Ambiguity of Innovation Typology in Innovation Measurement: Towards a Unified Typology of Innovation and Measurement Model

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Abstract: Innovations are seen as opportunities to sustain and accelerate countries' development of not only their companies but also their economies. The literature on the subject presents a number of different and often contradictory typologies of innovation. This raises the problem of discrepancies in terms of the definitions, as well as possible socio-economic effects of particular types of innovation and their relationships to *ex post* and *ex ante* phases in innovation process models. So far, no attempt has been made to address the problem of unifying the typologies of innovation. The main objective of this paper is to attempt this challenge and propose one consistent typology of innovation that allows the design of a framework for an innovation measurement model. The presented research results are the next steps towards developing a consistent innovation theory, and will help design a coherent innovation measurement model.

1 INTRODUCTION

It is beyond question that the development of innovation is closely linked to raising the level of knowledge, carrying out R&D activities, and seeking new ways to apply knowledge and technology in the economy. Hence, the knowledge-based economy, by nature, refers to innovation. The concept of the European Union Regional Policy for RIS3 (Regional Innovation Strategy for Smart Specialization) emphasizes the need to take into account the life cycle of the product, which varies according to the type of innovation RIS3 Guide (2012).

The World Bank proposal contains four pillars of the Knowledge Economy (KE) framework, one of which is strictly dedicated to innovation: "An effective innovation system of firms, research centers, universities, consultants, and other organizations" Derek et al., (2006, p. 4). The proposed innovation measurement system consists of 22 variables Derek et al., (2006). These variables, on the other hand, correspond to the subjective concept of innovation measurement presented in the Oslo Manual (2018). In this manual, the examination of connections between innovations and the economic changes, is considered as the main goal of measuring innovation (both at the microeconomic level, i.e. in an enterprise, as well as at the macroeconomic level), Oslo Manual (2018). Consequently, a typology of innovation is proposed, involving the classification of innovation based on the area in which it occurs. Thus, four basic types of innovation are identified in the following areas: products, processes, organization, and marketing, Oslo Manual (2018) and James (2017). However, in the literature on the subject, we find various alternative typologies of innovation, including, among others, classification of innovation as radical, breakthrough, incremental, disruptive, and displacement. Are these innovation typologies not important, both in the process of planning the strategy of innovation development and in the analysis of the level of innovative development of national or regional economies? In particular, the theory of innovation presented by Christensen et al., (2004) and Christensen (2016), where one of their types causes disruption is a proposal to establish a typology of innovation, whereby the impact on the economic environment has been applied as a criterion of classification. Plainly, reference to different types of innovation raises obstacles to their unique identification and interpretation. An efficient and effective model for measuring innovation cannot be

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based on different typologies of innovation, as this could lead to conflict or ambiguity in the results of any analyses performed. In addition, different types of innovation can be achieved in a single innovation process, Pombriant (2017), Prahalad et al., (2017). For example, the development of new technologies, in particular high-tech, is not only a complicated process, but also a complex one, Espinosa et al., (2017), that often lasts several-or, in some cases, a dozen or so-years, with numerous innovations consisting in improvements in various areas of the developed technology, Chiva et al., (2014), IBM (2007, 2016). The development of different types of innovation requires different methods of financing, the involvement of knowledge resources, different partnership agreements, and the use of various tools anticipating and measurement of the expected effects of implementation. So, the question arises: should not the innovation typology of the subject matter be included in the innovation measurement model? According to the definitions of innovation in the Oslo Manual (2018), the innovation take place only when its implementation is noted. How then should we anticipate the economic effects of innovation at the planning stage of an innovation development strategy, and indeed how can we predict the economic impact of implementing an innovation development project prior to actual commencement of implementation. Hence, it follows that separate analyses, based on different research tools, are needed at two stages of the innovation process: at the planning and implementation stage of R&D projects within a specific innovation development strategy, when the real economic value of innovation is hidden, and at the post-implementation stage, when it is possible to obtain empirical data from the economy, and to measure the impact and effects of the implementation or another form of commercialization of innovation. It seems that the correct and exhaustive innovation development measurement model should consist of two stages, with implementation as the only criterion for demarcation between these stages. The first is the *ex ante* stage, where it is necessary to predict and estimate the effects, and the second is the *ex post* stage, where the measurement of effects occurring in the economic environment is made. This means that the measurement results of the two stages cannot be compared. How does the typology of innovation, presented in the rich literature on the subject, refer to the division into *ex ante* and *ex post* stages? Answering this question can help in designing an appropriate innovation measurement model, applicable both to an enterprise as well as to the macroeconomic level, for national economies. Taking into account the different typologies of innovation, as part of a model for measuring the potential and actual economic effects of innovation, requires prior elaboration and adoption of a consistent innovation typology; otherwise, carrying out comparative analysis with different typological solutions is methodologically unreasonable. For this reason, the first step towards designing a coherent model for measuring innovation involves attempting, firstly, to present the different typologies of innovation and, secondly, to identify the main differences between them, these constituting the barriers to the development of a single, consistent innovation typology. The main objective of this paper is to attempt to delineate the major differences in innovation typologies, advancing a proposal to use a single, consistent typology of innovation that would help to build a framework of the innovation measurement model, both at the *ex ante* and *ex post* stages. So far there was no solution of such problem presented in the literature. The common issue in this case is to attempt to find solution with use of reductionist approach. In such complex and not only complicated phenomenon as innovation development is, using such approach may not provide the adequate solution. That is the point of novelty presented in this paper. In order to achieve the objective of this paper, the complexity theory paradigms, Cicmil et al., (2017), Espinosa et al., (2017), along with *mutatis mutandis* methodological approach was used. The framework of the innovation measurement model can helpful not only in measurement process but also in comparative analysis of innovations regardless of innovation typology. Thus, it is the first phase of design a coherent innovation measurement model, performed based on the subject literature.

