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Open Innovation Readiness Assessment within Students in Poland: Investigating State-of-the-Art and Challenges

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Abstract: In light of Poland's innovation performance level being below 70% of the EU average, open innovation can be a key path for innovation capacity increase. This paper explores the readiness of students in Poland for open innovation (OI). The study is based on a survey of a sample of 500 students using the Computer-Assisted Web Interview research technique. The main aim of this paper is to investigate Polish students' attitude to open innovation—in particular in terms of social product development, crowdsourcing, crowdfunding, and the sharing economy—to assess the state-of-the-art and identify challenges. Students are selected as the target group because they are open-minded, eager to use new solutions, and will soon enter the business sector to either become the staff of companies or set up their own startups or SMEs. However, the study shows that Polish students, if they use the OI-based platforms at all, use them passively. The key barriers identified within this study are a lack of knowledge about the open innovation paradigm, its elements and opportunities, and an issue of trust. Therefore, a change of mindset, the adjustment of universities' curricula, and the development of open innovation culture are critical.

Keywords: open innovation; social product development; crowdsourcing; crowdfunding; sharing economy; CAWI

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1. Introduction

At present, in the era of Industry 4.0, the way in which companies operate on the market is facing a significant change—not only in terms of manufacturing processes but also in terms of management and innovation. Implementation of state-of-the-art technologies (including the Industrial Internet of Things, cyber-physical systems, digital twinning, big data, and additive manufacturing) influences companies in several ways—among others by shortening product life cycles, increasing demand for innovation and necessitating rapid product development. In this context, it is worth considering which phenomena, methods, and solutions can support companies in this transformation process and which directions firms should select to successfully operate in the new digital era. According to the study by Mubarak and Petraite, a company cannot accelerate the pace of its innovation by exclusively relying only on its internal resources. This is the reason firms are increasingly adopting an open innovation strategy through collaboration with external stakeholders [1]. Obradović et al. notice that in the "new normal" posed by the COVID-19 pandemic, it is more important than ever to study the effects of managerial competencies, employee training and development, and reward systems in open cultures in manufacturing firms [2]. This statement is unquestionable. In many companies and organizations (including higher education institutions), the COVID-19 pandemic has sped up and enhanced digitalization at different levels. It showed that organizations can work differently from how they used to and that various tasks can be fulfilled digitally. Raghavan et al., notice that, "although these trends vary across sectors and within and across countries, there is an overall increase in the flexibility of organizations and employees in adopting new solutions, making

them more open to innovation" [3]. By implementing open innovation (OI) approaches, manufacturing companies can improve their collaboration process throughout the whole supply chain, minimize production waste, ensure better working conditions, and adapt business models [2]. Marullo et al., emphasize that "OI can allow firms to cope with the uncertain conditions that characterize economic downturns" [4]. A new reality has shown that remote and digital work is possible and often very efficient. Therefore, an increasing number of companies are considering opening up to new innovation models.

What is more, as the Open innovation 2.0 yearbook 2017–2018 outlines, "due to the very rapid development of digital technologies (e.g., robotics, artificial intelligence, and high-performance computing), we are facing a transformation highlighting the role of individuals/competencies and communities in the socioeconomic context" [5]. As a result of this process, not only do jobs and ways of working change dramatically, but we also face a significant structural change that causes certain professions to disappear while new ones come into being. It also brings a challenge to higher education institutions (HEIs) to redesign their curricula and ways of teaching as "new professions and new curricula are needed to provide skills in innovation systems creation, functioning and harvesting" [5].

For some time now, the European Commission has strongly supported OI and open innovation 2.0 (OI 2.0), a paradigm built upon integrated multidisciplinary collaboration, co-created shared value, cultivated innovation ecosystems, unleashed exponential technologies, and a focus on innovation adoption [6]. In global terms, the innovation performance of the EU is still behind those of Australia, Canada, Japan, South Korea, and the United States [7]. As Chesbrough and Vanhaverbeke underline, "if Europe wants to keep or improve its competitive position in the globalizing knowledge economy in the next decade, then the public policy has to develop some basic guidelines that are in line with the imperative of open innovation" [8]. Authors in general agree with this opinion; however, they also assume that to develop an open innovation paradigm in Europe, bottom-up initiatives should also be carried out and supported.

According to the European Innovation Scoreboard 2021, Poland belongs to the group of Emerging Innovators, which includes Member States with a performance level below 70% of the EU average [7]. This is a group with the lowest innovation performance, placed after Innovation Leaders, Strong Innovators, and Moderate Innovators. Although Poland's performance relative to the EU has increased over time, the vast majority of European countries perform better in terms of innovation than Poland, which means that Poland has to develop new ways to increase its performance. In this context, the right path to follow to boost Poland's innovation capacities can be a policy based on OI and OI 2.0. The starting point for this is an analysis of the current perception of OI among students—the group that will occupy middle and higher positions in the organizational structures of enterprises at any moment. They also represent a part of society that is likely to enhance innovation performance by creating startups that can be a significant source of many groundbreaking innovations [9]. There are over 1,200,000 students in Poland, whereas the population is slightly over 38,000,000. This means that, on average, every thirtieth Pole is studying. How this group understands OI depends somewhat on how OI will develop in the near future in business and industry. Therefore, this paper focuses on investigating Polish students' perception of OI and assessing their activities in this context. The study presented in this paper was conducted within the international project SYNERGY—"Synergic networking for innovativeness enhancement of Central European actors focused on high-tech industry" co-funded from Interreg Central Europe [10–12].

The paper is organized as follows: first, a literature review on the matter of open innovation in general and in four aspects—(1) the transition from open innovation to open innovation 2.0; (2) open innovation in the context of SMEs; (3) open innovation from the university's perspective, and (4) open innovation in Poland—was carried out. Second, a list of research questions concerning the main issues that arose from the previous step was identified. Subsequently, a structured survey was designed and conducted on a sample of 500 students using the Computer-Assisted Web Interview research technique. Next, results

analysis was performed based on (1) descriptive analysis and (2) initial quantitative analysis based on regression modelling and artificial neural networks. Finally, an outlook on the state-of-the-art and challenges as well as a summary of the results and the conclusions of the study are presented.

2. Literature Review

2.1. Introduction to Open Innovation

Open innovation has been discussed vastly in literature in recent years. "The paradigm of OI has developed over the years, and this has encouraged practitioners and researchers to study this topic from different perspectives" [5]. According to the Open innovation 2.0 yearbook 2017–2018, "open innovation has matured into a major innovation process during the past decade. Digitalization has enabled more sophisticated collaboration and value creation models that, along with the accumulated learning and knowledge base, have encouraged companies of all sorts to start with open innovation initiatives" [5]. The usage of information and communication technologies as tools enabling the development of OI has been indicated in [13,14]. Moreover, Inauen and Schenker-Wicki point out that information and communication technologies "allow different sectors and low-tech industries, including consumer goods, food, architecture and logistics, to begin opening their boundaries up systematically toward users, suppliers, universities, and other stakeholders" [13]. Zhou et al., point out that, contrary to closed innovation, OI "increases the external access to innovation resources of the firm and improves the holistic nature of R&D and innovation based on a wide range of knowledge and technology" [15]. Klofsten et al. underline that business success demands that companies focus on combining external assets with internal assets and capabilities and "collaborative approaches such as open platforms and open innovation that help organizations to generate new ideas, develop better products, solve problems, promote and even finance projects " [16]. From a business perspective, an increasing number of companies "are joining together and creating innovation ecosystems to improve their innovation capabilities by interacting with heterogeneous actors" [17]. It should also be noted that not only are companies introducing OI-based solutions to their everyday work, but also universities and authorities are slowly trying to become more open [18,19]. For the purpose of this paper, in this chapter, OI will be investigated from four primary perspectives—(1) the transition from open innovation to open innovation 2.0; (2) the SMEs' point of view, as they are one of the key groups responsible for a country's innovativeness; (3) open innovation from the university's perspective; and (4) the open innovation situation in Poland.

