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ENTERPRISE RESILIENCE ASSESSMENT – AN OVERVIEW OF MODELS

Introduction

Research on the enterprise resilience is particularly important due to the fact that resilience mechanisms (their construction, strengthening, improvement) determine the survival of the enterprise in risky situations or during crises. Enterprise resilience became a more widely researched topic following the business world's experience of the global COVID-19 pandemic. A significant correlation was found between the resilience developed by enterprises and their ability to cope with the pandemic situation [Acciarini et al., 2021]. Indeed, it turned out that many companies had coped badly or even had failed to cope with the pandemic crisis because they had not developed necessary resilience mechanisms that should be shaped, tested and improved on a continuous basis, even in safe, non-crisis conditions. Only such an approach to management allows organizations to overcome crises when they actually occur.

Besides unpredictable events and circumstances whose course cannot be modelled (such as a pandemic), another source of enterprises' demand for a high level of resilience is nowadays the increasingly chaotic and volatile business environment [Kantur, İşeri-Say, 2015].

From an organizational perspective, building enterprise resilience should focus on unique capabilities, developed in such a way that the entity can be prepared for uncertain and risky situations [Ma et al., 2018]. Such capabilities should include, in particular, the ability to anticipate developments, the ability to deal with risks and the ability to adapt to new situations [Duchek, 2020].

In addition to the need to build resilience mechanisms, there is also a demand for measuring the resilience of individual business organizations. This is because

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a diagnosis of the level of resilience is the starting point for planning further actions within the scope of the risk management, crisis management and business continuity management systems.

This paper aims to review, analyze and classify selected existing models used to measure enterprise resilience. This goal will be achieved by developing a taxonomy of resilience assessment models and analyzing the dimensions assessed in resilience assessment models.

1. Theoretical background

1.1. Enterprise resilience and its importance

Enterprise resilience is of key importance for modern enterprises operating almost all the time in a crisis-prone environment. Resilience concepts should therefore be incorporated into corporate strategies. Enterprise resilience should be understood as a business organization's ability to restore a state that guarantees its survival, as well as acquisition of the ability to operate under disruptive conditions. Resilience understood in this way has the following characteristics: 1) it is a non-continuous skill, 2) it is multi-level in nature and shows a close relationship with an enterprise's resources, processes and procedures, 3) it determines the survival and adaptability and development of an enterprise under difficult conditions [Xiao, Cao, 2017]. Thus, it can be concluded that resilience means the ability of an enterprise to return to normal operating conditions after a period of disruptive events [Morales et al., 2019]. Resilience is the organizational capacity to bounce-back and bounce-forward [Bartuseviciene et al., 2024]. It is also important to relate resilience concepts to crisis management, i.e. how they correlate with each other and how resilience mechanisms can influence crisis management processes [Williams et al., 2017].

The concepts of organizational resilience have appeared in literature and research for a long time. The works of Weick and Sutcliffe [2007] and Linnenluecke [2015], among others, have paved the way to understanding how this research construct should be perceived and understood.

In order to better understand the phenomena and characteristics of enterprise resilience, it seems useful to subject them to the process of modelling. The result of this process is the development of increasingly sophisticated resilience models that aim to explain the determinants of the building and effectiveness of resilience mechanisms. There are various models of resilience, for example, the compensation model, the provocation model, the protection model or the vulnerability model [Ledesma, 2014]. Another model of enterprise resilience takes into account the following three key concepts: shaping culture of preparedness, planning business

continuity and building disaster resilience [Jedynak, Bąk, 2021]. Yet another starting point for modelling enterprise resilience is its categorization into hard resilience, representing the direct strength of an entity's structures, and soft resilience, equated with the ability to absorb problems and cope with their negative effects [Proag, 2014].

Organizational resilience has several domains: the behavioral domain, the growth domain and the performance domain [Hillmann, Guenther, 2020]. What is associated with the domains is resilience traits. They are the qualities typical of enterprises perceived in their business environments as resilient to crisis phenomena. The core resilience traits include the following [Erol et al., 2010]: redundancy, absorbing capability, recovery capability, situation awareness, management of keystone vulnerabilities, adaptive capability, risk intelligence, agility, awareness, preparedness, flexibility, diversity, efficiency, adaptability, cohesion, collaboration, risk management culture and visibility.

