NACE rev. 2, 4 codes |
|---|---|
| 1 Fossil-fuel | 05, 06, 08.92, 09.10, 19, 35.2, 46.71, 47.3, 49.5 |
| 2 Utility-electricity | 35.11, 35.12, 35.13 |
| 3 Manufacturing | 07.1, 07.29, 08.9, 08.93, 08.99, 10.2, 10.41, 10.62, 10.81, 10.86, 11.01, 11.02, 11.04, 11.06, 13, 14, 15, 16.29, 17.11, 17.12, 17.24, 20.12, 20.13, 20.14, 20.15, 20.16, 20.17, 20.2, 20.42, 20.53, 20.59, 20.6, 21, 22.1, 23.1, 23.2, 23.3, 23.4, 23.5, 23.7, 23.91, 24.1, 24.2, 24.31, 24.4, 24.51, 24.53, 25.4, 25.7, 25.94, 25.99, 26, 27, 28, 32 |
| 4 Buildings | 23.6, 41.1, 41.2, 43.3, 43.9, 55, 68, 71.1 |
| 5 Transportation | 29, 30, 33.15, 33.16, 33.17, 42.1, 45, 49.1, 49.2, 49.3, 49.4, 50, 51, 52, 53, 77.1, 77.35 |
| 6 Agriculture | 01, 02, 03 |

*Explanation:* The table illustrates selected NACE codes for the first 6 CPRS Main categories. Note that when a 2-digit (or 3-digit) NACE code is indicated, it means that all 4-digit NACE codes contained in that code are mapped to the same CPRS.
Source: Battiston *et al.* (2022).

The CPRS can be applied to all types of financial assets (e.g., stocks, loans, bonds) and geographic jurisdictions, thus making possible

comparisons across investors. The CPRS is also fully in line with the EU taxonomy for sustainable activities. Moreover, the CPRS shall provide a standardised and practical classification of activities (at NACE Rev2 level, 4-digit) on which revenues may have a positive or negative impact in a disorderly low-carbon transition, based on their energy technology (e.g., based on fossil fuels or renewable energy). For this reason, the CPRS classification is considered a benchmark for assessing the financial risks associated with climate change and has been used by several international financial institutions to assess investors' exposure to climate transition risks. The use of CPRS methodology can be found in several reports, among other places.

- The European Central Bank (2019) provided in its June 2019 Financial Stability Report some preliminary estimates of financial institutions' aggregate exposures to the CPRS, relative to their total shares in debt securities, ranging from 1% for banks to around 9% for mutual funds.
- The European Insurance and Occupational Pensions Authority, (EIOPA, 2018, pp. 1-88) reported the aggregated CPRS exposures of EU insurance companies of approximately 13% of their total securities shares.
- The European Banking Authority (EBA, 2020), in its assessment of the financial risk of the banking system of December 2020, used the CPRS methodology to analyse the temporary risk associated with €2.4 trillion of EU bank loans.

According to the results of the studies by Battiston *et al*. (2022) and Alessi *et at.* (2019) for the EU countries and non-financial corporations in 2013, 2015 and 2018, based on the CPRS methodology for the equity and bond portfolio, the highest degree of the transition risk was shown by the following sectors: industry, followed by transportation and fossil fuels; electricity and buildings were exposed to the risk to a lower degree.

It is worth emphasizing that by identifying credit exposures by groups, sectors and sections (CPRS), banks can estimate their exposure to ESG risks and make decisions regarding capital requirements and reserves.

## 3. Empirical framework for Polish banking sectors

### 3.1. Data

In this study of loan portfolio exposure, the methodology developed by Battiston *et al.* (2022), that is, a mapping from the NACE codes of economic activities into Climate Policy Relevant Sectors (CPRS) and into

the variables of the process-based Integrated Assessment Models (IAM), is used by the Network for Greening the Financial System (NGFS) to provide its climate scenarios (according to Table 2) standards ISIC, NACE or NAICS and refers to a production process, e.g., electric power generation.

Data on credit exposures come from the databases of the National Bank of Poland (NBP, 2023; NBP300). The empirical analysis uses NBP reporting data, including the NBP300 database, i.e. banks' reports on loans to non-financial corporations. The time series included quarterly data for Q4 2013 to Q2 2022 (35 quarters). The Stata statistical package was used to calculate individual CPRS disaggregation's. Data descriptive statistics are provided in the Table 4-5 and Figure 1.

**Table 4: Summary Statistics, using the observations Q4 2013 – Q2 2022**

| Variable | Mean | Median | Minimum | Maximum |
|---|---|---|---|---|
| CPRR | 362.88 | 367.25 | 287.14 | 414.94 |
| Dirty | 192.21 | 195.25 | 157.88 | 212.01 |
| Black | 8.4387 | 7.5896 | 4.5084 | 15.970 |
| Brown | 79.369 | 82.194 | 58.877 | 90.414 |
| Green | 170.68 | 174.07 | 129.26 | 204.37 |
| Variable | Std. Dev. | C.V. | Skewness | Ex. kurtosis |
| CPRR | 35.563 | 0.09800 | -0.47263 | -0.94217 |
| Dirty | 13.267 | 0.06902 | -1.04640 | 0.36113 |
| Black | 3.0440 | 0.36071 | 0.97019 | 0.37596 |
| Brown | 8.9961 | 0.11335 | -0.94281 | -0.17412 |
| Green | 23.558 | 0.13802 | -0.13584 | -1.42020 |

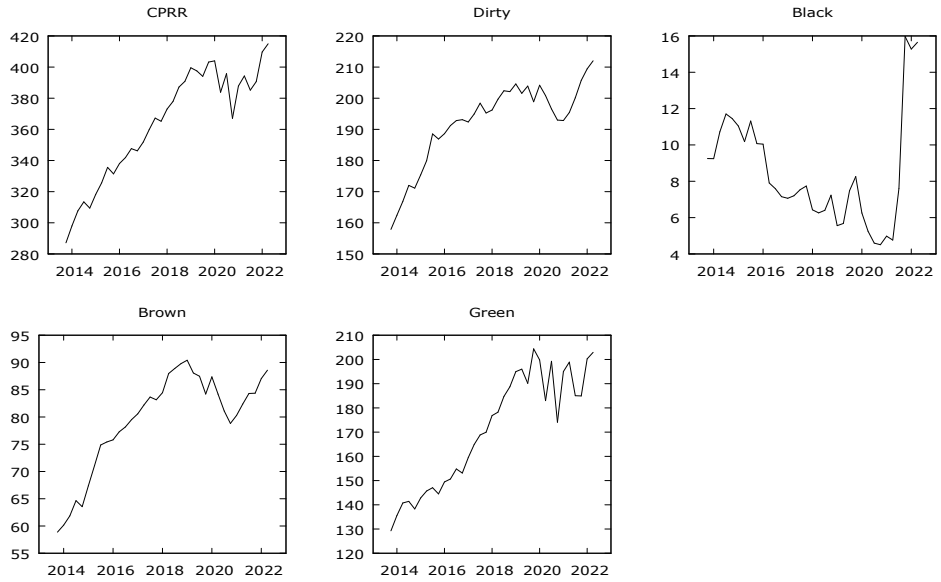
Source(s): Own calculations used StataSE 16.

**Table 5: Correlation coefficients, using the observations Q4 2013 – Q2 2022, 5% critical value (two-tailed) = 0.3338 for n = 35**

| CPRR | Dirty | Black | Brown | Green | |
|---|---|---|---|---|---|
| 1.0000 | 0.9387 | -0.2294 | 0.9316 | 0.9810 | CPRR |
| | 1.0000 | -0.1488 | 0.9754 | 0.8540 | Dirty |
| | | 1.0000 | -0.2931 | -0.2626 | Black |
| | | | 1.0000 | 0.8571 | Brown |
| | | | | 1.0000 | Green |

Source(s): Own calculations used StataSE 16.

