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Article

The efficiency of eco-innovation: Systematic literature studies

Economic and Environmental Studies (E&ES)

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Suggested Citation: Szutowski, Dawid; Szulczewska-Remi, Aleksandra; Ratajczak, Piotr (2017) : The efficiency of eco-innovation: Systematic literature studies, Economic and Environmental Studies (E&ES), ISSN 2081-8319, Opole University, Faculty of Economics, Opole, Vol. 17, Iss. 2, pp. 205-219, <https://doi.org/10.25167/ees.2017.42.4>

This Version is available at:

<https://hdl.handle.net/10419/178967>

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The Efficiency of Eco-Innovation. Systematic Literature Studies

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Abstract: Purpose: Eco-innovation appears to be at the very heart of the European Union policy. It is of crucial importance for both single companies and the whole economic systems. At the same time eco-innovation is driven by the countless factors. Thus the purpose of the present research was to indicate the determinants of the efficiency of eco-innovation.

Design/methodology/approach: The research relied on the systematic literature studies performed with the use of SALSA (Search, Appraisal, Synthesis, Analysis) method. It focused on the papers published between January 2000 and June 2016. A total of 469 publications were examined selected from Scopus database. The precise appraisal procedure allowed indicating the ones including the determinants of the efficiency of eco-innovation.

Findings: The studies of literature allowed indicating a total of 24 determinants. Moreover the results indicate that the determinants of the efficiency of eco-innovation may be divided based on two criteria. The first includes costs-related and revenues-related determinants. The second includes strategic and operational levels.

Research limitations/implications: Together eleven publications were omitted in the research due to their incompleteness or inaccessibility.

Practical implications: Stimulating eco-innovation seems vital for all companies. Delivering a comprehensive set of the determinants of its efficiency will support executives in managing eco-innovation.

Originality/value: The paper attempts to fulfil the research gap concerning the determinants of the efficiency of eco-innovation.

Keywords: eco-innovation, efficiency

JEL codes: O32, Q57

<https://doi.org/10.25167/ees.2017.42.4>

1. Introduction

A resource-efficient Europe – flagship initiative of the "Europe 2020" strategy – is primarily focusing on low-carbon economy, resource productivity and decoupling economic growth from

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the consumption. Stricter standards for the environment protection will thus be conducive to the eco-innovation development, and therefore it becomes necessary to increase confidence driving investment and innovation activity. The new action plan for eco-innovation (EcoAP) contributes to the development of innovations that reduce pressures on the environment and facilitate the introduction of innovation to the market, therefore mobilization of financial instruments and support services for small and medium-size enterprises (SMEs) will be one of the key aspects (European Economic and Social Committee 2012).

Due to the fact, that customer environmental awareness increases, social and government pressure on companies to reduce the environmental impact is rising and sustainable development becomes financially astute matter, managing eco-innovation is becoming an increasingly important issue for firms (Guoyou et al., 2013; Ormazabal and Sarriegi, 2012). For example, Guagnano (2001) found that over 86 per cent of consumers are willing to pay extra for a common household product that is less harmful ecologically. Tsen et al. (2006) support this finding in their study of consumers who were willing to pay a premium for green products.

Moreover, eco-industries in Europe are a significant part of the economy – their annual turnover is estimated at 319 billion euros, which represents approximately 2.5 per cent of the EU GDP (Action Plan for Eco-Innovation EcoAP) (European Economic and Social Committee, 2012). As stated by Haila and Rundquist (2011), eco-innovations are not only environmentally important, but also have an important impact on economical development. It is even claimed that eco-industry has the capability to help the world recover from economic crisis.

According to “Eco-Innovation. Enabling the transition to a resource-efficient circular economy” report (2014), the most significant barriers faced by companies include lack of funds, the relatively high cost of eco-innovative technologies, uncertain market demand and uncertain return on investment, the lack of economic and fiscal incentives, the growing competition as well as insufficient knowledge about environmental protection, inadequate awareness of the environmental impact of firm’s own activities and limited knowledge on economic benefits, also limited openness of customers towards new eco-designed products. This calls for more attention that should be paid to show eco-innovations effectiveness on companies.