1.2. Objectives of resilience measurement

In order to reliably diagnose the maturity and effectiveness of the resilience mechanisms implemented by enterprises, a methodical and structured assessment of resilience is necessary. This purpose is served by diverse measurement methods and tools, such as organizational resilience assessment models. It is also important to confront and test on an ongoing basis different approaches to assessing the resilience of enterprises [Hillman, Guenther, 2020]. These activities support the continuous improvement of resilience assessment procedures.

Measuring resilience is becoming increasingly important in the current business environment [Chen et al., 2022], as the result of such a procedure provides a clear answer about the degree to which an enterprise is prepared for various potential crises. Such an assessment facilitates further necessary adjustments to plans for risk management, crisis management and business continuity management. According to Kolay [2017], resilience measurement should take into account the extent of effective changes implemented in reaction to adverse events, the continuity of these changes over time and the size of the organization.

The issues of measuring enterprise resilience are included in the new management paradigm of resilience engineering. One of the main objectives of measuring enterprise resilience is to assess an enterprise's ability to reduce its vulnerability to expected and unexpected events, its ability to adapt to a changing environment and its ability to resume normal operations in the shortest possible time in the event of a disruptive event [Ozgur et al., 2010]. Another important objective of measuring resilience is to provide a basis for testing its effectiveness under different conditions and, in particular, to assess the potential of resilience possessed, i.e. the ability of an enterprise to recover organizationally after suffering a disruptive event. Measuring resilience

should also make it possible to compare different business entities with respect to their preparedness for crises and the extent to which they have assimilated the managerial qualities needed to cope with an uncertain environment [Bravo, Hernández, 2021]. Measuring resilience is also useful when entities from various industries want to monitor the effectiveness of implementing management concepts, such as lean management [Bąk, 2021; Bąk, 2022] or change management [Bąk, Bąk, 2024].

The identification of enterprises' activities and environmental conditions that have the potential to contribute to the strengthening of their resilience should also be considered as an objective of continuous assessment of business resilience [Fu et al., 2023]. In the context of developing projects aimed at improving resilience, it is also important to assess training systems and personnel competencies regarding safeguards and preventive measures already functioning in enterprises [Jnitova et al., 2020].

When analyzing methodologies for measuring organizational resilience, it is extremely important to take into account the fact that the complexity and instability of the business and social environment can make the process of reliably assessing the level of resilience much more difficult [Sell et al., 2021]. Hence, what is needed is a continuous update of the theoretical and empirical knowledge used to build business resilience assessment tools.

2. Research methodology

The objective of this paper was to analyze, compare and classify selected models for measuring enterprise resilience developed over the last 13 years (from 2010 to 2023). This particular period was chosen because of the growing interest in measurement tools for corporate resilience observed after the end of the global financial crisis. Another criterion for the selection of the catalogue of models included in the analysis was the possibility of becoming familiar with the full procedure of their development and application. Consequently, they were models presented in scientific texts published in the open access system. Taking into account the aforementioned criteria, we eventually qualified fourteen models of resilience assessment for further analysis.

In order to clarify the main objective of the study, we posed the following research questions:

RQ1: How can enterprise resilience assessment models be classified?

RQ2: What are the characteristics of the existing enterprise resilience assessment models and what are the differences between them?

RQ3: What dimensions are assessed in the existing enterprise resilience assessment models?

In order to realize the established research objective and to find answers to the research questions, we decided to classify the resilience assessment models selected for analysis according to the following four characteristics:

- type (qualitative, quantitative, mixed),
- using (self-assessment, respondents survey, expert assessment),
- application (all sectors or selected sectors),
- assessment result (resilience levels or other forms of presenting resilience assessment results).

We recognized the above characteristics as of key importance in the description of assessment models used in management because they allow enterprises to compare individual models and, based on the results of such comparison, make an informed decision about which of them will be the most appropriate with regard to their business environment and objectives.

Type determines the nature of the tools used to measure resilience, and specifically whether they are qualitative, quantitative or a combination of both.