2 TYPOLOGIES OF INNOVATION

One of the first innovation typology approaches proposed in the literature was Joseph Schumpeter's five-tier classification system. These categories are considered in the context of the changes that they induce in the economic environment Schumpeter (1934) as cited in Oslo Manual (2005, p. 29; 2018, p. 45):

- introduction of new products;
- introduction of new methods of production;
- opening of new markets;

- development of new sources of supply for raw materials or other inputs;
- creation of new market structures in an industry.

The introduction of new elements in the existing economic environment of a given industry branch-such as the opening up of a new market or the introduction of a new technology or method of production-falls under a single process, which, despite its nomenclature, does not necessarily implies neither revolution in the structure of an economic environment nor its destruction, but rather the creation of a new one. Joseph Schumpeter described this process as 'creative destruction', pointing out its fundamental importance to capitalism (Schumpeter, 2008, p. 85).

Stephen Kline and Nathan Rosenberg, whilst presenting the concept of the chain process of innovation, proposed the following typology of innovation (1986, p. 279):

- new product;
- new process of production;
- the substitution of a cheaper material, newly developed for a given task, in an essentially unaltered product;
- the reorganization of production, internal functions, or distribution arrangements leading to increased efficiency, better support for a given product, or lower costs;
- an improvement in instruments or methods of doing innovation.

Apart from the above classification, the following innovations were differentiated (Kline & Rosenberg, 1986, pp. 288-304):

- evolutionary – the small, cumulatively important, evolutionary changes that reduce costs and bring better fit of the product to various market niches;
- radical, revolutionary – these occurrences are rare, but often mark major changes that create whole new industries, and they should therefore not be excluded from consideration. Radical innovation is inherently a learning process. It is very difficult and may be counter-productive. Recent examples include semiconductors, lasers, atom bombs, Internet, and genetic engineering.

Stephen Kline and Nathan Rosenberg also specified a spectrum of innovations, a field within which all innovation occurs (1986, p. 294): "… it is far better to conceptualize this range as a spectrum than to think of two kinds of innovation, revolutionary and evolutionary. Where a given task lies along this spectrum of uncertainty has a major influence on many aspects of what is appropriate innovation." Since a certain spectrum of innovation was defined, with two types of innovation identified as the boundary lines of demarcation-on the one hand, evolutionary, and, on the other, revolutionary-then the question about the definition of these lines arises. How can one distinguish a change that is a refinement from evolutionary innovation, which is already part of the innovation spectrum and therefore lies within that spectrum? What are the criteria constituting this demarcation line that allow distinction between what is an innovation and what is not (and, such as lies beyond the innovation spectrum)? The solution to this problem, as well as to the problem of the second demarcation line in the innovation spectrum, for radical innovation, is proposed in the results and conclusion subsections.

According to Christensen et al. (2004, pp. 277-279), innovations are divided into two main types:

- sustaining to firms – developed systematically and allow firms to provide better and more profitable products that meet the expectations of the most demanding customers in the market;
- disruptive – initially inferior to existing offerings, not good enough to meet the performance requirements of the core market. There are two types of disruptive innovation:
  - those that can compete against non-consumption and establish a completely new market (new-market disruption), and
  - those that can deploy a business model that profitably serves the less demanding customers (low-end disruption).