**Figure 1. Time series data**



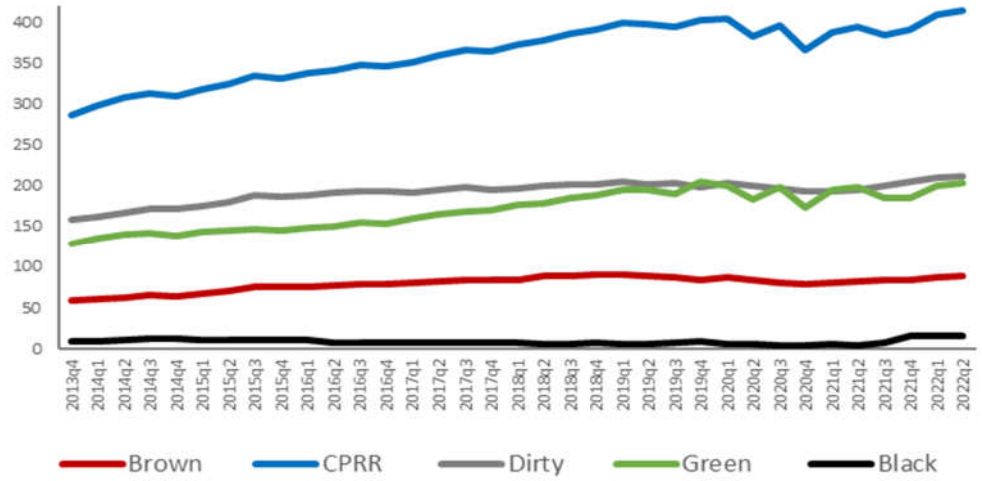

Source(s): Own calculations used StataSE 16.

### 3.2. Changes in Climate Policy Relevant Sectors (CPRS)

The total value of CPRS exposures increased from PLN 287.1 billion in 2013 to PLN 414.9 billion in 2022, i.e. by 45%. Nearly 50% of these exposures belonged to the group of the so-called dirty exhibitions, mostly including manufacturing, buildings and transportation. The value of dirty exposures in the years under review increased from PLN 157.9 billion to PLN 212.0 billion, i.e. 34%. In turn green exposures rose from PLN 129.3 billion to PLN 202.9 billion, i.e. by 57.0%, which had a positive impact on reducing the risk of transformation. The lowest exposure value (almost throughout the study years) corresponded to the group of blacks (fossil-fuels). However, in recent years, this group has shown a strong rebound after the Covid-19 pandemic and the war in Ukraine, exposures jump to nearly PLN 16.0 billion in Q2 2022.

The upward trend of CPRS (according to the notation of the function $y = 3.2232x + 304.87$) depended mainly on the increase in the trend of green exposures ($y = 2.1327x + 132.29$) and dirty exposures ($y = 1.0905x + 172.58$), with the slow decline of black exposures ($y = -0.0425x + 9.2031$) (Figure 2).

**Figure 2. The groups of CPRS credit exposures in Poland in Q4 2013- Q2 2022 (PLN billion)**

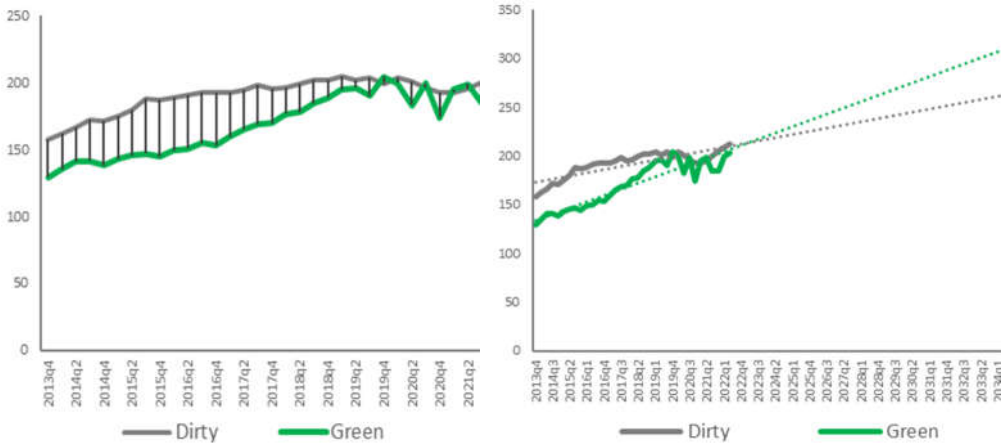



Source(s): The author's own calculations: NBP (2022), NB300 (2023).

Change trends of two key exposures: dirty and green, indicate that green exposures grew faster than dirty. Consequently, in several periods their values were equal, and in several periods the green values were higher.

If the current upward trend of green exposures is maintained ($y = 1.0905x + 172.58$, $R2 = 0.7094$), then, according to the forecast, in 2023 the share of dirty groups will exceed ($y = 2.1327x + 132.29$, $R2 = 0.8606$) (without further shocks) (Figure 3).

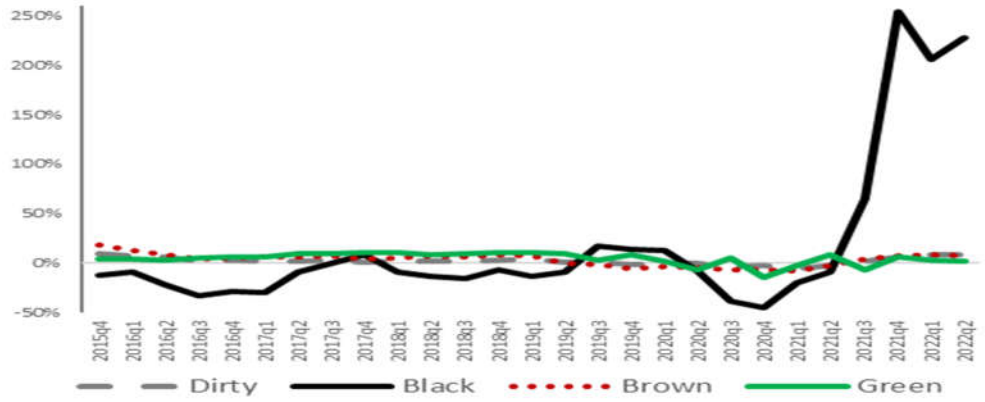
**Figure 3. Dirty and green exposures in the years Q1 2013-Q2 2022 and their forecasts for Q3 2022-Q4 2035 (PLN billion)**




Source(s): The author's own calculations: NBP (2022), NB300 (2023).

A significant increase in the dynamics of the black exposure group amounted to 254% in Q4 2021 compared to Q4 2020 (y/y; with a negative base effect related to the Covid-19 pandemic) and fell slightly, to 230%, in Q2 2022 (y/y). After the calming of the macroeconomic situation and the reduction in energy commodity prices in the global economy, a decrease in the financing of this group of black exposures and negative dynamics (2016, 2018 or 2020) should be expected. On the other hand, the dynamics of brown and dirty exposures showed relatively stable fluctuations, with a rise in the green group (Figure 4).

**Figure 4. Changes in the exposure of CPRS groups in Poland in Q4 2013 - Q2 2022 (%, y/y)**

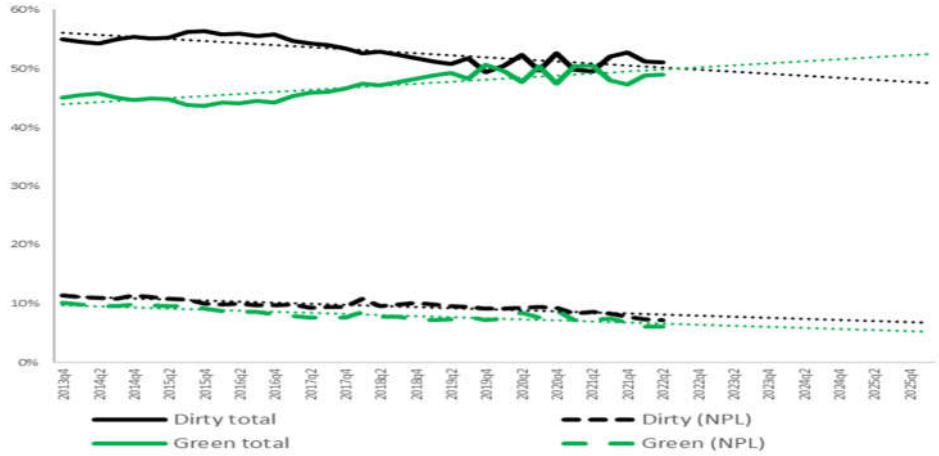



Source(s): The author's own calculations: NBP (2022), NB300 (2023).