Using determines whether a model is designed for internal self-assessment by enterprises, for evaluation by external experts in proprietary assessment procedures, or for use in surveys targeting various groups of enterprises, such as those operating in different sectors. Some models can be used in more than one way.

Application evaluates whether a model is dedicated to a specific sector or whether it is universal and can be applied universally across all sectors.

The final characteristic is assessment result, refers to the outcome of the resilience assessment procedure. It indicates how the final measure is used to assess the level of resilience obtained according to the recommended methodology.

In the next step, we compiled and analyzed the frequency with which dimensions appear in the resilience assessment process across individual models.

In the research process, we used several methods: a comparative analysis [Esser, Vliegenthart, 2017], a comparative approach to examine the changes in the models over time [Pennings et al., 2006], and a basic numerical data analysis [Babbie, 2010; Muijs, 2010] focusing of the selected dimensions in the analyzed models.

3. Results

3.1. Characteristic features of the analyzed models

The taxonomy of the analyzed models for measuring resilience, including their comparison in terms of the four selected characteristics, is presented in Figure 1.

The models selected for analysis and comparison use both quantitative (6 models) and qualitative (3 models) measurement methods. There are also 5 models that

use mixed methods (both quantitative and qualitative). The quantitative models recommend the use of statistical and mathematical methods to measure resilience, such as statistical analysis, multiple regression analysis, algorithms, dynamic programming, etc. The qualitative models, on the other hand, assess resilience using methods and tools like questionnaire surveys, case studies, the Delphi method, as well as interviews with both experts and enterprise representatives. The mixed models combine both quantitative and qualitative tools to measure resilience. In these models, qualitative methods most often precede the application of quantitative ones, as the latter numerically substantiate the obtained measurement results.

As a general rule, resilience assessment models should be simple enough in structure to be used independently by any business entity. This approach was pursued by the authors of six models under analysis. To facilitate the measurement procedure, five models propose using questionnaires in surveys of enterprise representatives. Among the examined models, seven are designed to be used exclusively by experts possessing specialist knowledge of risk management and organizational resilience.

In terms of their applicability, the majority of the models are universal – that is, they are not dedicated to any specific type of business and can be applied in any sector of the economy (7). However, some models are designed for use only in selected sectors, such as the industrial sector [Stephenson et al., 2010], the critical infrastructure sector [Hatton et al., 2019], the production sector [Sanchis, Poler, 2019; Sanchis et al., 2020], the IT and manufacturing sectors [Stocker et al., 2022], the hospitality and leisure sectors [Lucero, 2023], and the supply chain sectors [Zhao et al., 2023].

For most of the models under examination, the assessment outcome is expressed either as a resilience level (in five models) or a resilience scale (in one model), which aligns with the methodological rigor employed in developing measurement tools in management. It is interesting to note, however, that some models employ alternative approaches to measurement, t resulting, for example, in an assessment of resilience strategies [Hassan, Galal-Edeen, 2018], resilience profiles [Patriarca et al., 2018; Hatton et al., 2019], resilience return functions [Sanchis, Poler, 2019], or resilience capabilities [Sanchis et al., 2020]. Additionally, some models form the basis for the development of a resilience index as a professional measure of resilience [Zhao et al., 2023; International Labour Organization, 2023].