The systematic innovations play two fundamental roles in the market environment Christensen et al., (2004, p. 284):

- they define the path of incumbent improvement, and
- they allow for disruptive companies to develop their own improvement trajectories.

In the area of sustaining innovations, a classification system has been proposed that outlines the three main types of innovation Christensen et al., (2004, pp. 284-285):

- displacement sustaining innovations – are innovations that target a specific piece of an industry's value chain;
- radical sustaining innovations – are the complex end of the continuum, tend to be very complicated and expensive, can be introduced only by integrated incumbents that control large swaths of an industry's value chain, and also give firms an opportunity to dramatically change their competitive position in the market;

- incremental sustaining innovations – offer smaller improvements than radical sustaining innovations, are less expensive and less complicated, and, therefore, have less influence on competitive position in the market.

The point of distinction between the abovementioned innovations is the point of modularity criterion presented by Clayton Christensen. If innovation occurs at a point of modularity, then it is a displacement innovation. Otherwise, it is radical or incremental innovation. In Clayton Christensen's typology of innovations Christensen, et al., (2004), radical and incremental innovations are in the same area of the continuum. The same incumbent company can easily and efficiently create radical and incremental innovations. On the other hand, there is no continuity between sustaining and disruptive innovations, as the latter involve the introduction of other and, therefore, new products to the market (Figure 1).

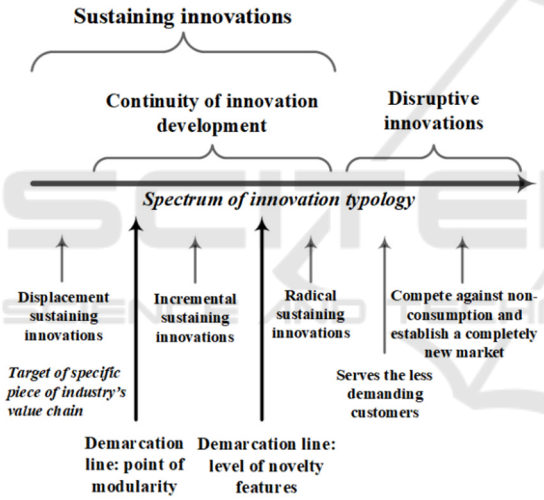

Figure 1: Spectrum of innovation typology based on Clayton Christensen's concepts.

The scale of modularity (novelty) in the area of radical and incremental sustaining innovations of the same product is a factor that distinguishes these innovations. So, there is a spectrum of innovations in the same product or service, with level of novelty features, which defines the following demarcation lines (Figure 1):

- for incremental sustaining innovations – a single change that has a novelty feature,
- radical sustaining innovations – the number or complexity of changes that have a large novelty feature.

The demarcation line between the continuity of innovation development (Figure 1) and displacement innovations is the point of modularity. The open question in the presented concept is to determine the degree of complexity of improvements between incremental and radical sustaining innovations, the latter being defined as the introduction of many changes at the same time or as a big leap in the development trajectory.

The lack of clarification through quantitative indicators (Figure 1) leaves efforts to identify a precise position for the demarcation line between these types of innovation open, significantly impeding its use in the innovation measurement model.

The spectrum of change, characterized by the novelty feature, was also defined by Joe Tidd, John Bessant and Keith Pavitt. On the one hand, incremental innovation has been adopted as the border of the discussed area, and, on the other hand, within radical innovation, the innovation termed by the authors as 'novelty for the world' was adopted. The defined area of changes, characterized by the novelty feature, makes reference to each of the four types of innovation (four "P") Tidd, et al., (2005, p. 10):

- product innovation – changes in the things (products/services) that an organization offers,
- process innovation – changes in the ways in which they are created and delivered,
- position innovation – changes in the context in which the products/services are introduced,
- paradigm innovation – changes in the underlying mental models that frame what the organization does.

The presented typology, therefore, represents a spectrum of innovation where each type has an area of innovation ranging from incremental innovation-as the minimum, representing of 'doing what we do better'-to radical innovation-as the maximum, representing of 'new to the world' Tidd, et al., (2005, pp. 11-13).

'New to the world' has been defined as introducing to the market new goods and services that lead to the emergence of a new market. An example of this kind of innovation that resulted in the emergence of a new market is the introduction of the first telephone, radio, TV, computer, wireless phone, and steam engine. Such innovations have been described separately in the conceptions of Joseph Schumpeter and Clayton Christensen, removed from the continuous area of changes in the innovation spectrum, as they are completely novel. Specifically, in the Clayton Christensen conception, new to the world innovation is defined outside of the continuity of sustained innovations development area, due to the

fact that it is not a result of systematic development of a product presented previously and therefore known in the market. On the other hand, further development of a completely new product that had previously been introduced belongs to the continuity of sustained innovations area.