2.2. The Transition from Open Innovation to Open Innovation 2.0

Open innovation 2.0 can be defined as "a new paradigm based on a Quadruple Helix Model where government, industry, academia and civil participants work together to co-create the future and drive structural changes far beyond the scope of what anyone organization or person could do alone. This model also encompasses user-oriented innovation models to take full advantage of ideas' cross-fertilization leading to experimentation and prototyping in real-world setting" [20]. It is also explained as "a new paradigm based on principles of integrated collaboration, co-created shared value, cultivated innovation ecosystems, unleashed exponential technologies, and extraordinarily rapid adoption" [21]. Jarvenpaa and Wernick underline the role of research units of universities in the context of OI networks [22]. Similarly, Chiaroni et al., indicate that companies need academia as actors outside their boundaries in order to effectively inflow and integrate knowledge into their innovation [23]. Kitsios et al. underline the role of media and state that they are a "substantial element in any innovation process and acts as a communication channel between the general public and potential auditors and implementers" [19].

Critical elements of OI 2.0 include wide networking, sustainability, and the co-creative collaboration of representatives of the society. Santos et al., notice that "finding suitable partners regarding several knowledge areas is crucial to achieving success with innovation

in the collaboration context" [24]. The recent findings published in the Open innovation 2.0 yearbook 2017–2018 underline three main factors enabling the transition from an OI to an OI 2.0 strategy: (1) the presence of a technological pivot, (2) a clear appropriation strategy, and (3) the ability to orchestrate a rich ecosystem [5]. The authors of this report also list four main conditions of success in the transformation process to OI 2.0—they are (1) careful balancing of internal and external resources, (2) leveraging on organizational culture, (3) development of a sound business model, and (4) managing human resources [5]. Practitioners must carefully consider these factors to gradually overcome organizational barriers, which are significant obstacles in the mindset change from OI to OI 2.0.

Terms closely related to open innovation and especially OI2.0 include crowdsourcing, crowdfunding, microworking, Social Product Development (SPD), and sharing economy. Brabham defines crowdsourcing (CS) as "an online, distributed problem-solving and production model that leverages the collective intelligence of online communities to serve specific organizational goals" [25]. In the literature, crowdsourcing is usually divided into four main types according to Howe's proposal: crowd wisdom, crowd creation, crowd voting, and crowdfunding, which "describes a funding model whereby individuals use the Internet to contribute relatively small amounts of money to support the creation of a specific product or the investment in a specific business idea" [25]. Deloitte, however, proposes a more detailed classification of CS platforms: crowd collaboration, crowd competition, crowd labor (microtasks, mesotasks, macrotasks), crowdfunding, crowd curation, and user-generated content [26]. Microworking (or microtasking) can be defined as "a new form of working beyond organizational boundaries, created mostly by social media technologies, in which organizations or individuals post engagement in work on a web-based, third-party platform in exchange for monetary remuneration" [10]. According to Forbes et al., Social Product Development (SPD) is a group of "coalescing tools and socio-technologies" represented by several tenants, including crowdsourcing, mass collaboration, open innovation, and cloud-based design and manufacture (CBDM)" [27]. SPD can also be explained as the joint development of a new product by a given group of users as part of a specific portal dedicated to this process (e.g., quirky.com accessed on: 1 October 2021). Another term investigated in this research, which is also related to OI, is the sharing economy (SE), which can be defined as the "acquisition or distribution of a source coordinated by people for compensation or a certain fee" [28] or as "an umbrella term that describes an emerging consumption trend: online peer-to-peer economic activities for sharing among consumers through intermediary service firms" [29].

2.3. Open Innovation in the Context of SMEs

The literature analysis on open innovation shows that most research has initially focused on the aspect of OI in large firms rather than SMEs [30–32]. Recently however, the number of studies focused on open innovation in SMEs has been increasing [30,31,33–48]. Marullo et al., emphasize that OI empirical research focuses not only on high-technology and large firms but also on low-technology and small firms, as well as public and nonprofit organizations [4]. Although, in general, many papers on the relationship between OI and performance in SMEs are still rather limited [33–35], the results of studies addressing this topic suggest a positive impact of OI on the performance of companies [30,37]. Chesbrough and Vanhaverbeke underline that OI can become a key factor in SMEs' innovation and market performance [8]. What is more, as "most of the European GDP is generated by low-tech and medium-tech SMEs", and the majority of these are not familiar with the benefits of the use of open innovation, it can be noticed that there is still a great potential for European SMEs to grow and innovate, provided that the OI paradigm is introduced [8]. In this context, a question arises—how to make European SMEs familiar with the OI and its advantages? This challenge certainly requires both—bottom up and top-down activities that should raise awareness about the possibilities and opportunities that OI brings. One of the potential paths to spill over the knowledge on open innovation is through students' education, as right after they finish their studies, they bring this knowledge to the business sector.

The topic of open innovation in Europe, especially in terms of SMEs, has been studied in several countries. Kapetaniou and Lee investigated the OI of SMEs in Cyprus, focusing on domestic and international aspects of openness [41]. In terms of Italy, Verbano, Crema, and Venturini published a paper presenting the OI profiles of SMEs [45], whereas Bigliardi et al. investigated how open innovation processes are managed in the ICT industry [49]. Urbinati et al. performed a multiple case study analysis to study stakeholder management in OI projects in Italy and Sweden [50]. Jarvenpaa and Wernick investigated open innovation networks in Finland [22]. Dong and Netten discussed open innovation in Germany in the context of information technology use for OI initiatives [51]. OI in terms of SMEs was discussed by Gewald and Birkle [52]. According to [52], "Germany has the strongest SME sector of all economies worldwide, followed by China, The US, and Italy. Around 99,8% of all registered corporations in Germany fall into that category, which employs around 80% of the German workforce". This is essential information, bearing in mind that the outcomes of this research show that only 6% of investigated companies in Germany actively uses OI methods, and that the term "open innovation" is not well-known by researched SMEs, although the majority of the firms are willing to integrate external entities into their activities. Bogers, Burcharth, and Chesbrough underline that, especially in terms of emerging markets, "despite the overall optimistic expectations, many companies struggle with the implementation of open innovation" due to many reasons—not only macroeconomic or societal but also organizational and individual [53]. It is especially interesting to find out what are the individual reasons in this context.

2.4. Open Innovation from the University's Perspective

OI, from the university's perspective, is investigated in literature relatively rarely in comparison to the exploration of this issue in relation to SMEs and big companies. Research investigating open innovation from the HEIs' point of view can be found in [54–56]. Open innovation and the role of a university are thoroughly discussed by Howells et al., in [57]. This study is, however, based on a questionnaire survey of companies in the UK. Among others, this research highlights that there exist significant barriers for companies, especially SMEs in particular, to interacting with HEIs [57]. Oganisjana published interesting research on OI among students at Riga Technical University (Latvia) [55]. This survey was, however, limited to only 85 bachelor students within one course, namely "Economics of entrepreneurship", in one semester in 2014. It was focused on the analysis of students' collaborative skills in an OI environment. Oganisjana underlines that taking part in OI activities "requires a specific set of thinking, skills, and behaviors founded on the willingness and readiness to exchange, accept, encourage, cooperate and co-create based on trust and collaboration" [55]. This statement proves that the investigation of students' perceptions and attitudes to open innovation is crucial to assess their later possible involvement in OI areas. Vélez-Rolón et al. published a paper on a case study from Colombia presenting an Open Innovation Community (OIC) for university-industry cooperation. They underlined the importance of students as members of OICs, given their crucial role in setting up bounds between universities and companies [54]. Again, therefore, it seems of great importance to explore how students understand OI. What are their sources of knowledge about the OI paradigm, and how do they act in OI areas—as an active side or rather a passive one? Another study based on a survey conducted among 50 students from 5 different universities in Turkey was performed by Eroğlu and Ekmekçioğlu [58]. This research was more focused on investigating students' preferences in terms of resemblance between product design project courses and open innovation activities. Among others, it was explored whether students were aware of the OI concept—according to this survey, out of "a total of 45 students that answered this question, 39 declared that they did not have an idea about the context" [58]. The results of this study also show that students tend to use media that are easy to reach and trustworthy [58]. This shows that the issue of trust is an important factor to be investigated in terms of the way in which students perceive

OI. Other features and barriers in the context of using OI tools and platforms should also be explored.

2.5. Open Innovation in Poland

From the Polish perspective, open innovation is relatively new, yet several researchers have already investigated it. Generally, the innovativeness of SMEs in Poland is low [59,60]. Researchers list a few main reasons for that—limited resources of the companies, relatively low innovation openness (shallow interest in open sources of innovation), minimal technology transfer-related activities, and a lack of possibilities to take part actively in the innovating process within the company [59,60]. Another study analyzed the biotechnology and pharmaceutical industry in Poland concerning OI. The results of this research show again that open innovation collaboration among Polish companies is still fledging, and several obstacles are listed, including the following: financial, legal, and institutional barriers, as well as socio-cultural factors [61].