In the light of previous research it appears that different companies differ in their abilities to profit from eco-innovation (Szutowski and Ratajczak, 2016). The relationship between eco-innovation and companies’ financial benefits is not as straightforward as a simple modelling would

have suggested. The general conclusion that eco-innovation impacts positively on company's value is marked by the discrepancies between the effects of single eco-innovation projects. In this context the crucial importance of the efficiency of eco-innovation emerges. Here the efficiency stands for the company's benefits stemming from eco-innovation and the company's outlay for it (Hollanders and Esser, 2007). It is important to notice that the economic efficiency of innovation projects is one of the key success factors in the business performance management (Szutowski, 2016). The management and control of the interplay between the inputs and outputs suffers from the lack of sound methodological solutions.

It seems that there are a number of variables which determine the relation. From the point of view of management and controlling the indication of the key determinants of the relation studied is of vital theoretical and practical importance. It appears that the extant literature failed to deliver consistent conclusions on the determinants of the efficiency of eco-innovation. In this context the intent of the present research is to indicate the determinants of the efficiency of eco-innovation. The research relies on the systematic literature study performed with the use of SALSA (Search, Appraisal, Synthesis, Analysis) method (Booth, Papaioannou and Sutton, 2012). The precise studies of literature allow summarising the existing scientific evidence in the field and draw conclusions based on it.

The paper is structured as follows. First the conceptual framework is delivered and the notion of eco-innovation is discussed. Second the method of conducting the systematic study of literature is presented. Third the synthesis of the papers under investigation and the analysis of their content are delivered. The paper terminates with conclusions.

2. Conceptual framework

Eco-innovation is defined by European Commission as “changing consumption and production patterns and developing technologies, products and services to reduce our impact on the environment” (European Commission, 2009: 2). The main objective of eco-innovation is to boost Europe's environmental and competitive standing by supporting innovative solutions that protect the environment while creating a larger market for ‘green’ technologies, management methods, products and services. Also eco-innovation may be defined as “the creation of new, or significantly improved, products (goods and services), processes, marketing methods, organisational structures

and institutional arrangements which – with or without intent – lead to environmental improvements compared to relevant alternatives” (OECD, 2008: 19).

The relevance of the relation between CSR and innovation streams from the public sector (European Commission, 2001; European Commission, 2006; European Commission, 2011; Norwegian Ministry, 2009), which corresponds to the broader academic discussion about interdependencies between sustainability performance, business competitiveness and economic performance. In the later Communicate published in 2011 the definition of CSR was formulated as “the responsibility of enterprises for their impacts on society” with the aim of “maximising the creation of shared value for their owners/shareholders and for their other stakeholders and society at large” (European Commission, 2011: 6). Therefore the most important shift lies in the purpose of CSR that appears to be value maximisation. Also, the document proposes to achieve it by the adoption of a long-term attitude to CSR and the introduction of innovation, services and business models. This new definition rejects a philanthropic or marketing attitude to CSR and follows the trend developed in recent years that CSR needs to be linked to the modification of business models and concentration on innovation (Visser, 2010). In other words, companies should implement innovation to transform the impact of its business activities on society.

In agreement with Arundel and Kemp (2009) eco-innovation is not limited to environmentally motivated innovations, but includes “unintended environmental innovations”. The environmental benefits of an innovation can be a side-effect of other goals, such as recycling heavy metals in order to reduce costs. Institutional innovations such as changes in values, beliefs, knowledge, norms, and administrative acts are also included, as are changes in management, organization, laws and systems of governance that reduce environmental impacts.

In the work of Jones, Harrison and McLaren (2001) there is a number of definitions of eco-innovation, which usually coincide with the above, but with different specificity approach. Ziółkowski (2013, p. 154) considers the term after as "novel and competitively priced goods, processes, systems, services, and procedures that can satisfy human needs and bring quality of life at life-cycle minimal use of natural resources per unit output (resource and energy efficient), and a minimal release of toxic substance". With eco-innovation often identified concepts are described, such as sustainable innovations, environmental innovations, environmental and green technologies, that is, those which have some environmental advantages. Substantially, eco-innovation combines innovative solutions with environment care in response to the demand of the

modern economy. For the purpose of this article eco-innovation is applied and defined as new or significantly improved product achieved in sustainable production taking into account product lifecycle, that reduces the use of natural resources (including materials, energy, water, biomass and land) and decreases the release of harmful substances across the whole lifecycle (Eco-innovation Observatory, 2010).