Another example of innovation typology that can be found in the literature is the innovation matrix, which presents three types of innovation, linked to the development levers in two areas Davila, et al., (2012, p. 41):

- the business model, which contains three levers: value proposition, value chain, and target customer;
- technology, which also contains three levers: product and service, process technology, and enabling technology.

The following three types of innovation are specified in each of the two areas Davila, et al., (2012, pp. 29-46):

- incremental – small change in one or more of all six levers within either business model and technology;
- semi-radical – business model-driven innovations include:
  - significant change in one or more of the three levers of the business model area;
  - small change in one or more of the three levers of the technology area;
- semi-radical – technology-driven innovations:
  - small change in one or more of the three levers of the business model area;
  - significant change in one or more of the three levers of the technology area;
- radical – significant change in one or more of all six levers within either business model and technology.

This concept (Figure 2) highlights the role of technological innovation and the impact of the application of new technologies on products, services, processes, and business model. As, in the previous concept, radical innovation is identified through the novelty of the object of implementation as a whole, an approach has been proposed whereby the type of innovation is defined by distinguishing between improvement – which, in this concept, means changes made to existing products – and novelty, which refers to wholly new and therefore non-existing objects of implementation. This distinction represents the demarcation line between incremental, semi-radical, and radical innovations. Given the criterion of distinguishing between small and significant changes, it leaves room for different interpretations, and not specify whether it is a single or cumulative change. After all, it is not necessarily the case that a small criterion that marks a single change is not at the same time significant.

The graphical representation of this innovation typology is shown in Figure 2.

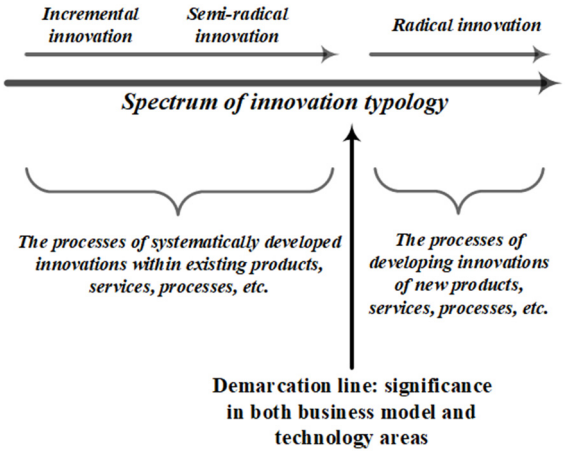

Figure 2: Spectrum of innovation typology based on concepts of Davila et al.

The blurry criterion causes creation of a single area of the typology of innovation, where a single demarcation line is characterized by subject to interpretation drift. It is important to point out in this concept the need to measure appropriately selected input values and output innovations including tangible and intangible assets that represent two *ex ante* and *ex post* areas of the innovation process Davila, et al., (2012). It is infeasible to design a valid innovation measurement model without simultaneously including the two types of variables belonging to both phases of the innovation process.

Vijay Govindarajan and Chris Trimble (2005, pp.21-22), proposed four different types, thus introducing a basic distinction between the types of innovation:

- continuous process improvement – improves existing business and involves countless small investments in incremental process innovations;
- process revolutions – improve existing business processes, but in major leaps—say, a 30 percent increase in productivity—through the implementation of major new technologies;
- product or service innovations – are creative new ideas that do not alter established business models;
- strategic innovations – they may include innovations in process or product but always involve unproven business models.

As innovation development is complex, multidimensional, and burdened by increased risk

level, each of the specified types of innovation requires a different management approach, so all efforts should be made at the planning stage of innovation development, followed by measurement and analysis of its effects with particular attention to unambiguous conclusions. Attention should be drawn to the quantitative specification given in the description of the revolutionary process, which represents a 30% increase in productivity, as the minimum criterion for this type of process. A similar criterion was proposed by Richard Leifer, et al. (2000, p. 5) as one of the conditions of a radical innovation project-namely, a 30% reduction in costs or a fivefold improvement in the achieved parameters that describe current functionalities-which, together with the description of revolutionary process by Vijay Govindarajan and Chris Trimble, allows treatment of these two categories as one type of innovation (Figure 3).