Moreover, most innovating companies select closed innovation or a mix of closed and open innovation collaboration models rather than the OI approach. Dziurski and Sopińska investigated drivers and barriers for open innovation in high-tech and non-high-tech industries in Poland. They surveyed 122 innovative companies, and one of the key findings shows that internal barriers are more critical for both high-tech and non-high-tech industries than external ones [62]. The very interesting topic of the OI capacity of Polish universities was explored by Baron [63]. The key findings of this research show that although the universities generally declare openness in their strategic documents and values, this has unfortunately little to do with reality. In this context, Guerrero et al. discuss the aspects of intrapreneurial capabilities of the universities in the digital era. They define intrapreneurial capabilities as "higher-level competencies that determine that entrepreneurial organizations will be able to improve/transform their routines into entrepreneurial actions to integrate, build, and reconfigure internal/external resources to address the challenges of the digital economy" [64].

A literature review on OI in Poland—although the amount of published research is quite limited—shows that Polish companies are somewhat reluctant to implement OI-based models. At the same time, their innovation performance is relatively low. An analysis of the perspective of universities, on the other hand—although it shows that the OI capacity of the Polish technical universities is potentially high—proves that the universities hardly use set up instruments and assets supporting OI for genuine transactions. In the case of both actors of the Quadruple Helix Innovation Model—industry and academia—several barriers exist, and a change of mindset is necessary. Poland, which is classified as an Emerging Innovator, can also still be considered as an emerging market. In this context, it is worth comparing its situation with other emerging economies to consider critical obstacles that may hinder OI implementation. These barriers include [53]:

- bureaucracy,
- corruption,
- the issue of trust,
- a lack of flexibility and the exploitation of external knowledge,
- internal resistance to ideas coming from outsiders or exploited by outsiders,
- a lack of employee autonomy, which is a key element in benefitting from OI successfully.

To summarize the literature review of OI in Poland, it can be stated that research on this topic is still relatively limited. The majority of research on OI in the literature focuses on companies' perspectives—either SMEs or big firms. Outcomes of the studies investigating the situation in Poland show that, basically, Polish companies are somewhat reluctant to the implementation of OI-based models. Authors see a need to explore the root causes of this problem. A starting point to investigate this issue is focusing on students because—as argued earlier—they are the group that either will occupy middle and higher positions in the organizational structures of enterprises at any moment or is very likely to create startups. What is more, as Vélez-Rolón et al. highlight, placing students at the center of

the knowledge transfer process between university and industry allows the addressing of issues related to closing the knowledge gap between academia and the productive sector [54]. The literature review presented above shows that there exists a research gap on how students, especially in emerging economies, perceive open innovation. Therefore, this paper aims to fill in this gap by exploring the readiness of Polish students in Poland for open innovation in several areas. A similar investigation has not yet been published, according to the authors' best knowledge. Thus, the authors believe that this paper may represent a valuable basis for future research on open innovation not only in Poland but also in similar economies—Emerging Innovators in Europe or emerging economies worldwide—e.g., in North Africa [65] or South America [53].

3. Research Methodology

Bearing in mind the literature review results and the urgent need to enhance innovativeness in Poland, the authors of this paper see the path to increased entrepreneurial and innovation capacity in higher education institutions through the popularization of activities based on an open innovation paradigm. This approach is in line with the recommendations of Chesbrough and Vanhaverbeke, who state that "top-level research and technology development hinge on the availability of excellent scientists and researchers. Universities play a key role in educating new generations of researchers and scientists and in generating new knowledge through research" [8]. Bearing in mind the knowledge gap identified on the basis of the literature review presented in the previous chapter, the main aim of this paper is to explore students' attitude and readiness to open innovation in Poland. This study focuses on the analysis of the knowledge and activities of students regarding open innovation and especially aspects of social product development, crowdsourcing, crowdfunding, microworking, and the sharing economy. The authors believe that they are an inseparable part of the OI concept. Students were selected as the target group of this study for several reasons. First of all, they represent a group of educated people who, in general, are open-minded and eager to test and use new ideas and solutions. Students often seek technological novelties. Moreover, they are the group that will soon enter the business/industry sector and will either become the staff of companies or will set up their own startups or SMEs. Therefore, they will directly bring new knowledge and skills to new jobs. In the near future, they will shape the market. What is more, they are the generation brought up in the Internet era, which is their "natural environment". The outcomes of the literature review show that this kind of research has not been published before, which proves that this study is novel and needed.

Based on the in-depth literature analysis and experience in working with students, we hypothesize that students, use the OI-based platforms passively, if at all. The methodology of the presented study, presented in Figure 1, is based on survey research, which is used in order to: "to answer questions that have been raised, to solve problems that have been posed or observed, to assess needs and set goals, to determine whether or not specific objectives have been met, to establish baselines against which future comparisons can be made, to analyze trends across time, and generally, to describe what exists, in what amount, and in what context" [66]. The study is based on the questionnaire survey, which is "a technique for gathering statistical information about the attributes, attitudes, or actions of a population by a structured set of questions" [67]. When designing the survey, the Authors followed a nine-step procedure of questionnaire development [68], presented in Figure 1. Six main research questions were raised. The survey was conducted in October 2020 on a sample of 500 students using the Computer-Assisted Web Interview (CAWI) research technique.

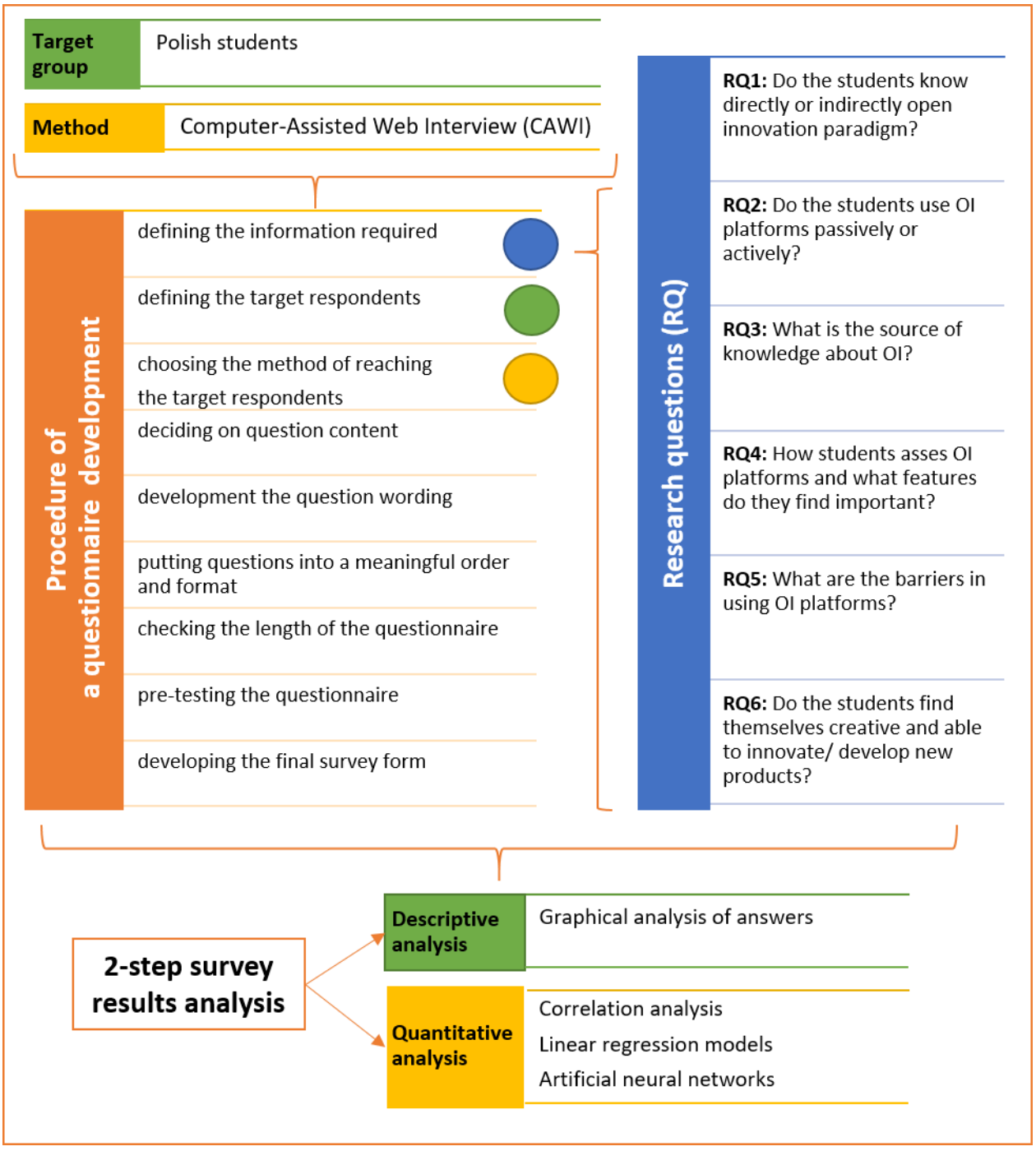

Figure 1. Research methodology.