In the years 2013-2022, dirty exposures gradually shrank (from 55% to 51%), compared to an increase in green exposures (from 45% to 49%). Their average shares in the exposures of the banking sector were 53%[4] and 47%, respectively. In contrast, the proportion of non-performing loans (NPLs) showed a slow decline from 11% to 7% and from 10% to 6%, respectively. The reduction in NPL exposure indicated an improvement in the ability to service loans, especially in the area of green exposure (a decrease by 4 pp), compared to a weaker one in dirty exposures (by 1 pp). These data therefore confirm a gradual increase in the share of green exposures against a fall in dirty exposures, with an improvement in their handling capacity. With continued growth, the share of green exposures in the banking sector may, according to the forecast ($y = 0.0017x + 0.4375$, $R2 = 0.6768$), reach a higher share than dirty exposures showing a weak but negative trend (y= $-0.0017$x + 0.5625, $R2 = 0{,}6768$) in 2023. In the case of these two exposures, but including non-performing loans (NPL), both groups showed similar downward trends (2013-2022). These changes were beneficial and showed an improvement in the quality of the banks' loan portfolio. According to the forecasts for the dirty group (NPL), the function takes the form $y = -0.009x + 0.1131$, $R2 = 0.790$, and for the green group (NPL) $y = -0.009x + 0.0982$, $R2 = 0.7462$ (Figure 5).

[4] Of course, for a clear reduction in the risk of transition, it will be necessary to achieve a clear surplus of green over dirty exposures.

**Figure 5. The share of dirty and green groups in the exposure of the banking sector in Poland in Q4 2013 - Q2 2022 (%), trends and forecasts for Q3 2022 - Q4 2035**

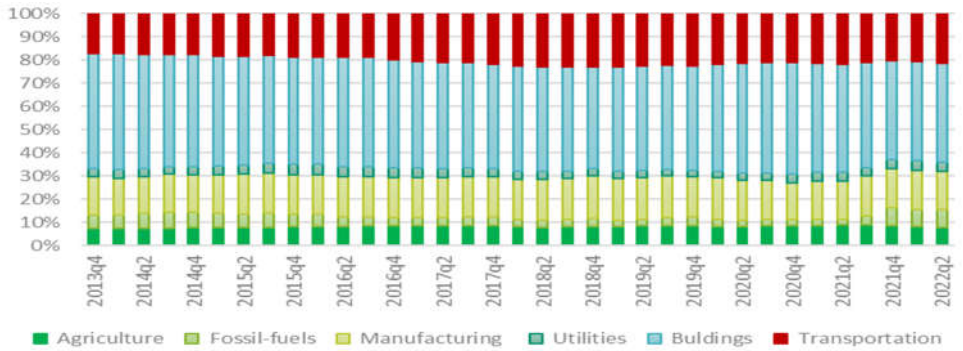



Source(s): The author's own calculations: NBP (2022), NB300 (2023).

## 4. The involvement of banks in CPRS industries

The credit exposures results of the Polish banking sector for the next degree of disaggregation, i.e. for the level of industries, prove that three industries (pillars) of CPRS, i.e. buildings, transportation and manufacturing, were of major importance in the years 2013-2022. The largest share of exposure was concentrated in the construction industry, despite its reduction by 7 pp (from 49% to 43%). The second pillar was the transportation industry, for which the exposure climbed by 4 pp (from 17% to 21%), while the third pillar of manufacturing maintained a stable share of 17% in the total CPRS (Figure 6). It is worth noting here that the three industries in Poland were also key to CPRS exposures according to the results of research for the EU countries in 2013, 201 5 and 2018 (Battiston *et al.,* 2022 and Allesi *et al.,* 2019).

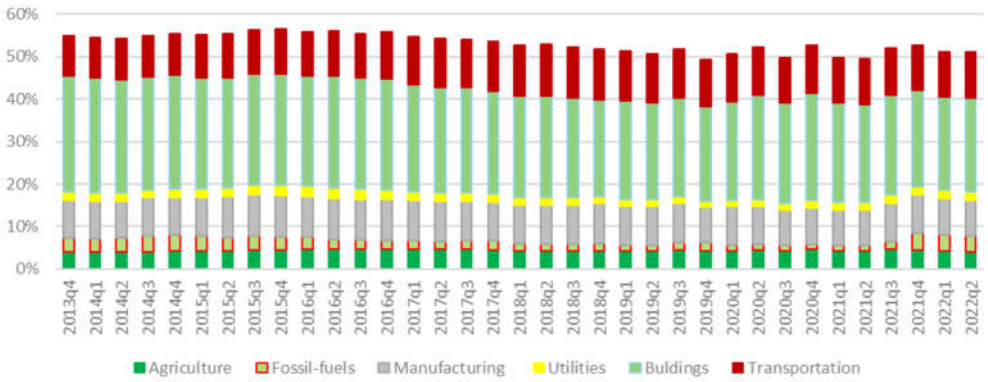
**Figure 6. Industry exposures in total CPRS exposure in Poland in Q4 2013- Q2 2022 (%)**




Source(s): The author's own calculations: NBP (2022), NB300 (2023).

Referring CPRS exposures to the exposures of the entire banking sector in Poland, it appears nearly 60% of the exposures relate to the transition risk. What this means is that the majority portfolio is sensitive to changes in ESG transformation risk and requires careful monitoring and supervision. Between 2013 and 2022, the buildings sector accounted for the largest share of this exposure, despite showing a contraction of 5 pp (from 27% to 22%), against an increase of 1 pp. in the transportation sector (from 10% to 11%) and a stable 9% share of the manufacturing sector (Figure 7).

**Figure 7. The shares of CPRS industries in the banking sector exposure in Poland in Q4 2013- Q2 2022 (%)**

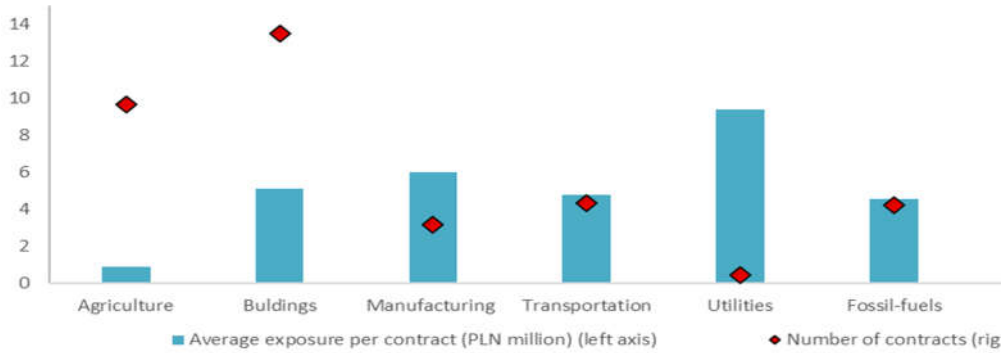



Source(s): The author's own calculations: NBP (2022), NB300 (2023).

In the analysis of ESG transition risks, their concentration is an important issue. One of the ways to identify it is the value of credit exposure for 1 contract. In Poland, the utilities (utility-electricity) industry maintained

the highest average exposure value for 1 contract in Q2 2022 (approx. PLN 9.4 million). Other unit exposures under a contract corresponded to manufacturing sector (approx. PLN 6.0 million) and buildings (approx. PLN 5 million), respectively, compared to the lowest in the agricultural sector (below PLN 1 million) (Figure 8).

**Figure 8. Average exposure by CPRS group and number of contracts for Q2 2022 (PLN million, number)**




Source(s): The author's own calculations: NBP (2022), NB300 (2023).

## 5. Concluding remarks

The use of the CPRS methodology to analyze the loan portfolio of the Polish banking sector in 2013-2022 allowed the identification of industries with a high risk of transformation. These industries turned out to be construction, transport and industrial processing, similarly to the results of Battiston et al. (2022) for market capitalization (stocks and bonds) of non-financial companies in EU countries.

Detailed results for Poland allowed us to estimate that the portfolio of credit exposures according to CPRS showed an increase of 45% in the analyzed period. The greatest increase in absolute values was recorded by dirty and green exposures, which reached comparable values in the second quarter of 2022. In the involvement of the entire banking sector in 2013-2022, the share of green groups increased (from 45% to 49%) while the dirty group decreased (from 55% to 51%). This indicates a positive trend towards the potential to reduce the risks of the transformation if it continues in the coming years. At the same time, these results confirm that in Poland there are slow changes in improving the structure of the loan portfolio in sectors important for climate policy, which are in the initial period of transformation in this area. Per loan agreement, the utility sector (electricity) is responsible for the highest concentration of exposure, which is also confirmed by EU-wide results (Battiston et al., 2022). There are connections between sectors (spillovers effects), which

indicate that three industries have a significant impact on other sections, i.e.: construction (on activities in sections C, F, I, J, K, L, M, N), transport (on activities in sections C, F, I, J, K, L, M, N), C, F, G, H, N) and industrial processing (for C and B).