Figure 1. Taxonomy of the selected resilience assessment models
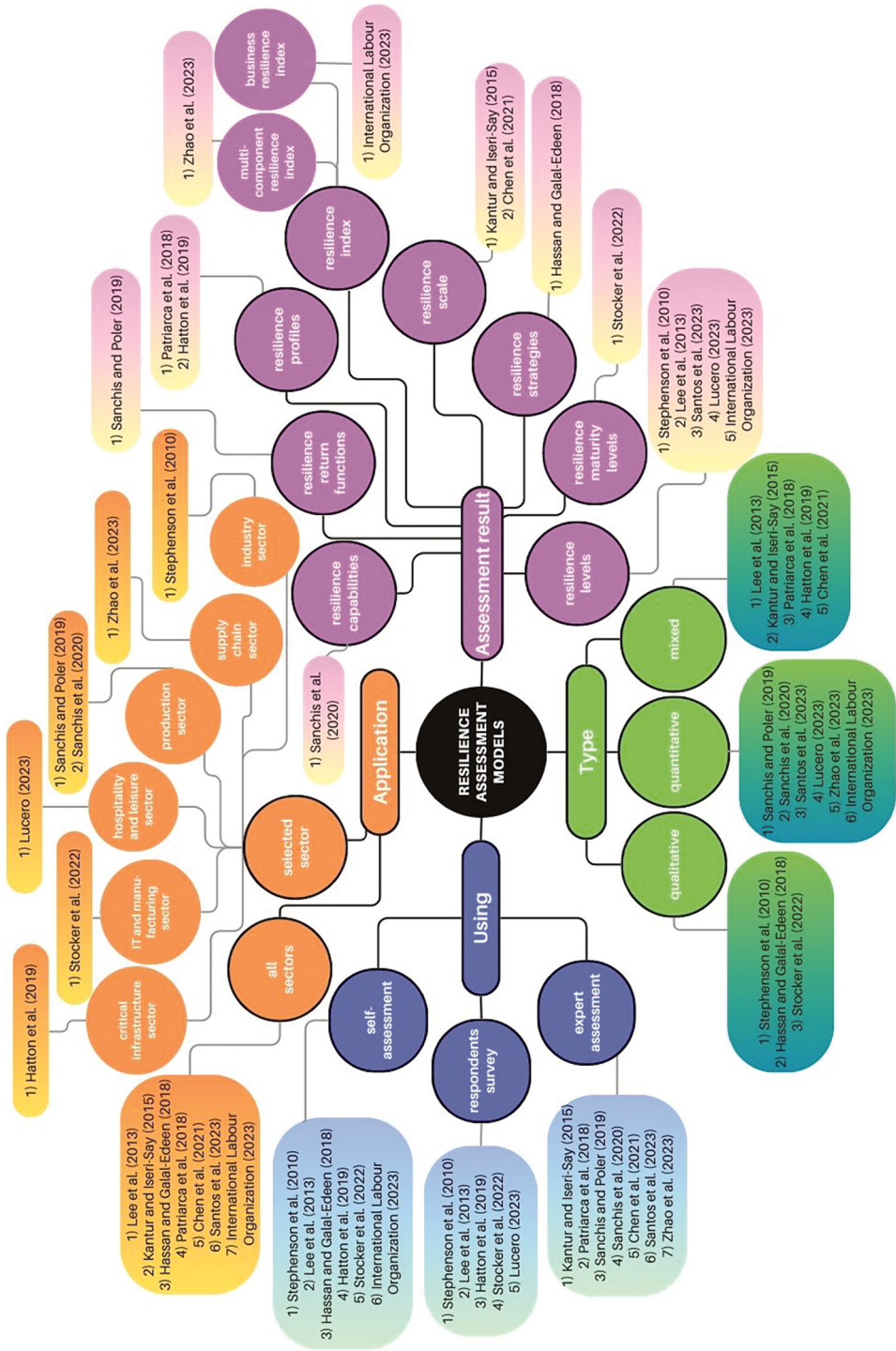
Source: own study.