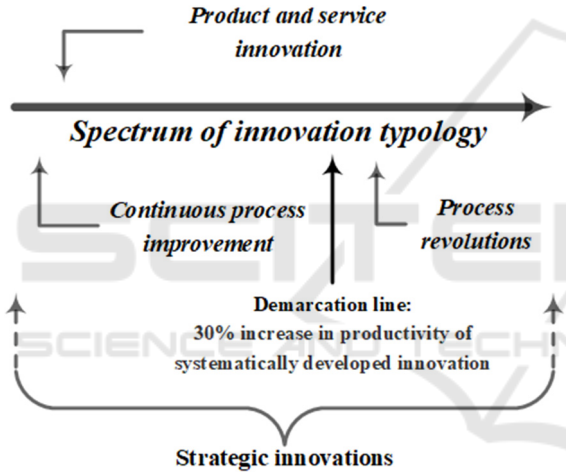

Figure 3: Spectrum of innovation typology based on concepts of Vijay Govindarajan and Chris Trimble.

In the presented typology of innovation, the continuous improvement process and the revolutionary process are a single, continual area of innovation that is being systematically developed. The criterion that distinguishes the continuous improvement process from the revolutionary process is the achievement of the proposed boundary value of efficiency, which belongs to the output values of the innovation measurement model. This value thus identifies the unambiguous position of the demarcation line, without drift, as was the case in the previous innovation typologies. The boundary value can be reached by implementing a new technology, which differs from Tony Davila, Marc Epstein and Robert Shelton's concept, where the introduction of a completely new technology is considered as semi-radical innovation, regardless of the increase in performance. Exceeding the boundary value can also be achieved either by a single improvement or by many cumulative improvements. In this innovation typology (Figure 3), we can speak of the cumulative nature of improvements or incremental innovations. When you exceed the boundary value of the selected indicator, you can speak of radical innovation. In contrast, in the area of product and service innovation, the boundaries between the types of innovation have not been specified. Nevertheless, product and service innovation compose one area of innovation that includes the entire spectrum of innovation typology, from incremental innovation of the same product or service to radical innovation of a new product or service.

Taking radical or revolutionary innovation together with incremental innovation, as one area of sustaining innovation, implies the need to establish a criterion for distinguishing between these two types of innovation in a single spectrum. Thus, the question arises whether these boundary values can be set separately for the input or output values of the innovation process.

An example of the concept of introducing tangible boundary values as demarcation lines between incremental and radical innovations is exemplified in Richard Leifer's proposal Figure 4).

This concept proposes two criteria for distinguishing between incremental and radical innovations Leifer, et al., (2000, pp. 4-5):

- novelty of used technology:
  - learning about new capabilities that technology offers, which leads to improvements in the existing products;
  - applying new technology, which leads to the development of new products;
- effects achieved by incremental and radical innovations:
  - incremental innovation highlights the issues related to the reduction of production costs and / or development, amendment, or extension of existing product functionality with new capabilities, which requires a deepening of competences within existing technology;
  - radical innovation highlights the creation and development of new types of businesses (or permanent changes in the way they are carried out) and the emergence of new product lines, which is possible to achieve on the basis of new ideas, technologies, or significant cost reductions.

The distinctions were made based on the example of technological innovation (Figure 4):

- criterion for the application of technology, belonging to the input quantities, where:
  - incremental innovation, as learning and applying new capabilities of known technologies;
  - radical innovation, as the introduction of new technology, which leads to obtaining a new product;
- the criterion of achieved results, belonging to the size of the innovations output quantities, where:
  - incremental innovation:
    - ✓ lowering production costs;
    - ✓ change or extension of existing product functionalities, requiring deeper competences in current technology;
  - radical innovation:
    - ✓ creation and development of new business (or permanent changes in the way it is run);
    - ✓ creation of new product lines, which is possible to achieve on the basis of new ideas, technologies, or significant reduction of production costs.

Both types of innovation are achieved as part of projects, which results in the process of systematic development. On the basis of differences in the implementation of innovation development projects, it was determined that, unlike projects bringing about incremental innovation, projects involving radical innovation have the following characteristics Leifer, et al., (2000):

- completely new set of functionalities designed to be achieved;
- improvements to the existing functionalities, only in the event they achieve five times better results than the previous ones;
- significant cost reduction, amounting to a minimum of 30% of current costs.

This kind of quantitative and qualitative specification makes it possible to unambiguously distinguish between incremental and radical innovations, thus determining the demarcation line without drift in the continuous innovation development spectrum (Figure 4).