**Limitations**

The limitations of assessing the impact of climate transformation on the portfolio of banks' credit exposures include: the fact that large enterprises conduct various activities, i.e. both green and dirty at the same time, which makes the classification of their liabilities in banks' portfolios difficult and e.g. limitations in access to statistical data from the financial and non-financial sectors, taking into account the impact of climate change.

**Future research areas**

Future research should address two areas. Firstly, analyzes at the level of microdata, i.e. more disaggregated data, would be important for Poland. The results of this research would allow for precise identification of which types of activities in the section/sector are responsible for the so-called green investments or, on the contrary, escalate dirty investments.

Secondly, interesting research would be analyzes of climate scenarios regarding the correct paths of climate transformation towards zero emission as well as negative paths, including difficulties with the transformation by 2030. Analyzes of the comparative results of such transformation paths for Poland and other EU countries, including the euro zone (e.g. for France, Germany) could also reveal time, area and, of course, financial differences.

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# POWER OF INNOVATION NETWORKS FOR THE ENERGY SECTOR AFTER COVID-19. A CASE STUDY OF THE ENTERPRISE EUROPE NETWORK

**Abstract**
*Innovation networks such as the Enterprise Europe Network (EEN) are an important element supporting the development of small and medium enterprises (SMEs) from various economic sec-tors. Their operations focus mainly on organizing brokerage events, business mission conferences, etc. These events are to facilitate networking, learning about new industry trends, or exchanging experiences. The global COVID-19 pandemic has significantly curbed the effectiveness of innovation networks, forcing them to look for new forms of contact. Entrepreneurs from the energy industry who have so far actively participated in events organized by the EEN have also been affected. The article analyzes the impact of EEN pandemic on the activities of the EEN and its effectiveness, focusing mainly on the quantitative aspect of the impact of the crisis. In particular, it shows how the number of events organized, their structure and the effectiveness of EEN's activities have changed, which is reflected in the number of cooperation*

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*contracts between entrepreneurs participating in the events. The paper compares the impact of the pandemic on the organization of all types of promotional events for companies in the energy industry. Furthermore, based on a case study, the article discusses the problems faced by innovation networks during the pandemic and those faced by companies in the energy industry. The results of the study clearly show a decrease in the number of events organized by innovation networks in times of crisis, but the decrease in energy-related events is not as significant as in events related to other industries. At the same time, the effectiveness of organized events increased.*

**JEL classification:** D22, O32

**Keywords:** impact of COVID-19 pandemic, innovation networks, energy promotion, EEN, efficiency

**Paper type:** Research article

## 1. Introduction

The concept of an innovation network has become a popular term for the structure of links between institutions and organizations. It is closely related to the conceptualizations of economics theories (Desmarchelier et al., 2021). In the available literature, researchers analyze in detail (Desmarchelier et al, 2020; Powell et al., 2005; Bergenholtz et al. 2011) national or regional networks of technological innovation run by commercial organizations that cooperate with public institutions (universities, research laboratories) supported by public administration. In their research, Möller and Halinen (2017) emphasized that the theory of industrial networks provides a broader picture of actors and their contribution to innovation. Research has also been carried out to understand how public-private cooperation contributes to business offering, based on research and development cooperation (Partanen et al. 2014). Other network researchers emphasize the role of nonbusiness actors in the final stage of innovation, i.e., in commercialization. Aarikka-Stenroos et al. (2017) stated that business partners outside the traditional supply chain facilitate the process of bringing innovation to the market and contribute to reducing the so-called "innovation resistance." The results of the research by Leite and Bengtson (2018) follow this trend, emphasizing that non-business actors are important primarily in social projects, because they can help companies gain public support and build trust and reputation.

Initiated in 2008, the Enterprise Europe Network (EEN) plays a special role in promoting innovation and popularizing technological cooperation. EEN aims, e.g. to improve the EU support services offered to enterprises

so that firms can access practical and effective solutions to their business needs through any contact organization (Ferraro, Iovanella, 2017). Thus, the Enterprise Europe Network offers a wide range of services to European SMEs. EEN provides entrepreneurs with the free use of support instruments in international cooperation, resulting in the finalization of technology transfer Kotulewicz-Wisińska, Gródek-Szostak, 2021). The network centers are run by diverse organizations supporting economic development, e.g., chambers of commerce and industry, regional development agencies, business support centers and technology transfer centers (Gródek-Szostak et al., 2017). The main goal of EEN is to offer comprehensive services to SMEs to increase their potential and innovative capacity. Its services are standardized and provided by qualified consultants in accordance with the code of conduct. The structure of EEN services includes three main areas of business development support: international partnerships, international growth and expansion consulting, and business innovation support.

With the detection of the SARS-CoV-2 coronavirus in late 2019 (Zhu et al. 2019;Kuckertz et al. 2020; Kraus et al. 2020; Al-Awadhi et al. 2020) and subsequent development of the COVID-19 pandemic (JHCRC, 2020), societies, economies and global inter-organizational networks experienced an unprecedented exogenous shock (GDA, 2020). In addition to the humanitarian tragedy, the COVID-19 pandemic has also had an increasing impact on local economies and the global economy. Concerns regarding the unpredictable effects of COVID-19 have already had a significant impact on the world's largest economies, and many economists are now predicting a recession (GDA, 2020). A crisis such as the COVID-19 pandemic has threatened not only the operations and efficiency of individual enterprises, but also inter-organizational networks and connections (Boin, 2009; Comfort, 2002; Williams, Vorley, 2015). Turbulence in business could result from disrupted structures, procedures, and opportunities (Williams et al. 2017). The authors of crisis research offer diverse views on the impact of this on the business environment. Some of them, such as Filippetti and Archibugi (2011) claim that crises have a negative impact on the innovative activity of economic organizations. Brem et.al (2020), who explained how the 2008 financial crisis hampered new, dominant projects following innovation, were of a similar opinion, as were Dachs and Peters (2020), who proved that the crisis caused by the COVID-19 pandemic, like other crises, curbs innovation in organizations.

At the same time, a second group of researchers believes that crises have the potential of new challenges, i.e., meeting new needs with innovation (Archibugi et al., 2013). Furthermore, innovation developed by innovation networks becomes the main driving force behind the success of an organization, especially in the aftermath of economic crises

(Devece, 2016; Naidoo, 2010). The activities of innovation networks that correspond to the determinants of the external environment can significantly contribute to the reconstruction of the innovative and competitive potential of enterprises to mitigate the crises (Hausman, Johnston, 2014). In the COVID-19 crisis, it is important not only to protect the key activities that determine the company's value, but also its knowledge base, technological facilities or access to network resources promoting innovative solutions (Zouaghi et al., 2018).

The COVID-19 pandemic caused changes in the business environment, posing new challenges to enterprises. Thus, it changed their priorities and needs. In response to new challenges, such as broken supply chains, an urgent need to find new customers and new sources of financing, creating new business plans, as well as a sudden transition from office work to home office, the Enterprise Europe Network (EEN) has taken certain steps to support business.

The fact that researchers rarely analyze the activity of innovation networks, which in turn causes a significant publication gap in this area, motivated the authors to work on the manuscript. This could also be due to the lack of access to detailed data that describe the activities of specific innovation networks. In particular, the authors of this manuscript did not identify any studies on the analysis of the impact of the COVID-19 pandemic on the effectiveness of innovation networks. The analysis of EEN is particularly relevant, due to its contribution to the promotion of innovative technologies, especially renewable energy technologies and environmental responsibility. The network's promotional activities aim to increase the efficiency of the energy sector and the number of innovations in the energy sector by developing smart energy, as well as to reduce the level of pollutant emissions generated by electro-energy operators.

The COVID-19 pandemic severely affected the environment (Facciola et al., 2021), as reported by a several authors, in different contexts, e.g., on the impact of plastic pollution during COVID-19 (Shams et al., 2021), and the impact of the COVID-19 crisis on the progress of Sustainable Development Goals (SDGs) (Fulzele et al., 2021). The research conducted by these authors showed that the pandemic has bot negative as well as positive impact on the SDGs. Other authors such as Pirasteh-Anosheha et al. (2021) analyzed the negative impacts of a pandemics on the environment, society and economy, with an emphasis on COVID-19, and showed that haloculture is an essential system, accelerated in the agricultural sector by COVID-19.

However, there is a lack of research and publications on the impact of the COVID-19 pandemic on the effectiveness of innovation networks. Therefore, this aim of the article is to present the limitations and problems for the operation of innovation networks resulting from the outbreak of the

COVID-19 pandemic and to present how they dealt with the aftermath of the crisis. In particular, statistical data on the number and structure of events organized globally were presented, as exemplified by the EEN network, with particular emphasis on the changes resulting from the COVID-19 pandemic. The analyzes included events for all sectors, with a focus on and analysis of those related to the energy sector.