CAWI is a quantitative data collection technique based on providing information via an online survey questionnaire. The respondent fills in the questionnaire independently, and the system automatically verifies the logical correctness of the answers given and saves them on the server. In this case, the observation of the course of research using the CAWI technique is facilitated by the ability to control changes from anywhere with Internet access. The advantage of using the CAWI type test is the elimination of the so-called "interviewer effect", namely the influence of the interviewer on the respondent's statements. The respondents are guaranteed total anonymity, which influences their more reliable answers to complex, sensitive, or embarrassing issues. CAWI also benefits from presenting the respondent with sounds, movies, or images, which cannot be done during a

traditional telephone interview. According to the above-presented methodology, a final form of the questionnaire was developed. It was composed of 20 questions presented in Appendix A. Next, after gathering the answers, a two-step data analysis was performed—first, (1) a descriptive analysis and then (2) an initial quantitative analysis based on correlation coefficients, regression modeling, and artificial neural networks.

The first part of the quantitative analysis was based on correlation analysis and regression modeling. The dependent variable y was defined as a binary variable. Initially, values of the variable y were aggregated based on the answers related to the questions on active and passive usage of crowdsourcing (CS), crowdfunding (CF), microworking/microtasking (micro), the sharing economy (SE), and social product development (SPD). A set of 25 explanatory variables was created (Table 4) that consisted of factors that may potentially be related to dependent variable y. For the purpose of the regression analysis, variable y was defined as a participation in open innovation activities. In the case of either active or passive participation in any kind of OI area, y takes a value of 1; in the case of no participation, it is 0. Next, five more regression models (respectively CS, CF, micro, SE, SPD) were built. In each of them, the dependent variable y represented participation in one of the investigated areas the open innovation activities ($y = 1$ means active or passive participation in crowdsourcing; $y = 0$ lack of participation). The aim of building these models was to investigate which factors (represented by 25 explanatory variables) influence participation in open innovation.

The last part of quantitative analysis was based on artificial neural network models (ANN) due to certain limitations of the regression modeling. The input layer of the neural network model was based on the set of 25 explanatory variables presented in Table 4. The analysis was performed similarly to regression modeling. At first, a model with aggregated values of variable y was developed—y meaning participation in the open innovation activities—was defined as a categorical variable with three levels: "Actively", "Passively" and "Not", meaning that either a person participates in OI activities actively, or passively, or not at all. Next, ANN models for each investigated OI area (CS, CF, micro, SE, SPD) were created—in which, of these, the dependent categorical variable y represented participation in one of the investigated area's OI activities—respectively "Actively", "Passively" and "Not". These models can serve as a predictive tool for forecasting whether, based on particular criteria represented by the values of the variables x_1–x_{25}, a student will—actively or passively—or will not participate in particular OI activities—namely SPD, SF, SC, micro or SE. The code for the calculations is presented in Appendix B. For both the regression analysis and the neural network models, datasets were split into the training set (70% of data, $n = 357$) and the testing set (30% of data, $n = 143$). Each developed model was assessed based on the misclassification rate. Detailed calculations and assumptions are presented in Section 4.2.

Limitations

Concerning the limitations of our study that should be taken into account, we would like to underline several issues. First, we assumed that the presented research was an initial step for further analysis of the investigated topic. Therefore, our study did not consider the type of studies or qualifications of the questioned students. We assumed that the answers to the developed questionnaire would define an area for further in-depth quantitative investigation. We decided to focus more on the level of correlations rather than causal relations at this point. For this reason we did not define control variables. We focused on descriptive analysis and preliminary quantitative analysis based on regression modeling and artificial neural networks (ANN) models. Data mining-based analysis, however, also needs further development. We must stress that in this paper we decided to limit the regression analysis to linear models. Non-linear regression models were not considered. Further, we stopped the regression analysis at the statistical significance of the model's coefficients. We did not include verification of the random error (residuals analysis) based on a Durbin-Watson test, a Shapiro-Wilk test, and a Goldfeld-Quandt test, runs and symmetry tests, as they are

planned in future research. In terms of data mining techniques, we decided to limit the analysis to neural network models. In the future, we plan to investigate the accuracy of decision trees and a Support Vector Machine for our data. When it comes to developed neural networks models, we did not apply any methods of variables selection (unlike in the regression analysis where we used Schwarz Bayesian Information Criterion—BIC). We developed ANN models with one hidden layer, for which a number of neurons were optimized, yet we did not investigate models with more than one hidden layer. We used resilient backpropagation with a weight backtracking algorithm and did not explore the efficiency of others. Similarly, we used default activation functions, which is another area that may require in-depth investigation. We assumed that further neural networks models' optimization would be explored in the future.

4. Research Results

4.1. Descriptive Analysis

The survey was conducted nationwide on a sample of 500 respondents. The percentage of women participating in the study was 59.4%. Over 4/5 of the respondents were aged 19–24. Every ninth respondent was under 19 years of age, and every thirteenth was between 25 and 29. A similar percentage of respondents indicated that they live either in the countryside or in a city with more than 500,000 inhabitants—the percentage of responses was 22.8% and 23.4%, respectively. Almost 1/5 of the respondents lived in cities with 20,000 up to 100,000 inhabitants, and 15.4% lived in cities with between 200,000 and 500,000 residents. Every tenth respondent lived in a city with up to 20,000 inhabitants (10.0%) or a city with between 100,000 and 200,000 inhabitants (9.8%). 6 out of 10 respondents had a general secondary education. A higher education was indicated by 3 out of 10 respondents, while every eleventh respondent had a post-secondary education. Approximately 1/5 of the respondents had a net income of PLN 1001 to PLN 2000 or PLN 2001 to PLN 3000—19.2% and 20.6%, respectively. An income of up to PLN 1000 per month was on hand for a total of 29.2% of the respondents, while an income over PLN 3000 per month was indicated by a total of 12.6% of the respondents. 18.4% of the respondents refused to answer. Almost half of the respondents were students who were currently unemployed, whereas 50.2% were respondents who studied and worked at the same time.

Analysis of the research results shows that almost all respondents admitted that they actively used social networks (Figure 2); however, only slightly over 1/5 of respondents knew websites to share their idea for a new product (Figure 3).

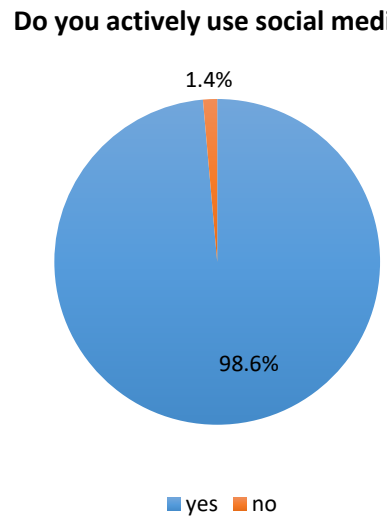

Figure 2. Social media usage.

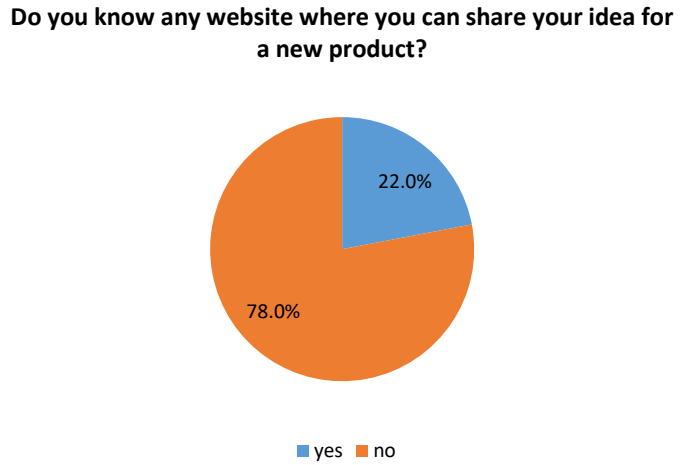

Figure 3. Sharing a new product idea possibility.