One of the main measurement approaches of innovativeness of European Union Member States is the Eco-Innovation Scoreboard (Eco-IS). The scoreboard aims to promote a holistic view of economic, environmental and social performance and capture the different aspects of eco-innovation by applying 16 indicators grouped in five areas: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resources efficiency and socio-economic outcomes. Based on EUROSTAT and Thomson One data socio-economic outputs are calculated taking into account exports of products from eco-industries, as well as employment and revenues in eco-industries and circular economy (Eco-innovation Observatory, 2013).

However, according to Miedzinski (2015) Eco-IS strongly relies on proxies because of the limited access to data allowing for making strong assumptions and further reflection on existing measuring systems. Tundys (2015) also points out that the indicators of its effect are poorly correlated with indicators of development and implementation of eco-innovation. It is not enough to reflect the firm's eco-innovation efficiency and hence there is a need for the assessment tools. It is necessary to adapt an appropriate combination of existing sets of indicators that could help businesses gain more comprehensive picture. Accordingly, OECD Innovation Strategy postulate for clearer and more consistent set of measurements applicable for SMEs that would increase their abilities to manage and improve environmental performance (OECD, 2009).

The growing importance of corporate social responsibility (CSR) and eco-innovations and their impact on a company's value is perceived as a shift in a management paradigm (Porter and Kramer, 2011). Fatemi and Fooladi (2013) went further, arguing that companies, which did not take into account the needs of all stakeholders, experienced a gradual destruction of their market value. Linking the financial performances of different companies with CSR has been already introduced in the literature in the 1980s and less explicitly even earlier (Carroll 1999). Nevertheless the relation between CSR and innovation has gained academic attention only over the last decade (Rexhepi, Kurtishi and Bexheti, 2013). Innovation was made a key to understanding the linkage between CSR and a company's social and financial performance (Visser, 2010). Nidumolu,

Prahalad and Rangaswami (2009) pointed out conclusively that CSR is a fundamental driver of innovation. European Commission (2006) argued that CSR may contribute to sustainable development and simultaneously increase corporate competitive potential by stimulating innovation. Scientific evidence exists, that companies strong in CSR compliance were in most cases highly innovative. Moreover Rexhepi, Kurtishi and Bexheti (2013) argued that nowadays CSR and innovation are the foundation of business competencies.

The ecologically and socially-oriented actions taken by an enterprise, related to the reduction of costs, improve the relations with stakeholders and market opportunities, influence the asset and capital standing as well as the results of the enterprise from the point of view of increasing its value (Kochalski, 2016). There are empirical studies of eco-innovation effectiveness in companies, mainly supported by internal and external factors as well as examining connections between eco-innovation and financial performance of companies (Ghisetti and Rennings, 2014; Heras-Saizarbitoria et al., 2011). Triguero et al. (2013) explore the drivers of different types of eco-innovation in European SMEs using Flash Eurobarometer survey. Horbach et al. (2012) identify eco-innovation determinants targeting different environmental impact areas based on the German Community Innovation Survey. He found that (1) technological capabilities as well as appropriation problem and market characteristics on supply side besides market demand and social awareness of the need for clean production and (2) the environmental consciousness and preference for environmentally friendly products on demand side are the most important. Halila and Rundquist (2011) showed that access to capital and network are especially important to the market success of eco-innovations, while Doran and Ryan (2012) found that regulation and customer perception can explain firm's decision to engage in eco-innovation. Other authors indicated regulation, perceptions, external linkage and knowledge generation as main eco-innovation factors. It was also noticed lately by Hojnik and Ruzzier (2016) that product eco-innovation is driven by regulations, market pull factors, EMS and cost saving. Przychodzen and Przychodzen (2015) suggested that eco-innovation was generally characterized by higher return on assets and equity and lower earnings retention.