The structure of the article is as follows: the next section describes the methods and data used in the research. Additionally, research questions were formulated. Then, the results obtained were described and discussed. The last part, which contains conclusions, limitations, and recommendations, summarizes the article.

## 2. Materials and Methods

The analysis in question was carried out by using an empirical study of an innovation broker network, i.e. the Enterprise Europe Network (EEN). The Enterprise Eu-rope Network helps enterprises to innovate and enter international markets. It is the world's largest support network for SMEs, which have ambitions to expand internationally. The network operates in over 60 countries around the world. It brings together 3,000 experts from over 600 member organizations who are renowned for their excellent business support (EEN, 2021).

The research was carried out in two stages. In the first stage, a statistical analysis of the number and type of events organized by the EEN was carried out. Statistical and visual analysis of the instruments that promote innovative technologies was carried out based on data obtained from EEN for the years 2016-2020. Their database of pro-motional events contains over 4,200 records, of which over 800 (i.e. approximately 20% events) was related to all types of energy. Each record contains detailed information on the organized events: the type of event, categorized as: brokerage event (BE), company mission (CE), conference/seminar/information day (C/S/ID), sector group meeting (SGM) and workshops (W) (35.Gródek-Szostak et al., 2020), place, form (on-site or remote), number of meetings as part of the event, and the number of cooperation projects launched.

In the second stage, the most important problems EEN faced during the COVID-19 crisis and methods of adapting the network's activities to the current situation were presented based on an interview with EEN employees and using the case study method (Yin, 2009). The article presents the following research questions:

Q1: The number of events organized by innovation networks has decreased significantly over the course of the epidemic, regardless of the location of the event. This decrease also applies to promotional events related to the promotion of energy technologies.

Q2: The structure of the events organized in 2020 has changed significantly compared to previous events both general events and those promoting energy technologies.

Q3: The average effectiveness of individual events increased, i.e., the average number of formalized partnerships per one meeting increased.

Q4: Online events have become an alternative to traditional events.

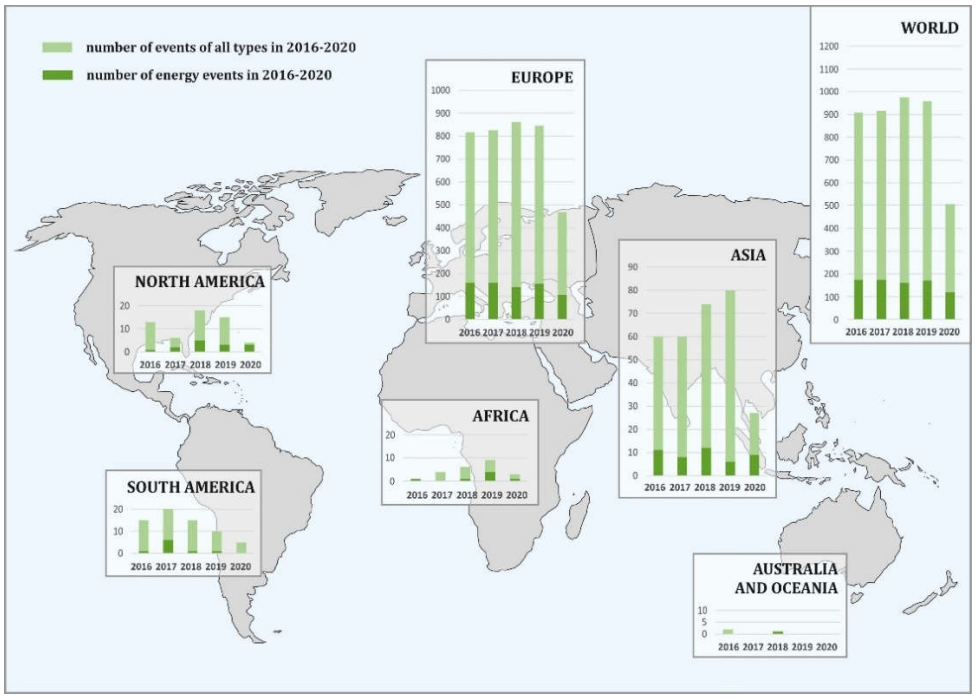
## 3. Results and Discussion

This part of the article presents the results of a two-stage research and analysis of the activities of the EEN network in 2020, i.e. in the period when the COVID-19 epidemic began. The first stage is a statistical analysis involving elements of graphical presentation, in which the changes that took place in the network's activities in 2020 were compared to the previous four years. The analysis included events related to all industries and highlighted those related to the energy industry. There was also a comparative analysis of changes in the global network activity and that sphere that concerned energy aspects. The second part presents conclusions from an interview with EEN employees who organize events and monitor all network activities related to supporting the SMEs associated with the network, especially those related to the energy industry.

The first element of the statistical analysis of the data and their graphical presentation was the analysis of the change in the number of events in selected years.

Figure 1 shows the number of events organized by the EEN in 2016-2020. Charts presenting changes in the annual number of events have been drawn up, both globally, and broken down by continent. In addition, the events during which the meetings were held were listed.

**Figure 1. Change in the number of promotional events organized by EEN in 2016-2020 listing events related to the energy industry.**

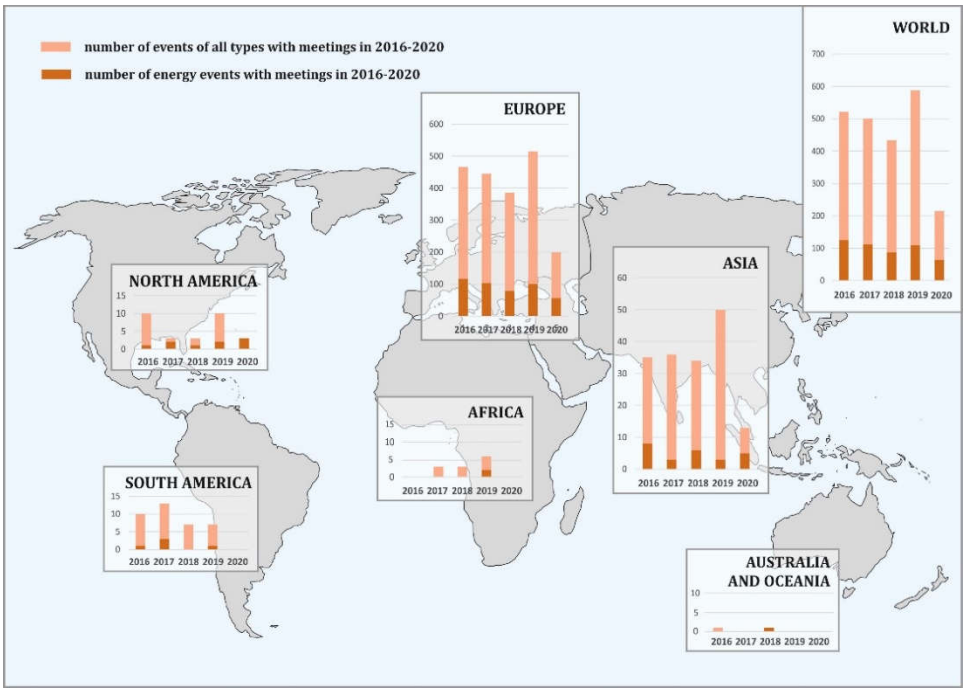



As observed, in the period under consideration, the vast majority of events were organized in Europe (an average of 90% of events a year). There are fewer of them in Asian countries (an average of 7% per year). Only a few to a dozen or so events took place on other continents each year. In 2016-2019, the differences in the annual number of events organized by the EEN network were slight, the average was 940. In 2020, i.e. during the COVID-19 pandemic, a sharp decrease in the number of events was recorded, clearly visible both in the chart relating to the world and in those presenting the number of events organized in Europe and Asia. In Europe, out of approximately 800 meetings on average organized annually in 2016-2019, there were just over 400 in 2020 (a decrease of nearly 50%). In Asia, on the other hand, the decline was relatively greater. Here, EEN organized approximately 80 events annually before the pandemic; in 2020, there were only 30 of them. In 2020, a total of 507 promotional events took place worldwide, which is only 54% of the average annual number of events in the previous four years.

The second part of Fig. 1 presents the dynamics of the change in the annual number of energy-related events compared to the annual change in the number of all events organized by the EEN between 2016 and 2020.