Respondents who indicated that they knew the websites where they could share their ideas for new products (n = 110) were asked to indicate the addresses of these websites. In this case, the respondents most often mentioned social media—mainly Facebook and Instagram, with 53 responses each; Twitter was indicated by 14 people, as was Pinterest. 11. 7 respondents pointed to the YouTube platform. The kickstarter.com (accessed on 1 September 2021) website was indicated spontaneously by five respondents, and Producthero.pl (accessed on 1 September 2021)—by 4. Table 1 below includes only those websites/platforms indicated by at least four respondents.

Table 1. List of the portals where ideas for new products can be shared (n = 110).

Portals	Number of Indications (n)
Facebook	53
Instagram	53
Twitter	14
Pinterest	11
Youtube	7
Kickstarter.com	5
Producthero.pl	4

Another question referred to the respondents' familiarity with the concept of open innovation. Obtained answers show that over half of the students do not know the OI concept (Figure 4).

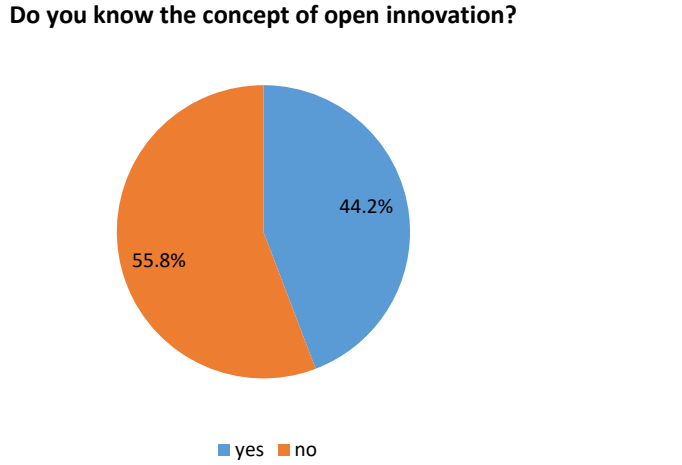

Figure 4. Open innovation concept.

Figure 5 presents the answers of students related to the knowledge of OI terms. Over 50% of surveyed students have come across SPD, yet in terms of the sharing economy, microworking, crowdfunding, and crowdsourcing, the majority of respondents have never heard of them—respectively 56.2%, 54.2%, 58.4%, and 70%.

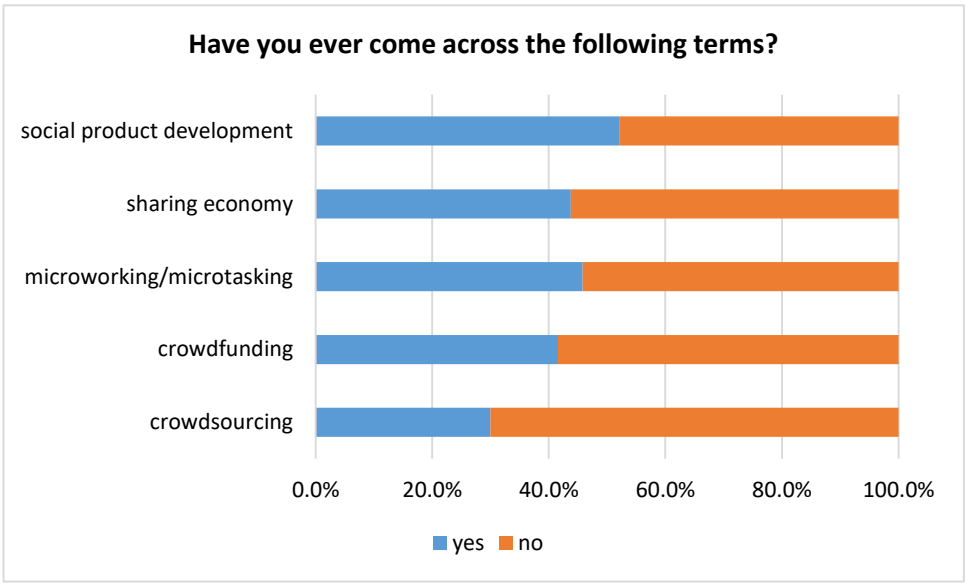

Figure 5. Knowledge of terms.

Students were also asked if SPD, SE, microworking, CF, and CS can be considered elements of OI (Figure 6). In the case of SPD and SE, the majority were sure that they were elements of OI (62.2% and 52.4%). However, in terms of microworking, CF, and CS, most of the respondents were not sure.

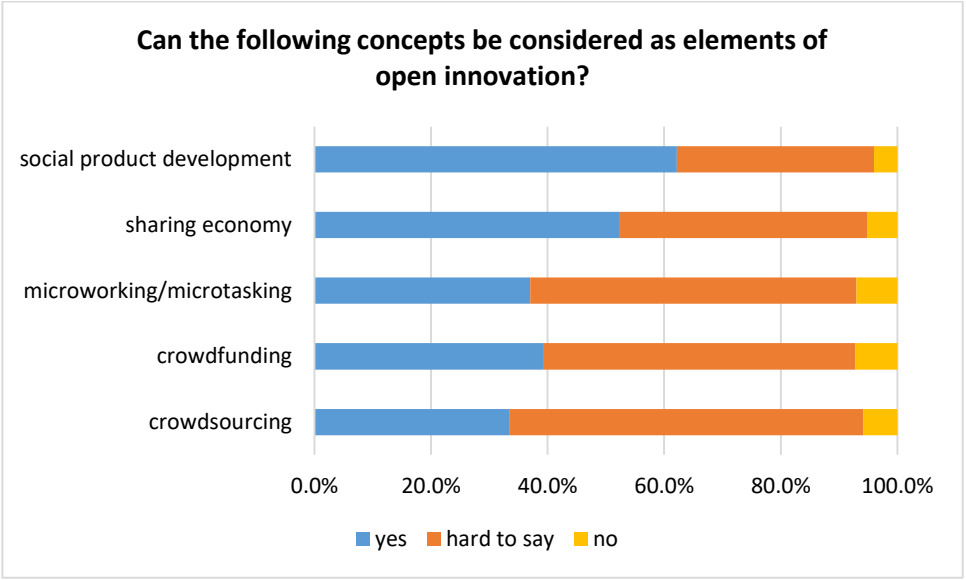

Figure 6. Elements of OI.

Next, participation in OI activities was investigated (Figure 7).

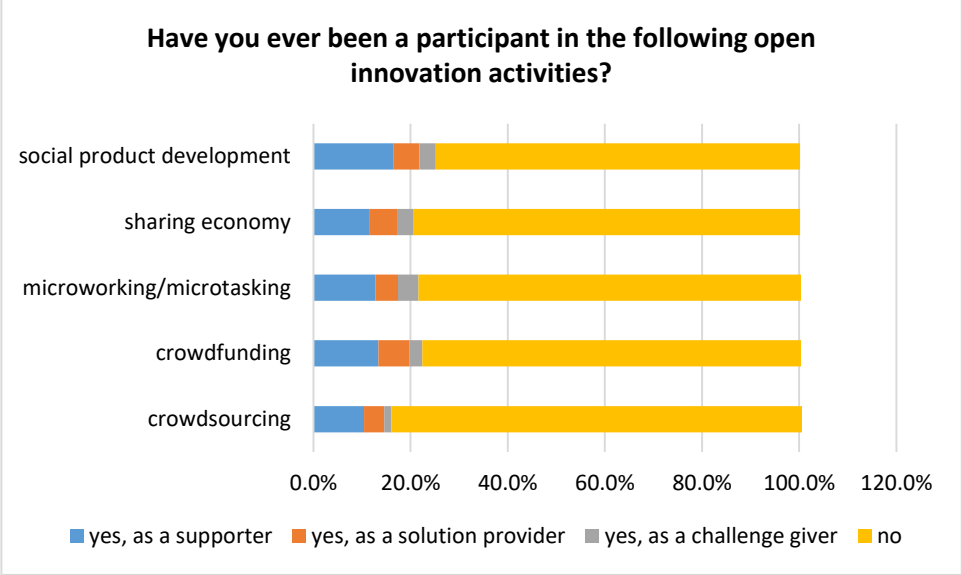

Figure 7. Participation in the OI activities.