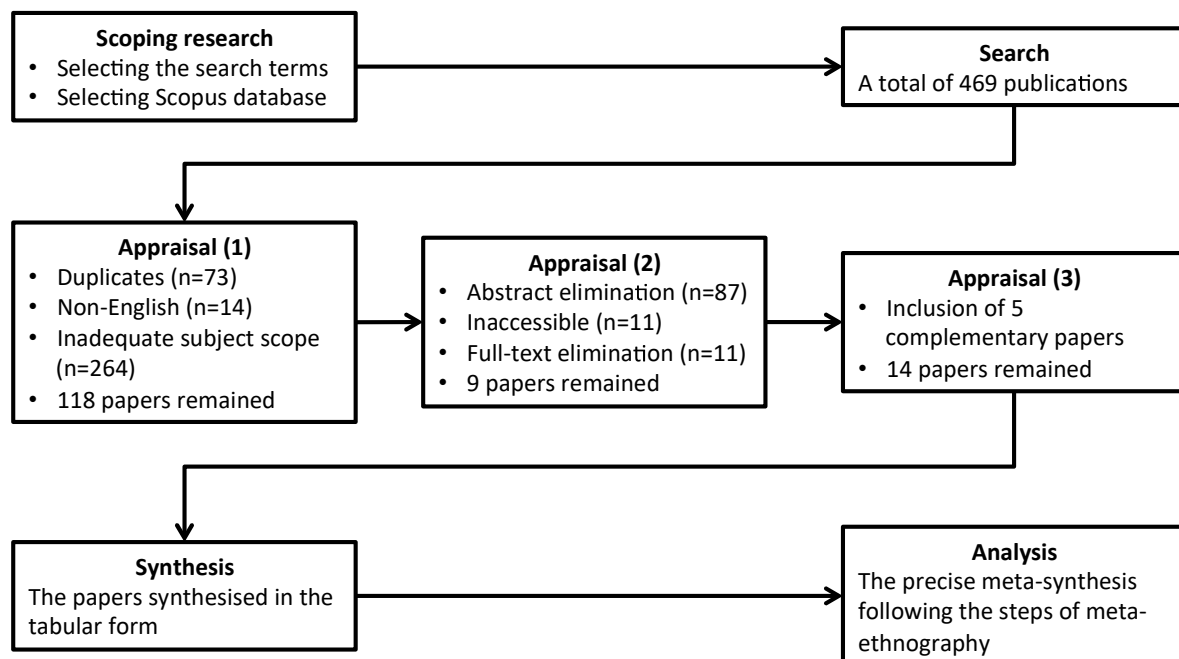
Recently, Bossle et al. (2016) identified drivers that impact companies' adoption and motivation for the implementation of green innovations while Doran et al. (2016) examined how different types of eco-innovation impact on firm performance. Both authors suggest that further investigation of how those drivers can actually result in outcomes from eco-innovation would have

important practical implications for companies in terms of their performance and strategic policies. So far, no single method or indicator is likely to be sufficient, hence there is a justification for tackling this scientific problems.

3. Conceptual framework

The present systematic literature study relied on the SALSA method which consists of four stages – Search, Appraisal, Synthesis, and Analysis – preceded by the scoping research. It aimed at indicating the determinants of the efficiency of eco-innovation. The purpose of the scoping research was to determine the search terms and the electronic database to perform the research. The procedure is delivered on the Figure 1.

Figure 1. The procedure of the systematic literature studies



Source: own development

Based on the scoping research the search terms were divided into three groups. The first one referred to innovation (innovation, invention, modernisation). The second one covered the ecological aspects (ecological, green, environmental). The third group included the terms referring

to the efficiency (efficiency, input, output). Scopus database was selected to perform the research. No grey (not formally published) literature concerning the subject was found.

Search

In order to assure the timeliness of publications, the search was limited to the papers published between January 2000 and June 2016. It encompassed scientific papers, conference proceedings and books. Every single search was performed in Scopus with a combination of the three search terms presented above (referring to innovation, ecological aspects and efficiency). Therefore a total of 27 independent researches were performed.

First, the search terms were searched in publication titles. However this resulted in 13 papers only. Therefore the research coverage was expanded to articles' titles and keywords. Both American and English spellings were covered. The procedure resulted in identifying 469 publications.

Appraisal

Titles, abstracts and full texts of all 469 publications were examined manually. First the papers were selected based on the three siftings: title, abstract and full text. Second the complementary publications were included in the sample based on the one step forward and backward snowballing (Jalali and Wohin, 2012).

The title sifting procedure resulted in indicating duplicates ($n=73$) and papers not in English ($n=14$). Furthermore it allowed eliminating the papers in the inadequate subject area from the point of view of the present literature study ($n=264$). The selected papers represented such areas as: business, management and accounting, social sciences, decision sciences, economics, econometrics and finance. 118 papers remained at this stage.