A clear decrease in the number of energy events in 2020 compared to previous years can be observed in the graph referring to the world and to Europe. As can be seen in the bar charts for the other continents, energy-related events outside Europe were sporadic and their annual number ranged from zero to no more than a dozen (depending on the year and the continent). Conclusions regarding the impact of the pandemic on the number of energy-related events should therefore be based primarily on data relating to the world as a whole, and to Europe. The number of all such events in 2020 was 120 which is 70% of the 2016-2019 average. In European countries, the number of such events in 2020 decreased by about 26% compared to the average of the previous four years (107 events in 2020 compared to an average of 145 events annually in previous years). These results, as well as the bar charts in the second part of Fig. 1 clearly show that although the number of energy industry events decreased significantly during the pandemic period, the decrease was not as strong as the overall decrease in the number of all EEN events.

**Figure 2. Change in the number of promotional events (witch meetings) organized by EEN in 2016-2020 listing events related to the energy industry.**



Similar drops are visible in the charts showing the annual number of events with meetings in 2020. In 2016-2019, the number of such meetings worldwide ranged from 434 in 2018 to 588 in 2019 and represented an average of 55% of all events organized by ENN in a given year. However, in 2020 only 215 evens took place, which was 42% of the total number. The vast majority of them were organized in Europe (199).

A comparison of the change in the annual number of events with meetings be-tween all event types and those related to the energy industry is presented in Fig. 2. In 2020, there were 64 energy-related events with meetings (53% of the total). In the previous four years, the number averaged 109 (63%). Again, a significant decrease is evident in 2020. The bar charts in Fig. 2 show, however, that in energy-related events the trend is weaker than in the group of all events organized by the EEN. However, it is clearly visible only in the graphs relating to the world and to Europe, which is due to the fact that each year approximately 90% of the events took place in European countries.

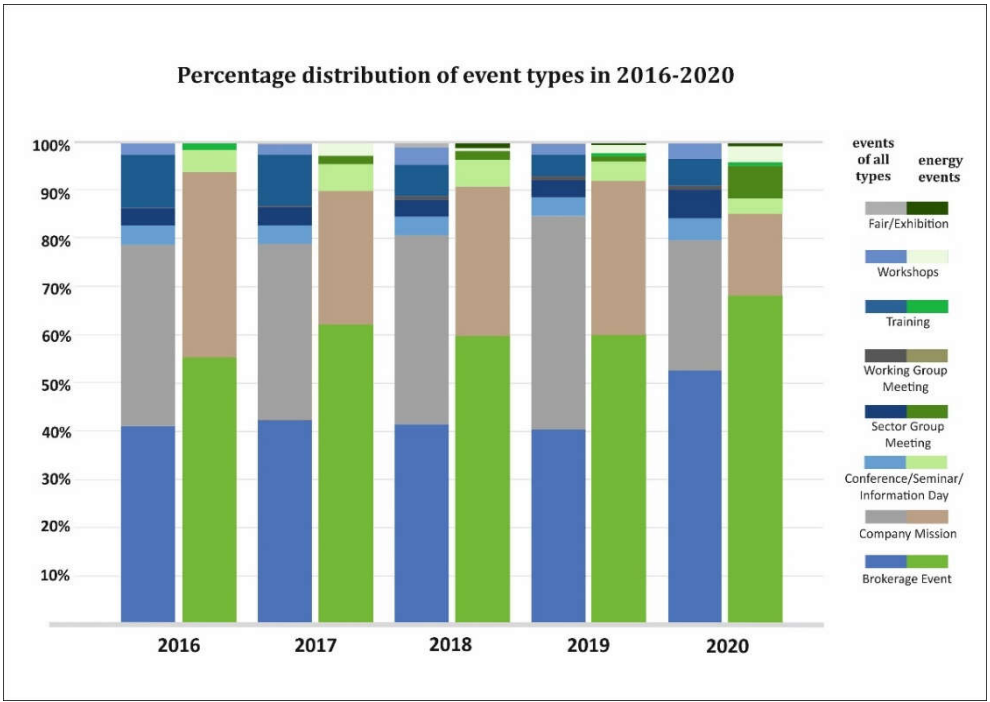
In summary, the data in Figures 1 and 2 clearly show that the outbreak of the COVID-19 pandemic contributed to a significant decrease in the number of events organized by the EEN network, and to a decrease in the percentage of events which included meetings. However, please note that the decrease in the number of energy-related events was relatively lower than in the total of all events. Thus, the answer to research question Q1 is partially confirmed positive.

As it turns out, the pandemic not only affected the number of events, but also slightly changed the structure of the types of these events worldwide. Fig. 3 presents the cumulative distribution of the types of promotional events organized by EEN in subsequent years, from 2016 to 2020, with a particular focus only on events organized for the energy industry. The charts show that in the years 2016 to 2019, the number of brokerage events (BE) and company missions (CM) was similar and each of them rep-resented approximately 40% of all events. The year 2020 brought a slight change in this structure and this year the majority of events (i.e. over 50%) were BE, while CM accounted for approximately 28%.

Upon analyzing the graph depicting the structure of event types from the energy industry, we see that it differs from the structure observed for a total of events organized by the ENN. Each year, there was a clear predominance of brokerage events, and there were significantly fewer company missions. Other types of events were organized only occasionally. Nevertheless, also in this specified group a clear decrease in the percentage share of company missions in the total number of events is observable in 2020 (17% in 2020 against an average of 32% in 2016-2019) with a simultaneous in-crease in the share of brokerage events (from an average of 59% in the previous four years to 68%).

This change can result from the fact that the EEN has found new ways to connect companies. At the start of the crisis, network partners have set up helplines to support SMEs; most of the callers expressed concerns about liquidity and measures to limit job losses. EEN collected, updated and provided information on measures and/or regional, national, and European institutions supporting SMEs. Also, most of the events organized by EEN have been changed to the online formula, e.g., online customer meetings, or brokerage meetings. The network has launched a special so-called "fast track" of publication of technological profiles related to COVID-19, i.e. disinfectants, medications, masks, etc. These offers were promoted to the maximum in the network to find a partner as soon as possible and help combat the global pandemic. The above conclusions confirm the positive answer to question Q2.

**Figure 3. Cumulative distribution of all events by type in 2016-2020.**




Since every year most of the events organized by the EEN take place in the countries of Europe and Asia (cf. Figure 1 and 2), the impact of the COVID-19 pandemic on the number of events that took place in 2020 in individual countries of these two continents was examined in detail. For this purpose, the average annual number of events in a given country in 2016-2019 was compared with the number of events held there in 2020.

Individual countries in Europe have been divided into four groups. The first three are countries in which a decrease in the number of events was recorded, compared to the average for the previous four years by, respectively: less than 25%, from 25% to 50% and more than 50%. The last group includes countries in which the number of events in 2020 was greater than the 2016-2019 average. The results of the analysis are presented in Figures 3 and 4.

**Figure 4. Map of changes in the number of all promotional events in individual European countries (2020 compared to the average for 2016-2019).**

**Figure 5. Map of changes in the number of energy promotional events in individual European countries (2020 compared to the average for 2016-2019).**


As observed, in the vast majority of 46 European countries included in the study (cf. Fig. 4), in 2020 there was a decrease in the number of events compared to the average for the previous years. At the same time, 21 countries recorded a decrease of more than 50%. In 17 countries, including Poland, the reduction in the number of events ranges from 25% to 50%, and in five countries it did not exceed 25%. Figure 3 shows that only three European countries: Norway, Switzerland and Ukraine saw an increase in the number of events organized by the EEN in 2020 compared to the aver-age of the previous four years. In generalizing the results of the analysis of the impact of the COVID-19 pandemic on the number of events organized in Europe, it should be stated that in most European countries the outbreak of the pandemic contributed to a significant reduction in the number of events in question. This result is understandable because 2020 was a time of widespread isolation, resulting both from the ubiquitous fear of disease and the lockdowns introduced in many countries. For many people, it forced a radical limitation of social contacts, also changing the way of working to home office-based. Thus, the EEN's possibility of organizing on-site events was severe-ly limited in the first year of the

pandemic. In turn, the increase in the number of events compared to previous years in a few selected countries was the result of the fact that these events took place earlier that year, when there were no restrictions in Eu-rope. Additionally, some of them were organized online.

Fig. 5, comparing the number of energy-related events with the average annual number of such events in a given European country in 2016-2019, differs significantly from the previous figure. It can be observed that in up to 13 of the 43 European countries considered (30%), the number of energy events in 2020 was not less than the 2016-2019 average. However, in the remaining countries, there was a decrease in the number of events in 2020 compared to the previous years' average, and in almost half of them (21 out of 43) it was greater than 50%. Upon juxtaposing Figs. 4 and 5, we can therefore conclude that the negative impact of the COVID-19 pandemic on the number of events organized by ENN in European countries is evident both overall and in the group of events related to the energy industry. Nevertheless, the impact is weaker than average for this particular group of events.