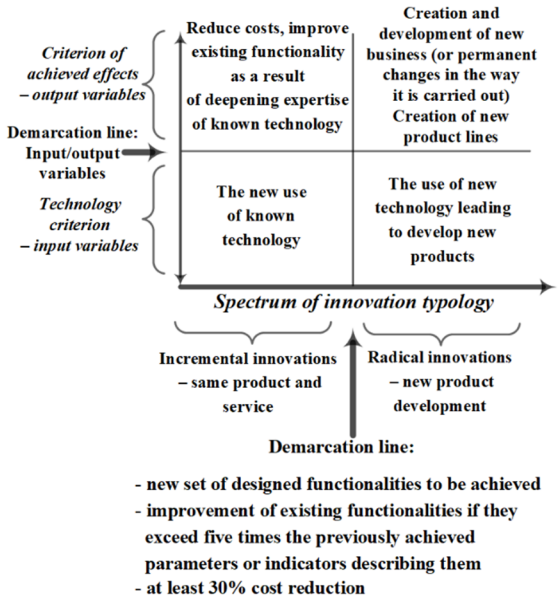

Figure 4: Spectrum of innovation typology based on concepts of Richard Leifer et al.

Therefore, from all the presented concepts, this seems to be most appropriate for use in the innovation measurement model. It seems that it is also possible to use this concept as a starting point for building a model for measuring innovation.

The development of knowledge, creativity, and need, which are the sources of innovative ideas, are not the exclusive domain of companies today. The development of ICT, the increasing availability of technology, and the presence of ideas outside the internal structure of the company leads to the opening of the innovation process to the economic environment. This leads to the concept of open innovation, which (unlike closed innovation) is defined as a process where valuable ideas can come from within or outside the country, region, or enterprise. This approach means treating equally the significance of external and internal ideas, inventions, or patents Chesbrough, (2005), Wisła, (2012), Sierotowicz, (2015, 2017).

3 MATERIALS AND METHOD

There is no doubt that innovation is a process not only complicated but above all complex. The traditional scientific approach used to describe new and unrecognized phenomenon was based on reductionists methodologies. Such approach, used commonly in XX century, mainly consisted in searching for the most important components of the

complicated phenomenon, and then reducing its description to elements considered to be common. This approach raised discussion what are the common elements which describe in a very limited particular phenomenon taken under research. Different arguments and experience provide not only common characteristic, but many different concepts, typologies and approaches to the same phenomena. Discussion continues over three decades and still there is no way to achieve the consensus. There is no issue related to methodology, but rather inadequate methodology used to describe not only complicated but complex phenomena as the innovation development process is. According to complexity theory, Richardson (2008), Cimini et al., (2017), the phenomenon is not only complicated but complex when consists of elements, where each of these elements is also complex. The innovation development process is definitely complex phenomenon, since people, (scientist, researchers, engineers and entrepreneurs) taking part of it Espinosa et al., (2017). That is the point of novelty presented in this paper. If innovation development process is complex, then in order to describe it more deeply and in constitutive way, the complexity theory paradigms, Cicmil et al., (2017), Espinosa et al., (2017), along with *mutatis mutandis* methodological approach was used. There is no reason to identify common components, because each innovation development process is different. In the complexity approach, it should be rather identified those, which constitute innovation development process, which satisfy the condition sine qua non of the studied phenomenon. In the theory of complexity, it is clear that a comprehensive description of the complex phenomenon is not possible. However, without reducing the phenomenon to several elements, it is possible to indicate the ones that constitute this phenomenon and create unifies spectrum of innovation development process and innovation measurement model.

4 RESULTS - TOWARDS A UNIFIED TYPOLOGY OF INNOVATION AND INNOVATION MEASUREMENT MODEL

A properly designed innovation measurement system (to which analysis of patent data belongs) cannot rely solely on commercialization output values, but must also include input values. Two main stages need to be distinguished while preparing the innovation measurement system:

1) an analysis of the potential inputs and benefits that can be gained as a result of the achievement and commercialization of the generated added value; and
2) measurement and analysis of inputs and benefits gained in real time, when implementing a specific innovation development project.

In the first stage, the potential value of innovation requires analysis for the two phases of the planned innovation development project:

- investments, expenditures, and costs, often incurred over many years, relating to the *ex ante* phase in the area of commercialization; and
- the benefits that can be achieved in various forms of commercialization of the generated added value, and therefore taking place in the *ex post* phase.