Table 1. Dimensions undergoing assessment in the resilience assessment models

Model	Resilience ethos	Situation awareness	Management of keystone vulnerabilities	Adaptive capacities	Overall resilience	Commitment/responsibility	Network perspective	Planning	Robustness	Agility	Integrity	Disruptions/adverse events	Profile of the enterprise	Strategies/strategic resilience	Transformation	Response to disruption	Resilience characteristics	Responding	Monitoring/reporting	Anticipating	Learning/knowledge	Sector culture and cohesion	Sector dependencies and external networks	Sector agility and change readiness	Preventive actions/decision making/management	Transition elements	Capital resilience/resources	Cultural resilience	Relationship/partnership	Case handlers	Unity of purpose	Stress testing plans	Innovation, technology and creativity	Leadership	Processes and simulation process	Profits/opportunities	Risk factors	Institutions	Financial (liquidity and funding)
Stephenson et al. (2010)	✓	✓	✓	✓																																			
Lee et al. (2013)	✓	✓	✓	✓	✓																																		
Kantur & Iseri-Say (2015)						✓	✓	✓																															
Hassan & Galal-Edeen (2018)									✓	✓	✓																												
Patriarca et al. (2018)												✓	✓	✓	✓	✓	✓																						
Hatton et al. (2019)					✓			✓						✓				✓	✓	✓	✓																		
Sanchis & Poler (2019)												✓										✓	✓	✓															
Sanchis et al. (2020)												✓		✓							✓					✓													
Chen et al. (2021)				✓										✓			✓				✓				✓		✓	✓	✓										
Stocker et al. (2022)						✓						✓		✓					✓		✓									✓									
Santos & Spers (2023)						✓		✓													✓				✓		✓		✓		✓	✓	✓	✓					
Lucero (2023)					✓	✓							✓																✓						✓	✓			
Zhao et al. (2023)						✓						✓																							✓	✓	✓		
International Labour Organization (2023).																									✓			✓	✓				✓					✓	✓
Total	2	2	2	3	3	5	1	3	1	1	1	5	2	5	1	1	2	1	2	1	5	1	1	1	3	1	2	2	4	1	1	1	2	1	2	2	1	1	1

Source: own study.

3.2. Dimensions under assessment

The subsequent stage of the comparison analysis covers the dimensions undergoing assessment in the analyzed models to obtain information about the level of resilience demonstrated by a given enterprise (Table 1).

The comparative analysis, whose results are presented in Table 2, shows, first, that there is a wide dispersion and variety of the dimensions undergoing assessment in the individual models under comparison. This highlights that the tools are not uniform and do not employ similar methods for assessing resilience. This may indicate a lack of universal model fully adapted to the conditions of a changing environment. Considering the chronology of the emergence of the compared models, it is possible to observe the gradual emergence of increasingly holistic dimensions being assessed, which is certainly related to events that affected the resilience of enterprises globally in particular years (e.g., the global financial crisis or the COVID-19 pandemic). It was only beginning in 2021 that awareness about the dimensions that should be assessed in the process of evaluating resilience started to increase, such as: capital resilience, relationships, innovation, technology, leadership, etc.

Secondly, taking into consideration the recurrence of the assessed dimensions across different models as a criterion for their validity, it can be concluded that, despite their low recurrence level, there are several dimensions that were used in more than one of the compared models. The greatest number of recurrences, as many as five, appeared in the case of such dimensions as commitment/responsibility, disruptions/adverse events, and learning/knowledge. It can therefore be concluded that these management areas currently have the greatest impact on the process of shaping and sustaining business resilience. Subsequently, it can be assessed that the ongoing identification and anticipation of negative events, the involvement of employees and the distribution of responsibility for resilience mechanisms, as well as the acquisition of knowledge and skills through experiences from past crises, are the criteria most responsible for the levels of resilience represented by individual enterprises.

Conclusion

Organizational resilience is an extremely important research issue in contemporary management. The interest of both practitioners and theoreticians in this area has been steadily increasing [Raetze et al., 2021]. The first studies on resilience mechanisms and, more specifically, the factors influencing the development of resilience, date back to the 1990s. Over the years, and with the emergence of various problems in the global economy and society, the topic of building and maintaining corporate resilience has become increasingly relevant. Currently, the main global issues directly affecting

resilience processes include the resilience of security networks, cybersecurity, cyber resilience, disaster management, organizational innovation, sustainable development, and sustainability management [López-López et al., 2022].

Given the growing relevance of resilience issues in contemporary business management, methods for measuring and assessing resilience constitute meaningful research directions. Many tools for assessing resilience are currently being developed, each representing a different approach and different assessment criteria. Thus, it can be concluded that there is currently considerable confusion and inconsistency surrounding resilience measurement [Fisher, Law, 2020], which certainly calls for systematization and clarification.

Therefore, it is now more crucial than ever for enterprises to select the right tool to reliably assess their resilience to potential crises and other disruptive events [Ilseven, Puranam, 2021]. However, decisions regarding the choice of measurement tools are complicated by the emergence of new approaches to measurement methodologies, as well as the fact that new crises and global changes often render existing t methods obsolete.