Therefore, this analysis largely confirms the positive response to Q1 regarding the decrease in the number of events not only globally but also locally, but this is true mainly for global events. For events related to the energy industry, the decrease is not so clear-cut, with a large variation for European countries. This fact can be associated with differences resulting from the policy of governments of individual countries in combatting the pandemics. The inability to organize promotional events on-site encouraged entrepreneurs to search for other forms of contact. One solution was to organize online meetings by the EEN. As shown in the graph in Table 1, while in 2016-2020 the percentage share of online events in the total number of events con-ducted by EEN was 0% in 2019, in 2020 it amounted to as much as 40%. It turned out that more than 200 online meetings were held in 2020. An even more pronounced in-crease in the demand for online events can be observed in the group of events related to the energy industry. While in 2017-2019 all events of this kind were held on-site, in 2020 as many as 59% of them (71 out of 120) were held online. These data clearly confirm the positive response to question Q4.

**Table 1. Percentage share of online events in all events and energy events organized between 2016 and 2020.**

| | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|
| **all type of events** | 4% | 3% | 1% | 0% | 40% |
| **energy events** | 2% | 0% | 0% | 0% | 59% |

Source: own elaboration

The number of promotional events to be organized by the EEN is of course an important element that could affect the effective operation of the organization, as its main goal is to facilitate international technological cooperation of businesses. Reducing the number of events certainly hampers the achievement of this goal. However, the effectiveness of EEN's operation is demonstrated not only by the number of events organized but also by the number of cooperation projects initiated during these events. Table 2 contains information on the number of cooperation projects initiated during meetings in the years 2016-2020, broken down by continent and in total for the entire world, to verify whether the pandemic affected the initiation of cooperation by organizations participating in organized events.

**Table 2. Number of cooperation projects initiated during meetings in 2016-2020 on individual continents (events related to the promotion of energy technologies are given in brackets).**

| | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| **Europe** | 16340 (4898) | 15021 (4769) | 9863 (2324) | 15343 (3941) | 9046 (2821) |
| **Asia** | 843 (416) | 1016 (29) | 337 (37) | 399 (121) | 460 0 |
| **Africa** | 0 0 | 32 0 | 110 0 | 22 (11) | 0 0 |
| **North America** | 134 (36) | 92 (87) | 98 (12) | 224 (99) | 24 (24) |
| **South America** | 132 (71) | 170 (81) | 25 (0) | 95 (25) | 0 0 |
| **Australia and Oceania** | 0 (0) | 0 (0) | 11 (0) | 0 (0) | 0 (0) |
| **TOTAL** | 17449 (5421) | 16331 (4966) | 10444 (2384) | 16083 (4197) | 9530 (2845) |

Source: own elaboration

The table above shows that in 2020 the number of cooperation contracts decreased by approximately 40% -45% compared to 2019, 2017 and 2016. However, compared to 2018, this change is not so significant (a decrease of approximately 9%). The data in Table 1 show that the decrease in the total number of cooperation projects undertaken in 2020 was mainly due to the reduction in cooperation projects following the events organized in Europe (in 2019 there were approximately 1.5 times more of them than in 2020). In turn, in Asia, the number of cooperation projects undertaken in 2020 was higher than in the previous two years.

In the group of events related to the energy industry, in 2020 a decrease in the number of collaboration projects can be observed compared to 2016, 2017 and 2019 (by 48%, 43% and 32% respectively). Compared to 2018, however, an increase is visible (by 19%). This is due to a higher number of collaboration projects undertaken after events organized in European countries and in North American countries than in 2018. After five events with a nonzero number of meetings held in Asia, no collaboration projects were undertaken in 2020. Meanwhile, in previous years, just a few energy industry events held annually in Asian countries resulted in dozens to hundreds of collaboration projects.

However, based on the above data, no conclusions can be drawn with respect to the negative impact of COVID-19 on the operation of the EEN. In 2020, a sharp decrease in the total number of events organized by the EEN was observed, by approximately 50% (30% for energy sector events) compared to the four previous years (cf. analysis of Figure 1), which naturally resulted in a decrease in initiated cooperation projects.

Therefore, reliable information on the effectiveness of the organized events can only be established by analyzing the average number of cooperation projects initiated per one event. Such data, broken down by continents, are presented in Table 3. A significant drop in the efficiency of events in terms of initiated cooperation projects can be observed in events that took place in North America. No cooperation was initiated following the three events that took place in 2020 in African countries and the five events organized in South American countries. However, taking into account all events jointly, as well as considering separately the events in Europe and Asia (accounting for a total of approximately 97% of all events), it should be stated that in 2020 the efficiency, measured by the average number of cooperation projects undertaken per one event, increased significantly compared to previous years. When analyzing the events organized in Europe, it can be observed that this number amounted to approximately 45 in 2020, while in the previous years it ranged from less than 26 (in 2018) to approximately 35 (in 2016). An even greater increase is visible in the case of Asian events. The average number of cooperation projects initiated per event was approximately 35 in 2020 and was twice as high as the average for 2016-2020.

An analysis of the average number of collaboration projects per event dedicated to the energy industry shows that in 2020, the increase in effectiveness of this type of event was observed only for 56 events organized in Europe. The average number of collaboration projects was approximately 50 compared to an average of 39 in the previous four years. Interestingly, the other 8 events held in 2020 showed a decrease in the average number of collaboration projects. As already noted when discussing the data in Table 2, no collaboration projects were carried out

following the five events held in Asian countries. After the three events held in North America, the average number of collaboration projects was only 8, while the year before the two meetings on the continent had resulted in an average of approximately 50 projects. Energy-related events held outside of Europe should therefore be considered exceptions to the observed rule of increased effectiveness of events, as measured by the average number of collaboration projects in 2020 compared to previous years.

Such an increase in the effectiveness of the events could be related to the fact that access to events is more difficult. Not only is the number of events lower, but participation in an event taking place on-site carries the risk of contracting the virus. Therefore, this result can be interpreted as follows: people who decided to participate in an event organized by the EEN during the pandemic despite various difficulties were adequately motivated to do so. It can therefore be understood that they were much more interested in cooperation with the EEN than participants of the meetings organized in previous years. On the basis of the above discussion and analysis, it is clear that the answer to question Q3 is fully confirmed.

**Table 3. Average number of cooperation projects initiated per event with at least one meeting (events related to the promotion of energy technologies are given in brackets).**

| | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| **Europe** | 35.06 (42.22) | 33.68 (45.86) | 25.55 (29.42) | 29.79 (40.33) | 45.46 (50.38) |
| **Asia** | 24.09 (52.00) | 28.22 (9.67) | 9.91 (6.17) | 7.98 (40.33) | 35.38 - |
| **Africa** | 0.00 - | 10.67 - | 36.67 - | 3.67 (5.50) | 0.00 - |
| **North America** | 13.40 (36.00) | 30.67 (43.50) | 32.67 (12.00) | 22.40 (49.50) | 8.00 (8.00) |
| **South America** | 13.20 (71.00) | 13.08 (27.00) | 3.57 (0.00) | 13.57 (25.00) | 0.00 - |
| **Australia and Oceania** | 0.00 - | 0.00 - | 11.00 (11.00) | 0.00 - | 0.00 - |
| **TOTAL** | 33.43 (43.02) | 32.60 (44.34) | 24.06 (27.40) | 27.35 (38.50) | 44.33 (44.45) |

Source: own elaboration

Meeting the current needs of the participants and customers of an innovation network is possible thanks to the flexibility that characterizes the Enterprise Europe Network project, in which rigid compliance to the previously scheduled events is not necessary. This allows for dynamic

adaptation of the offer to the needs and requirements of the market and the current economic situation. This also allows training, BEs, or information meetings to be organized when they are needed. This flexibility allowed the entire network to offer the SME sector a number of webinars and information meetings. It also allowed responding to the need for information and advisory services in terms of subsidies, the so-called 'anticrisis shields', as well as the business challenges of the COVID-19 pandemic last year.

The first need reported by EEN clients was related to the legal and organizational aspects of running a business on international markets. The centers of the network offered free expert consultation on legal and procedural issues that were to secure business or limit the negative effects of COVID-19. The network also enhanced its activities and developed a training offer in securing foreign markets and developing export in a crisis.