It came out that the vast majority of respondents did not participate in any of the listed activities (SPD, microworking, sharing economy, crowdfunding and crowdsourcing). The respondents who admitted that they had participated in any of the investigated activities most often supported social product development (16.4%), and least often crowdsourcing (10.4%). The respondents were also asked to indicate to what extent, on a 10-point scale, they rated their experience in the field of OI. Figure 8 below shows the average of respondents' ratings for each of the categories.

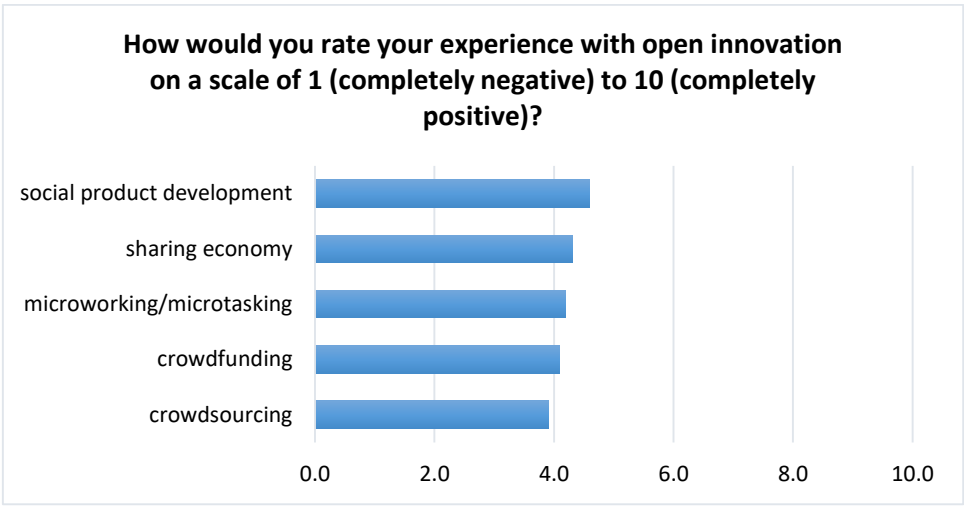

Figure 8. Experience with Open Innovation.

The respondents rated their experience in social product development the best—the average score was 4.6—and the lowest score for their experience was in crowdsourcing—the average score was 3.9. Another outcome of the questionnaire was that most respondents did not consider participating in OI activities in the future (Figure 9). However, in the case of respondents who considered such activities, their indications were more often related to SPD (52.6% of positive answers in total) and crowdfunding (46.2% of positive answers in total).

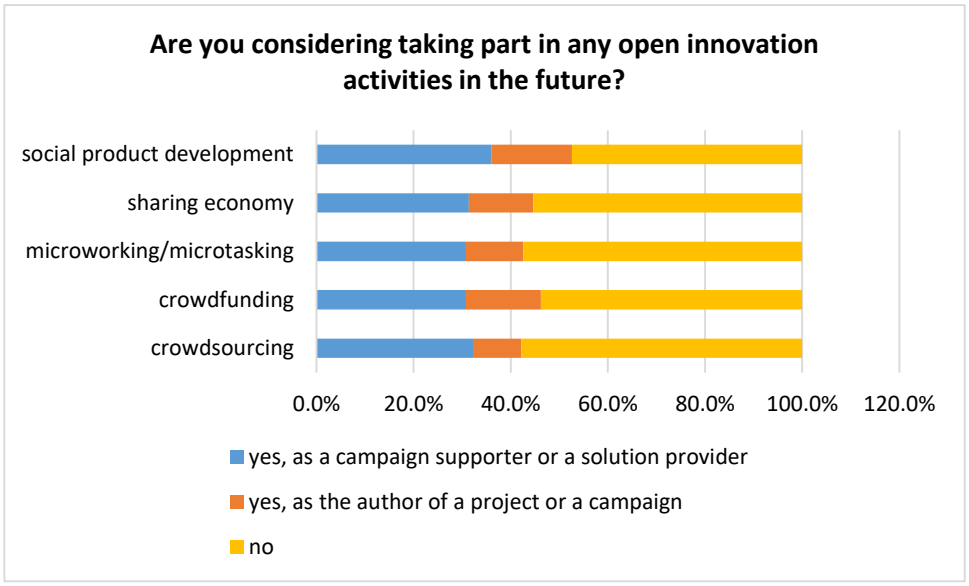

Figure 9. Participation in OI activities in the future.

Respondents were also asked to express their views on the suitability of OI activities as research and innovation tools. They were to express their assessment on a scale of 1 to 10, where 1 meant utterly useless, and 10 was useful. Figure 10 summarizes the average grades given by the surveyed students for each type of OI activity.

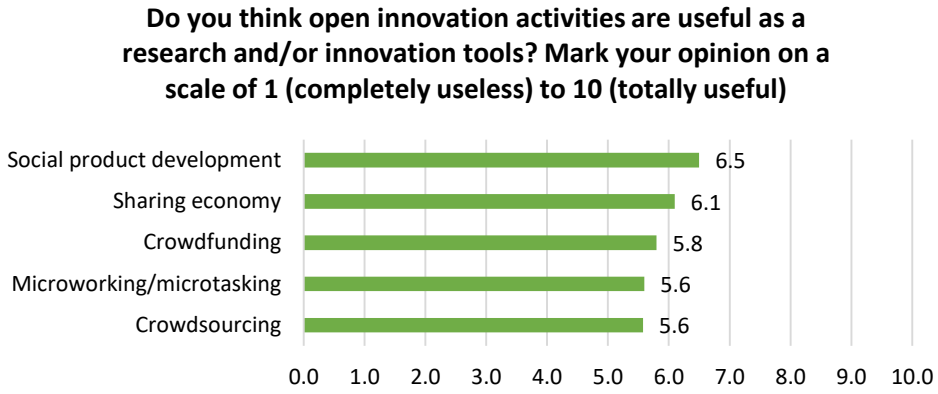

Figure 10. OI activities as research and innovation tools.

The respondents rated the usefulness of activities in the field of SPD as a research and innovation tool the highest—the average score was 6.5—and the sharing economy activities came second at 6.1. On the other hand, the lowest ratings were given for the usefulness of microworking/microtasking and crowdsourcing as research and innovation tools—the average score was 5.6 each.

The next part of the research focused on analyzing the international OI-related platforms. The respondents were asked to indicate, from a given list, the international online platforms that they had ever used either as a campaign supporter, a solution provider, or an author of a project or a campaign (Figure 11).