This stage of analysis should take into account all possible forms of *ex ante* analysis, enabling as precisely as possible the prediction of various scenarios for the development of innovation. There is therefore room for appropriately selected econometric analyses, foresight analyses, SWOT analyses, as well as analyses aimed at indicating the sources of financing for the project, the ways and costs of acquiring the sources, the risk of innovation development failure, the needs and expectations of the market concerned, the absorption capacity of the target market, and many other methods and techniques known in the field of project management (PMI, 2013). It should be noted that commercialization is also a cost factor for the

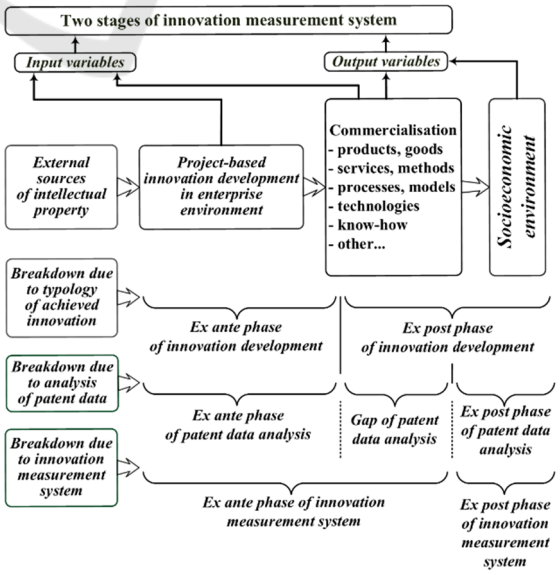

Figure 5: Two stages of innovation measurement model.

innovation development process (Figure 5). This is the input value of the innovation measurement model, which belongs to this model (Figure 5). In order to achieve the highest level of efficiency, script variants of commercialization should be developed for both radical and incremental innovation. Therefore, the demarcation line between the *ex ante* and *ex post* stages, in this analysis, is not located on moment of implementation but before choosing the most effective form of commercialization (Figure 5).
It may turn out that the launch of a new innovation development project on the basis of invention, combined with patents already owned, enables the development of radical innovation, whose effects, after analysis, show an achievable, and many times higher efficiency level than simple implementation of the final product constituting incremental innovation. Hence, in this case, it seems necessary to analyze the patent gap Okoń-Horodyńska et al., (2012).

In the second stage, the innovation measurement model is used to analyze, on the basis of real data, the actual projects (or portfolios) of the innovation development. At this stage, the criterion of division into *ex ante* and *ex post* stages is the area of commercialization. It seems useful in this case to periodically carry out an analysis of the trajectory of innovation development, which, in the *ex ante* phase, has to answer the following question: is the goal that was set at the start of the project still achievable in the same form? This is the question pertains to both competition activities, and thus the early implementation of the assumed innovation by competition, as well as the estimation of the achievement of the goal. In addition, when measuring and analyzing in real time, the specificity of the measurement is different. In the Oslo Manual (2018), the difference is defined as a subjective and objective approach. The measurement based on actual data is obviously stretched, because it covers the life cycle of a given innovation in a socioeconomic environment. The demarcation point that marks the end of this stage is dependent on the form of commercialization. It will be designated differently while licensing and when the product (or service) is deployed to the target market.

In both the *ex ante* and *ex post* stages of the innovation measurement model, where commercialization is the demarcation area, it is possible to determine the type of innovation as the objective to be achieved within the project of innovation development. In the presented concepts of innovation typology, the main difficulty was in unambiguously defining the division criterion which determine position of demarcation line without deprived of the significative drift between the different types of innovation. Moreover, the vast majority of the presented concepts are based on *ex post* factors in relation to the implementation. In the presented concept of innovation typology, it is proposed that the demarcation criterion be unified in order to distinguish between radical and incremental innovation, both *ex ante* (in the stages of initial analysis, where the goal to be achieved is set within the design of the innovation development project), as well as *ex post* related to the fact of commercialization, with the distinction between these as follows:

- radical innovation is the introduction of a new-i.e. absent so far-type of product, service, method, process, or model (including business model) to the socioeconomic environment, regardless of the form of this introduction (commercialization) or the geographical area concerned;
- incremental innovation is the introduction of a new, improved version of an existing product, service, method, process, or model (including business model) to the socioeconomic environment, regardless of the form of this introduction (commercialization), the geographical area concerned, or the nature of improvement (single or cumulative).

In addition to the proposed demarcation line between types of innovation, the proposal includes a demarcation line that allows for the distinction between incremental innovation and minor changes, modifications, and improvements that may be cumulative. The criterion for this distinction is that minor changes, modifications, and improvements belong to the kaizen sphere, and, even being cumulated, do not lead to the introduction of a new version of an existing product, service, method, process, or model (including business model) to the socioeconomic environment. In other words, the demarcation line, which is the boundary between what is innovation and what is not yet, is outlined by the kaizen concept Imai 1986), Ortiz (2009) and Maurer (2012). Where kaizen ends, incremental innovation begins. On the other hand, on the other side of the innovation area, radical innovation is not limited, except by the level of possessed knowledge, technical and technological capabilities, and imagination of the creators. The presented proposal makes it possible to clearly identify the type of innovation (Figure 6):

- radical, and
- incremental.