In the interviews, EEN employees as well as customers pointed to the solutions introduced during the pandemic:

1. "*Due to the specific needs of the medical market that emerged during the pandemic, the network launched an international platform for enterprises, healthcare providers and state institutions*." (EEN consultant).

Care & Industry together against CORONA offers targeted and effective contacts with all actors in the healthcare, industry, academia and government sectors. Interested parties can submit their offers, orders, and demand via an internet platform.

2. *"For me, a client of the EEN, a very important element of a trade fair is participation in brokerage meetings. The pandemic has significantly changed the market of fairs and exhibitions, and brokerage meetings have been moved into the online channel. I believe this is a very good solution because I can participate in a brokerage meeting and at the same time the online participation saves time and money, making access to the meetings easier."* (Entrepreneur).

Among the various ways of reaching foreign audience, brokerage meetings play a special role. Meetings are initiated during international industry events, both in Poland and abroad. Its participants have a unique opportunity for direct contact with potential business partners: not only presenting their offer, but identify their expectations and establishing lasting business relationships. Such meetings are often the beginning of a long-lasting and fruitful cooperation. The catalog of brokerage meetings is constantly updated and published on EEN websites.

3. *"I operate in international markets and the collision with the COVID -19 pandemic was a real shock for me as an entrepreneur, as well as for my business. Scheduled participation in fair and ongoing*

*negotiations with technological partners and all the efforts made over the years were jeopardized. The support of the EEN network allowed me to find solutions to a seemingly unsolvable situation. During the COVID-19 pandemic, I chose to work with various business partners from geographically different markets."* (Entrepreneur).

Establishing cooperation with other external partners, including business customers and competitors, has allowed SMEs to create an effective process to create innovation, which positively impacts coping with the effects of the COVID-19 crisis. This quick response to market and business environment changes was possible due to the high flexibility of SMEs, due to their simple structures and small sizes (Bigliardi, Galati 2016; Koporcic, Törnroos 2019).

Many companies during the COVID-19 pandemic switched to remote work in a wide variety of areas. This is confirmed by the statements of our respondents below. The first area mentioned is the change in meeting mode from onsite to online.

1. *The crisis has cut down on unnecessary travel; many company meetings that used to be held on-site have been replaced by online meetings.* (Entrepreneur 1)
2. *We handled the crisis very well because we had already worked on the on-line system (i.e. the meetings and training platform). In our case, the crisis accelerated the implementation of these solutions.* (Entrepreneur 2)
3. *This crisis revealed new solutions; for example, we started organizing online meetings.* (Entrepreneur 3)

The second area implemented in the online paradigm is remote work.

4. *If someone had people at risk at home, we tried to organize their work in such a way that they could work on-line (although it was not easy because we are a service company)* (Entrepreneur 4)
5. *We organized online work for our office staff* (Entrepreneur 5)

The third area implemented in the online paradigm is training.

6. *In the midst of the crisis, we included on-line training in our offer. We have built an entire system to support on-line training* (Entrepreneur 6)
7. *We have tried online training*. (Entrepreneur 1)

The fourth area is related to changing the business model.

8. *The crisis changed our sales model. Online sales were twice as high as the previous year.* (Entrepreneur 7)
9. *We switched the company to online in 5 days; it required our trainers and clients to undergo a drastic change. This change saved us, as it slowed down the decrease in number of orders*. (Entrepreneur 6)

10. *We introduced a virtual showroom, in which a salesperson can tour the customer online*. (Entrepreneur 5)
11. *We have gone online when it comes to administration and management.* (Entrepreneur 7)

As can be seen from the above examples, remote work yielded environmental benefits, such as less environmental pollution due to lower fuel consumption and decreased traffic in cities, as well as time savings for commuters. For entrepreneurs, it has reduced business costs associated with renting office space and parking, but has not contributed to overall lower energy consumption. Home-office work increased household energy consumption. Employees often appealed to their employers for a remote work allowance to compensate for the additional power costs incurred. As a result, employer cost increased costs.

In conclusion, the crisis caused by the COVID-19 pandemic positively impacted a number of environmental issues mentioned, but had no impact on the economic situation of companies in the energy sector in the operational perspective. On the other hand, when considering the impact of COVID-19 in strategic terms, it can be presumed that the decrease in the number of meetings in which energy market stakeholders could discuss plans for the development of the sector could have a negative impact on the development of energy companies in the future.

Based on the research results conducted and presented, it can be concluded that the network coped perfectly with the increase in online activities at the expense of on-site activities. The form of online meetings was appealing and attracted the interest of companies which held business meetings online, in private online „rooms", and dis-cussed the potential cooperation. The effectiveness of online meetings was similar to that of on-site meetings. Now the EEN is slowly returning to face-to-face meetings. At the moment the hybrid form is proposed, i.e. participation in on-site fairs and at the same time connecting with the participants online.

## 4. Conclusions

The COVID-19 pandemic and numerous restrictions in economies around the world have created a unique situation that has no documented equivalent in the literature on entrepreneurship and innovation networks. However, the literature review provided a series of studies on entrepreneurship, networking, and crisis management (Williams, Vorley 2015; 41.Williams et al., 2017) that present two research currents. The first of them can be called crisis management in the organization. It relates to the response of companies to the crisis. and much of the research concerns resilience (Doern, 2016). The second current suggests what policies can support an organization's survival during a crisis (Barreiro-Gen 2020) and identifies

the barriers. It can support policymakers in developing appropriate intervention tools.

Unfortunately, preparation is needed to deal with the crisis well, and few innovation networks (Al Omoush, 2020) were prepared for a crisis the size of the COVID-19 pandemic. The limited amount of research available on entrepreneurial resilience, innovation networks and crises focuses mainly on the precrisis period and on the skills or re-sources that entrepreneurs and organizations accumulate to resist or adapt to crisis events. In general, the character of innovation networks should enable them to be better prepared to deal with the COVID-19 crisis than other organizations. Being a member of an innovation network is a prerequisite for resilience, as innovative actors tend to constantly anticipate and adapt to a wide range of crises. However, innovation organizations and networks are not always aware of the real threat posed by a potential crisis event.

In a turbulent environment, contemporary organizations and interorganizational networks need to monitor trends and skillfully use digital opportunities. Al Omoush (2020) lists the level of proactivity of the top management as one of the main organizational resources that support the role of online business in creating the organization's future survival strategy. Quickly grasping opportunities, spotting obstacles, organizing resources and creating innovation is a powerful engine of organizational resilience in a dynamic environment

COVID-19 has shown that the flexibility of innovation networks, and their ability to quickly implement IT solutions, is an effective approach to support the technological development of SMEs to generate appropriate innovations to overcome the negative effects of the pandemic. In the third decade of the 21st century, the world has faced an unprecedented situation that requires additional analysis and efforts in all areas of innovative activity of the EEN.

Furthermore, during the pandemic crisis, EEN has reinforced the collaborative mindset of SMEs, triggered by a “common cause” that relates to technological development. Maciel and Fischer (2020) argue that it is the “common cause” that usually drives a collaborative mindset. In the literature on the subject, there is a lot of evidence showing the response of organizations to critical crisis situations (Alesi, 2008). This article contributed to a comprehensive and evidence-based analysis of the actual responses of a business network in the face of a pandemic. Please note that the COVID-19 pan-demic has encouraged a new look at business networks and management to foster survival in the turbulent conditions of the epidemic (Kraus et al., 2020). What is more, the cross-network, innovative business cooperation has great potential for its participants to face the challenges resulting from the global pandemic.

In conclusion, it can be stated that the analyses conducted in this paper based on statistical studies of the number and effectiveness of meetings, as well as interviews with EEN network staff and participants, have partially confirmed the initial assumptions contained in the research question. First, the COVID-19 pandemic had a significant impact on innovation network activities in general (for events related to all sec-tors and industries). This impact was confirmed mainly by the drastic changes in the number of events organized by these networks. However, the analysis of the number of events dedicated to the energy industry does not provide such clear results anymore. Although globally there was a noticeable decrease in the number of events, it was not as drastic as in the overall picture. In particular, there is a large disparity in this respect for individual countries. This demonstrates the strong determination of players in the energy industry and the fact that this industry is crucial for many economies. In turn, the results of efficiency studies show a greater awareness and involvement of participants in promotional events in general for all industries as well as for the energy sector.

The main limitation of our research is the fact that the analyzed data relate only to one innovation network, the EEN. The analysis also lacks data on the types and effectiveness of EEN's activities in 2021. These data would allow us to determine how the network dealt with the crisis in the long run. For this purpose, research work has been planned, to include the analysis of EEN's effectiveness when data for the year 2021 are collected.

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