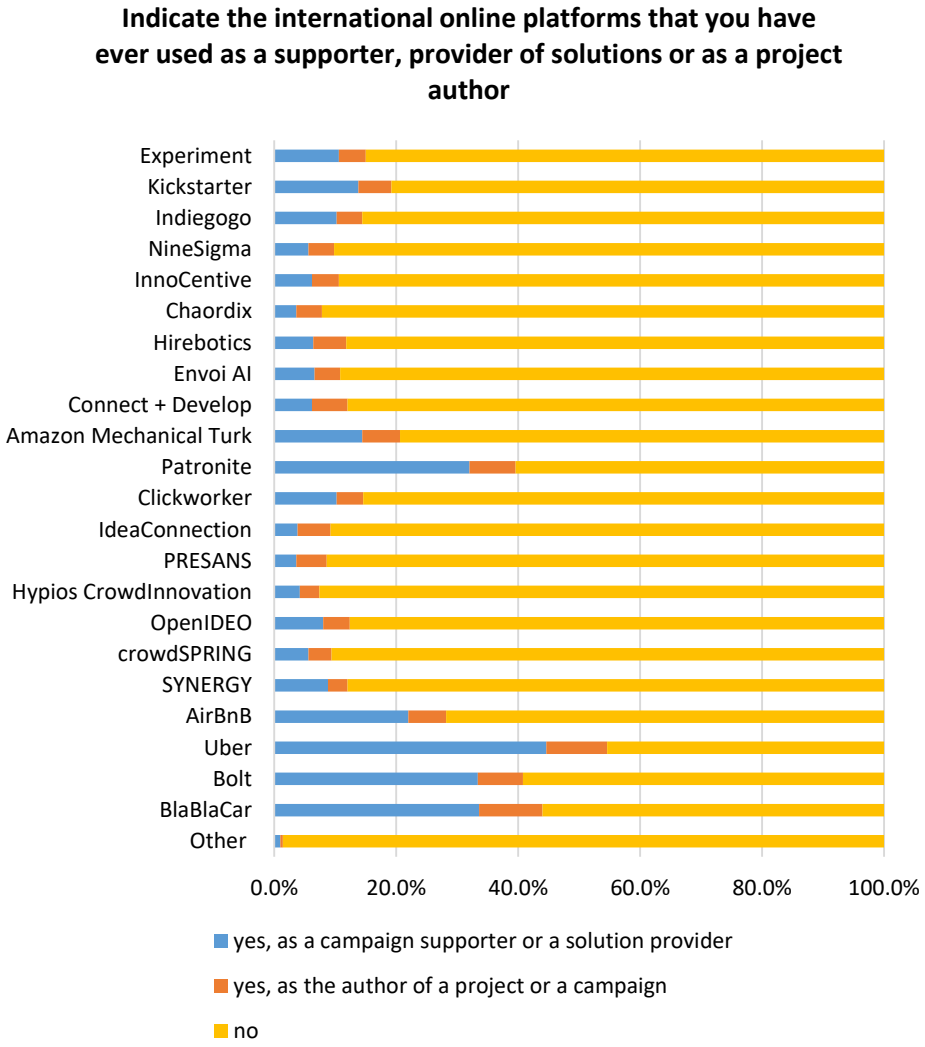

Figure 11. International OI-related platforms.

The analysis of the obtained results shows that from all the listed platforms, only 6 can be indicated as used actively by a significant part of the surveyed students: Uber (54.6% in total), BlaBlaCar (44% in total), Bolt (40.8% in total), Patronite (39.6% in total), AirBnB (28.2% in total), and Amazon Mechanical Turk (20.6% in total). In the remaining cases, the sum of positive indications was below 20.0%. However, it should be clearly emphasized that the vast majority of students did not actively use the listed platforms—neither as a supporter, solution provider, nor as a project or campaign author. The other platforms mentioned by the respondents included: patreon (n = 2), nextbike (n = 1), panek cs (n = 1), citybee (n = 1), sindbad (n = 1), skycash (n = 1), and twitter (n = 1).

Next, the usage of Polish platforms was investigated. The results are presented in Figure 12.

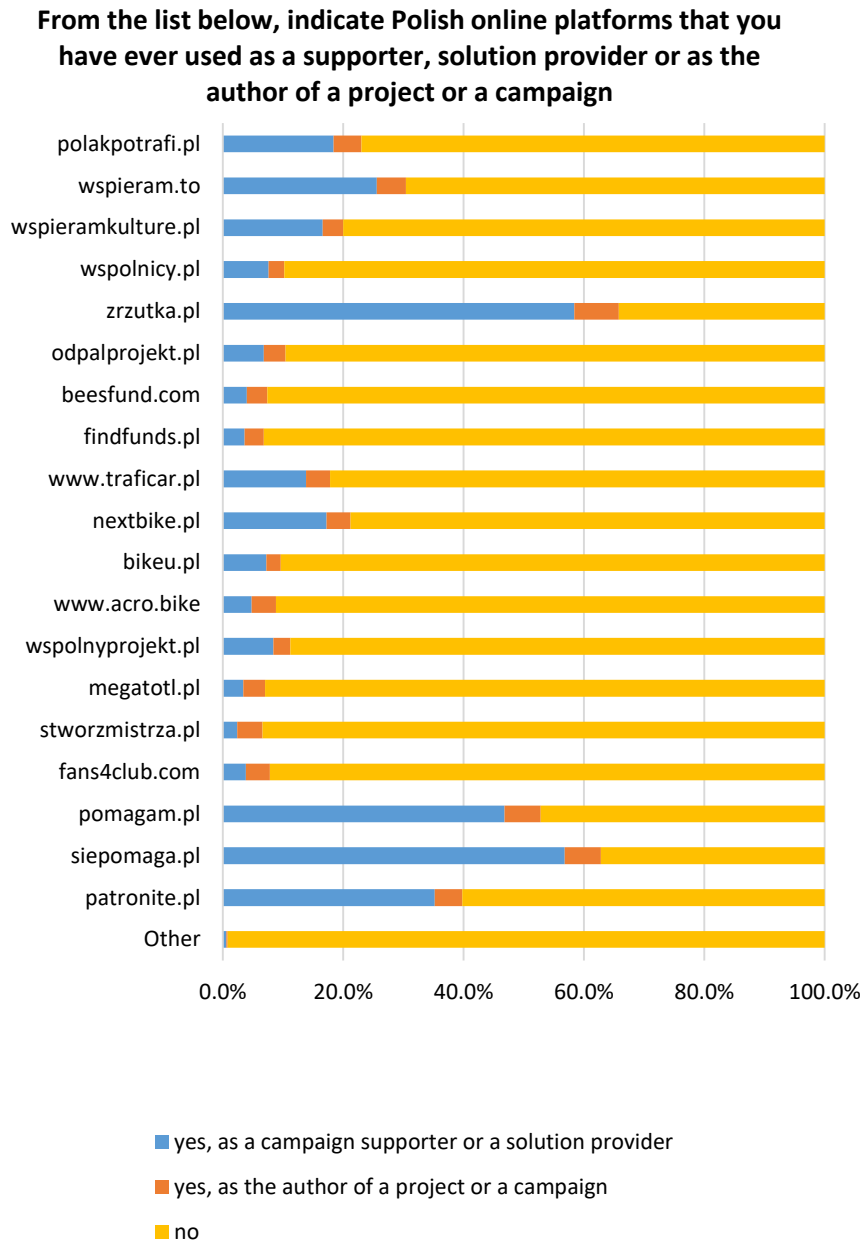

Figure 12. Polish OI-related platforms.

The analysis of the received answers shows slightly higher activeness of students in the usage of the platforms as follows: zrzutka.pl (65.8% in total), siepomaga.pl (62.8% in total), pomagam.pl (52.8% in total), patronite.pl (39.8% in total), wspieram.to (30.4% in total), polakpotrafi.pl (23.0% in total), nextbike.pl (21.2% in total), and wspieramkulture.pl (20.0% in total). It can be noticed that in terms of both types of platforms—international and Polish—the respondents rather acted as campaign supporters or solutions providers than authors of projects or campaigns.

Moreover, it is visible that among all investigated areas of OI, crowdfunding platforms based on the sharing economy model are especially used. What is more, it can be seen that the surveyed students significantly support Polish charity-oriented platforms. Nevertheless, as in the case of international platforms, most of the respondents do not use the investigated Polish platforms at all.

According to Figure 13, 3/4 of the respondents indicated that in their opinion, the most important source of knowledge about OI was the Internet. Every twelfth respondent pointed to advertising and every twentieth to television or their own research (5.0% of

responses each). In the case of the open answer "other, what?" one respondent mentioned universities.

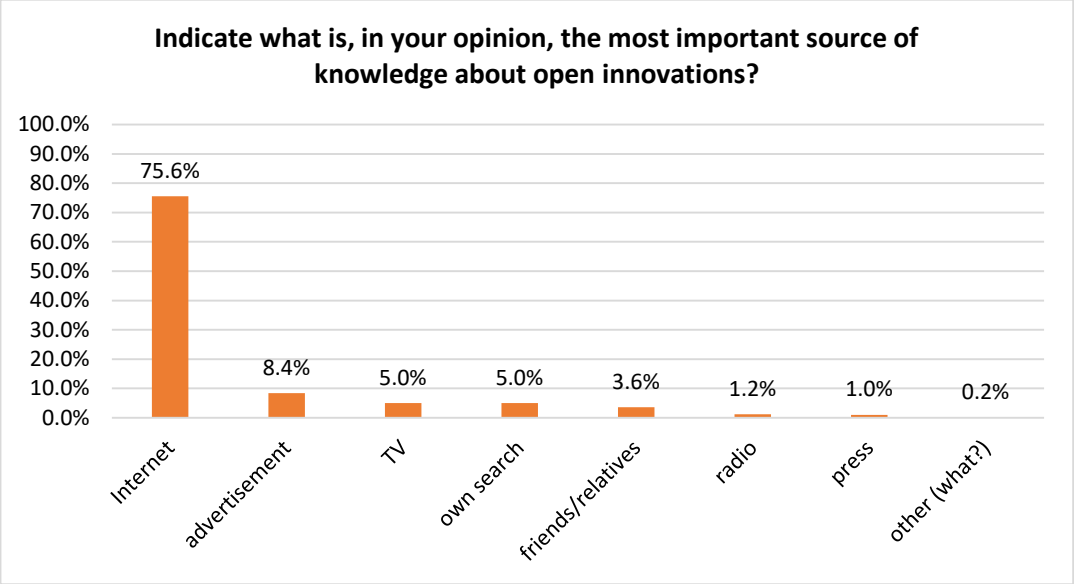

Figure 13. Source of knowledge about OI.