In the abstract sifting all the abstracts of the remaining papers were analysed to indicate the publications important from the point of view of the present research ($n=31$). However, eleven articles were excluded due to incompleteness or inaccessibility. The full-text sifting of the remaining 20 papers assured their rigorous selection for the synthesis and analysis. At this step 9 papers left for further investigation.

To assure the comprehensiveness of the set of publications a reference check was performed. The set was complemented with the selected publications indicated in the references.

The procedure resulted in adding 5 publications. Thus the systematic study of literature included 14 publications in total.

Synthesis

All the publications were examined in details. In order to organise the research the publications under investigation were synthesised in the tabular form. The main referential and substantial information on the papers were extracted. Table 1.

Table 1. Synthesis of the studied publications

No	Author(s)	Year	Focus	Paper type	Sample
1	Nill and Kemp	2009	Strategic level	Conceptual	-
2	Wang and Huang	2007	Strategic level	Empirical	30 countries
3	Amore and Bennesen	2016	Strategic level	Empirical	5725 companies in the US
4	Gerstlberger, Knudsen and Stampe	2014	Operational level	Empirical	3068 companies in Denmark
5	Weiss, Hoegl and Gibbert	2011	Operational level	Empirical	94 innovation projects and 434 individual responses
6	Xue, Ray and Sambamurthy	2012	Strategic level	Empirical	341 firms and 1023 observations in US and Canada
7	Wang, Fan, Zhao and Wang	2016	Operational level	Empirical	124 observations in China
8	Sarkar	2013	Strategic and operational levels	Conceptual	-
9	Valle and Avella	2003	Operational level	Empirical	125 firms in Spain
10	Zhang and Doll	2001	Operational level	Conceptual	-
11	Alegre and Chiva	2006	Operational level	Empirical	132 firms in France
12	Rennings and Zwick	2003	Operational level	Empirical	1594 observations in UK, Germany, Switzerland, Netherlands and Italy
13	Arundel and Kemp	2009	Strategic and operational levels	Conceptual	-
14	Eco-innovation observatory	2013	Strategic level	Conceptual	-

Source: own development

Analysis

Analysis covered main determinants of the efficiency of eco-innovation. It relied on the meta-synthesis following the steps of meta-ethnography method was used (Siau and Long, 2005). All the studies were compared with each other. The procedure resulted in indicating a total of 24 determinants and creating authors' own classification of determinants consisting of two criteria: level (strategic and operational) and relation (cost-related and revenues-related).

4. Results and discussion

The concept of effectiveness covers the relation between useful output and total input. In the context of eco-innovation on the one hand it involves the total company's benefits stemming from it and on the other the whole company's outlay for eco-innovation (Hollanders and Esser, 2007). Thus the efficiency of eco-innovation is calculated as the quotient of revenues and costs related to single eco-innovation.

Even though the ratio of outputs over inputs may be applied in order to calculate the effectiveness of eco-innovation, the concept is not as simple as suggested by a simple modelling. There are a series of potential determinants of the so calculated efficiency which require to be indicated.

The concept of the efficiency of eco-innovation relies on the strict financial approach. However so defined efficiency is a subject of influence of divers determinants. The effort carried out to achieve a certain degree of success may be perceived on the operational and strategic levels. Furthermore the variables may determine either costs related to eco-innovation or the benefits stemming from it. Thus, the determinants of the efficiency of eco-innovation may be grouped into four categories: operational-level cost-related, operational-level revenue-related, strategic-level cost-related, and strategic-level revenue-related.

Based on the systematic literature studies it was concluded that the cost-related determinants of the efficiency of eco-innovation on the operational level cover (Zhang and Doll, 2001; Valle and Avella, 2003; Alegre and Chiva, 2006; Sarkar 2013):

- innovation project development time,
- number of innovation projects working hours,
- priority given to eco-innovation,

- enabling technologies,
- supporting infrastructure.

The cost-related determinants on the strategic level consist of (Arundel and Kemp, 2009; Amore and Bennesen, 2016; Wang et al., 2016):

- research and development (R&D) expenditures,
- R&D personnel,
- innovation expenditures (including investment in intangibles),
- corporate governance,
- knowledge stock (accumulated granted patents),
- company technological advancement.