The introduction of the presented typology with the *ex ante* and *ex post* stages constitutes the unification of considerations concerning the type of innovation. It forces a clear definition of the type of innovation that is to be developed as added value, at the early stages of planning and designing the innovation development project, which will remain relevant during project implementation.

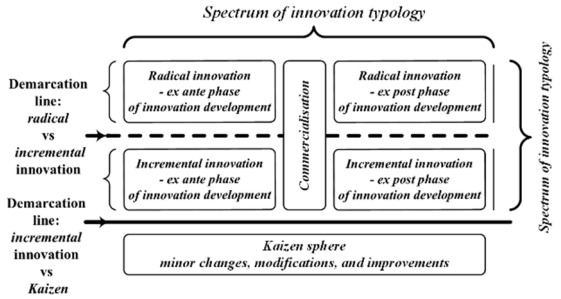

Figure 6: Two stages of innovation measurement model.

At the same time, the innovation measurement model, being a part of the presented innovation measurement model, must be flexible, which should be reflected in the systematic analysis of the socioeconomic environment for the presence of such or similar innovations, and including the analysis of patent-related gaps. It seems that, in the age of globalization, and with the increasing availability of information, the inclusion of the geographical factors in the innovation typology systematically loses its importance.

5 DISCUSSION, CONCLUSION AND FUTURE RESEARCH

The definition of innovation shows that implementation is a *sine qua non* of innovation Oslo Manual (2018). The fact it has been noted allows you to move onto the next stage, which is the identification of the innovation type. Hence, the presented typologies of innovation are built on the basis of the *ex post* stage in relation to the implementation. The exception to this rule is the division into areas that relate to innovation, that is, the product, process, organization, and marketing areas Oslo Manual (2018). This kind of typology can be used both in the *ex ante* and *ex post* stages of the multidimensional development of innovation. However, this kind of typology does not help to carry out an analysis of the expected *ex post* effects that should be made in the *ex ante* phase, which is essential at the stage of planning and designing of the innovation development project Cicmil et al., (2017). It does not answer the question: what kind of impact will the innovations planned in the strategy have on the economic and social environment? At the same time, modern companies, both small and global, are developing innovations within individually designed innovation development projects, which comprise the innovation process as a whole, and therefore consist of *ex post* and *ex ante* stages in terms of implementation.

Within the typology of innovation, implementation is a hotly debated form of commercialization of innovation. Innovation also takes place when the intellectual property value developed in the course of a project has been protected by law, and then, for example, licensed. Hence, when talking about innovation, it should not be linked to implementation as a specific demarcation line between what is *ex ante* and what is *ex post*. In fact, design work is about generating value that resembles a growing wave of values, where some of it is isolated and restricted by patent regulations, and then commercialized, for example, by licensing. The phenomenon of incremental wave of added value pertains to any type of innovation development project. This is evidenced by the fact that such projects are one of the most important sources of generating innovative ideas Drucker (2006), Bessant et al., (2015). On the other hand, not every value is used in the further design work. Therefore, it is important to discuss the area of intellectual property commercialization, since, for example, patents can be commercialized in various forms and times, not necessarily in the form of a final product. Hence the proposed demarcation area between *ex ante* and *ex post* stages in the innovation process.

Commercialization should be professionally managed Govindarajan et al., (2010). Hence, at leading global corporations, you can find a separate intellectual property management department that has its own strategy. The tasks of this department relate not only to the commercialization of intellectual property, but also to their acquisition from external sources through acquisitions, mergers, acquisition of patent rights to selected inventions, transfer of completed technologies, and development processes in progress IBM (2001, 2005, 2010, 2016). The processes of acquiring and commercializing intellectual property, and indeed intellectual property management strategies, are therefore part of the routine functioning of the corporation.

In practice, the proposed typology of innovation and the innovation measurement model means that the complex and systematic (sustaining) development of

incremental innovation seems to be faster to achieve, to require less investment, and, in combination with the patent gap analysis, seems to serve as a tool offering competitive advantages to both the enterprise and the national economy. The conceptual framework of the innovation measurement model arose from the proposal of one consistent typology of innovation. Both a consistent typology of innovation and a conceptual framework of the innovation measurement model are the results achieved in the first phase of the conducted research. The future research will be the second phase of the design process, where the most suitable mathematical analysis will be selected and performed based on empirical data related to the innovation development processes.

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