The results of our comparison of the selected resilience assessment models confirm that the number of measurement tools is steadily increasing. Unfortunately, this increase is not accompanied by any deliberate attempts to standardize or universalize the approaches to this issue. On the contrary, different tools are based on different assumptions and, most importantly, assess entirely different areas of business operations and management to diagnose resilience levels. What is needed in these circumstances is further research, more testing of existing models, and proposals for new ones, ultimately leading to the development of a tool that remains functional and reliable in the face of new crises. Therefore, these activities should guide further research in this area. Given the high degree of dispersion among existing models, there is a significant likelihood that assessing the resilience of the same enterprise under the same conditions and using two different assessment models could give different results. This is one of the major shortcoming of the current state of knowledge concerning enterprise resilience assessment.

However, a clear advantage of the analyzed assessment models is that they incorporate a wide range of perspectives [Cheng et al., 2020] – adopted by academics, practitioners, and representatives from various scientific and business disciplines, making it possible to hope for their further improvement. Continuous improvement of these tools is absolutely essential, as demonstrated, for example, by the previously unforeseen COVID-19 pandemic, which triggered a renaissance of the concept of organizational resilience [Radic et al., 2022].

The results of our research have several practical and theoretical implications. First and foremost, they contribute to the current state of knowledge on enterprise resilience measurement methodologies by comparing and systematizing the existing

models. This allows for the identification of strengths and weaknesses within resilience assessment tools, which in turn raises awareness among theoreticians and researchers about areas that still require improvement. In terms of practical implications, our list and comparison of models can serve as a catalogue for enterprise representatives. By understanding how the models work and what they recommend assessing to determine resilience levels, enterprises can choose the most appropriate model for their specific needs.

Our research also has some limitations. The primary limitation is that only models from a selected time range were analyzed, and rather than all models developed to date. Since the number of models will likely continue to increase (as existing ones require further improvement), research such as ours should be repeated periodically.

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ENTERPRISE RESILIENCE ASSESSMENT – AN OVERVIEW OF MODELS

Abstract

Enterprise resilience and approaches to its assessment are a current and important research trend in management sciences. The intensification of interest in resilience issues can be seen in the wake of the emergence of the COVID-19 pandemic, which strongly interfered with the activities of enterprises in various sectors. The purpose of this text is to review, analyze and classify selected existing models of assessment enterprise resilience. For our analyzes, we selected resilience assessment models developed between 2010 and 2023. We classified them, taking into account four criteria: type, using, application and assessment result. In the next step, we collated and compared the dimensions assessed in all the measurement models included in the analyzes. The obtained results showed that the existing models for assessment enterprise resilience are characterized by a wide dispersion and diversity, in terms of both the recommended measurement methodology and procedure and the dimensions to be assessed.

POMIAR ODPORNOŚCI PRZEDSIĘBIORSTWA – PRZEGLĄD MODELI

Streszczenie

Odporność przedsiębiorstw oraz podejścia do jej pomiaru są aktualnym i ważnym wątkiem badawczym w naukach o zarządzaniu. Intensyfikację zainteresowania problematyką odporności można dostrzec w związku z pojawieniem się pandemii COVID-19 mocno ingerującej w działalność przedsiębiorstw w różnych sektorach. Celem niniejszego tekstu jest dokonanie przeglądu i analizy porównawczej oraz opracowanie taksonomii wybranych dotychczasowych modeli pomiaru odporności przedsiębiorstwa. Do analiz wybraliśmy modele pomiaru odporności powstałe w latach 2010–2023. Dokonaliśmy ich klasyfikacji przy uwzględnieniu czterech cech: typ, sposób użycia, zastosowanie oraz rezultat pomiaru. W kolejnym kroku zestawiliśmy i porównaliśmy obszary poddawane ocenie we wszystkich analizowanych modelach pomiaru. Wyniki przeprowadzonych analiz wykazały, że dotychczasowe modele

pomiaru odporności przedsiębiorstwa charakteryzują się dużym rozproszeniem oraz zróżnicowaniem zarówno pod kątem zalecanej metodyki i procedury pomiaru, jak i pod kątem obszarów poddawanych ocenie.

Słowa kluczowe: odporność, pomiar odporności, przedsiębiorstwo, modele pomiaru odporności

Kody klasyfikacji JEL: H12, D81, G32