Similarly, the degree of success of a eco-innovation may be perceived from the two above perspectives. The revenues-related determinants of the efficiency of eco-innovation on the operational level include (Rennings and Zwick, 2003; Arundel and Kemp, 2009; Nill and Kemp, 2009; Weiss, Hoegl and Gibbert, 2011; Wang and Huang, 2007; Gerstlberger, Knudsen and Stampe, 2014):

- extension of product range,
- opening of new markets abroad and new domestic target groups,
- fulfilling a niche,
- receiving patent,
- receiving media coverage,
- releasing scientific publications,
- team climate for innovation,
- proportion of highly educated manpower,
- user-friendliness of the new product.

The strategic perspective implies (Eco-innovation observatory, 2013; Xue, Ray and Sambamurthy, 2012; Son et al., 2011):

- improving firm's image,
- increasing market share,
- overall sector riskiness,

- industry sector (manufacturing or nonmanufacturing).

Even though the efficiency of eco-innovation in most companies is perceived from the operational point of view it may not be detached from the determinants at the strategic level. They constitute the wider context which should not be ignored.

The attitude to the determinants presented in the research is situated on the micro level as opposed to the majority of scientific papers, where macro (mainly national) level determinants lie in the centre of interest. The presented taxonomy of the determinants is especially useful for the controllers who look at an enterprise through the prism of budgeting processes, where costs and revenues have to be planned and controlled in the operational and strategic perspective. Burrit and Schaltegger (2001) claim that accounting and financial staff have to be involved in the planning of the eco-efficiency improvement. Thus measuring eco-efficiency and budgeting should be integrated.

5. Conclusion

Eco-innovation is of crucial importance for all the companies. However, the previous research indicated that the results of its implementation differ strongly among companies. It appears that there is a number of variables determining the efficiency of eco-innovation and in turn their financial outcomes. In this light the purpose of the present research was to indicate the determinants of the efficiency of eco-innovation. In order to achieve such purpose the research employed the method of systematic literature studies - SALSA. It focused on the scientific publication published between January 2000 and June 2016.

The research allowed indicating 24 determinants of the efficiency of eco-innovation. The determinants were presented in the authors' own classification framework introducing the division of determinants according to two criteria: level (strategic and operational) and relation (cost-related and revenues-related). It appears that such comprehensive set of determinants is of vital theoretical and practical importance. The research attempted to summarise the previous research in the field and may support executives in managing eco-innovation.

The purpose of the research was successfully achieved, however it was burdened with some limitations. Some publications were inaccessible due to the restricted access. Their inclusion could improve the results. Also, quantitative research testing the practical usefulness of the selected

determinants appears to be a promising direction for the further research.

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Efektywność ekoinnowacji. Systematyczne studia literaturowe

Streszczenie

Cel badań Ekoinnowacje leżą w samym sercu polityki Unii Europejskiej, co jest szczególnie istotne zarówno dla pojedynczych spółek jak i całych systemów ekonomicznych. Jednocześnie, ekoinnowacje zależą od niezliczonej liczby czynników, stąd też celem podjętych badań było wskazanie determinant warunkujących efektywność ekoinnowacji.

Metodologia badań Badania przeprowadzono w oparciu o systematyczny przegląd literatury z wykorzystaniem metody SALSA (Search, Appraisal, Synthesis, Analysis). Skoncentrowano się na artykułach opublikowanych między styczniem 2000 a czerwcem 2016 roku, łącznie przeanalizowano 469 publikacji korzystając z bazy danych Scopus. Szczegółowe badania pozwoliły na określenie tych, które dotyczyły czynników warunkujących efektywność ekoinnowacji.

Wyniki badań Studia literaturowe wskazały 24 determinant. Ponadto, wyniki badań pozwoliły na dokonanie podziału czynników określających efektywność ekoinnowacji według dwóch następujących kryteriów: zależnych od kosztów i przychodów, oraz na poziomie operacyjnym i strategicznym.

Ograniczenia badań Łącznie 11 publikacji zostało pominiętych w badaniu z uwagi na ich niekompletność lub niedostępność.

Zastosowanie praktyczne przeprowadzonych badań Stymulowanie ekoinnowacji ma szczególne znaczenie dla wszystkich przedsiębiorstw. Zestawienie czynników warunkujących efektywność ekoinnowacji może wspierać kierownictwo w ich zarządzaniu.

Oryginalność/znaczenie przeprowadzonych badań Praca wypełnia lukę badawczą w zakresie czynników warunkujących efektywność ekoinnowacji.

Słowa kluczowe: ekoinnowacja, efektywność.