The answers presented in Figure 14 show that almost 80% of the respondents learned about the possibilities, tools, or portals related to OI from the Internet. In comparison, less than 1/5 were found out from friends or relatives (19.6%) and advertisements (17%). The smallest number of respondents indicated the press and the radio: 4.4% and 3.6%, respectively. In the case of the open answer, "other, what?", university/college was mentioned by 5 respondents.

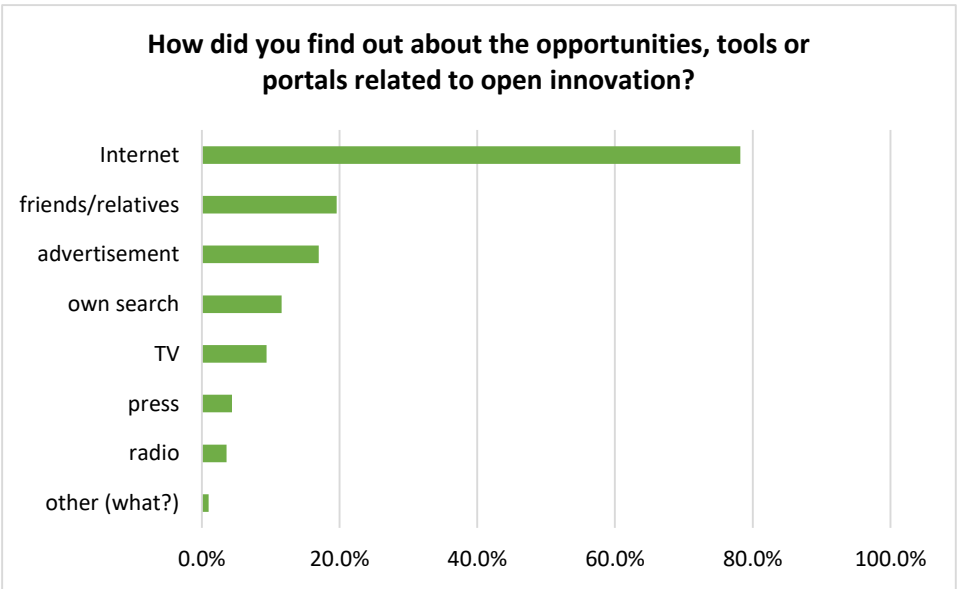

Figure 14. OI—opportunities, tool, and portals.

Next, the research focused on analyzing the attitude of the surveyed students towards the usage of tools and portals related to OI in terms of their features, including, e.g., credibility, convenience, transparency, and language barriers (Table 2).

Table 2. How do you rate the use of tools and portals related to open innovation due to (% of responses for each criterion).

	Definitely Negative	Rather Negative	Neither Positive Nor Negative	Rather Positive	Definitely Positive
Credibility	0.8%	6.0%	35.8%	50.8%	6.6%
Creativity	0.0%	2.4%	19.0%	45.2%	33.4%
Convenience	0.2%	2.8%	22.8%	47.6%	26.6%
Ease of use	0.4%	3.8%	31.0%	44.4%	20.4%
Language barriers	2.0%	10.2%	48.2%	30.2%	9.4%
Communicativeness	0.6%	4.2%	31.0%	50.0%	14.2%
Transparency	1.2%	7.0%	42.6%	40.4%	8.8%

Almost 80% of the respondents positively assessed the use of tools and portals related to open innovation due to creativity, and over 1/3 of them indicated a definitely positive opinion. Slightly fewer positive indications were noted for convenience (74.2% in total), ease of use (64.8% in total), and communicativeness (64.2% in total). Almost half of the respondents could not unequivocally assess the issue of language barriers, and over 40% did not clearly assess the transparency of these websites. At the same time, language barriers were assessed negatively more often than other issues (12.2% of responses, including 10.2% of rather negative responses). Subsequently, the respondents were asked to rank how certain important features of usage of OI tools and platforms were for them (Table 3).

Table 3. Which of the following do you consider important in using open innovation tools and platforms? On a scale of 1-completely irrelevant to 5-definitely significant.

Feature:	1—Completely Irrelevant	2	3	4	5—Definitely Significant
description of the project	2.2%	6.2%	21.2%	22.6%	47.8%
language (way) of the description	3.6%	8.0%	26.0%	33.4%	29.0%
personal acquaintance with the authors or participants of the project	11.2%	23.2%	36.2%	18.4%	11.0%
confirmed knowledge about the authors or participants of the project	3.0%	9.0%	27.0%	32.0%	29.0%
trust in the authors or participants of the project	1.2%	6.6%	22.2%	28.4%	41.6%
credible goal of the project	1.6%	3.4%	15.8%	22.0%	57.2%
realistic goal of the project	2.0%	6.0%	19.6%	26.0%	46.4%
the potential of the project	2.2%	7.2%	27.2%	36.6%	26.8%
expected profits or other benefits	5.6%	10.8%	31.6%	31.6%	20.4%

The surveyed students indicated that a reasonable goal of the project, a realistic goal of the project, description of the project, and trust in the authors of/participants in the project were reasonably important factors for them. Personal acquaintance with the authors of or participants in the project was somewhat irrelevant for the majority of the respondents. Expected profits or other benefits were assessed as insignificant by 16.4% (1–2), whereas 52% (4–5) of the surveyed students found them essential. According to Figure 15, approximately half of the respondents admitted that they encountered technical and thematic barriers when using OI tools and platforms (50.4% and 49.8%, respectively). Over 2/5 of respondents admitted that they encountered language barriers, and over 1/3 did not trust this form of innovation. In the case of other barriers, the respondents mentioned generational barriers (n = 1), misunderstanding (n = 1), and poor dissemination of the action (n = 1).

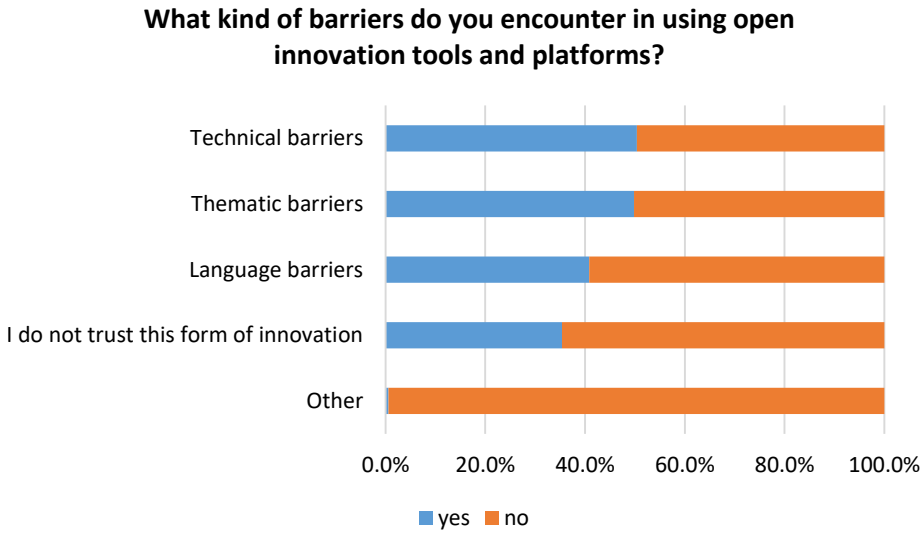

Figure 15. Barriers in using OI tools and platforms.

The last four questions of the questionnaire were focused on the SPD aspect. Firstly, surveyed students were asked if they found themselves to be creative (Figure 16)—6 out of 10 respondents confirmed, while over 30% of the respondents could not clearly answer this question. Only 6.6% assessed themselves as not creative persons.

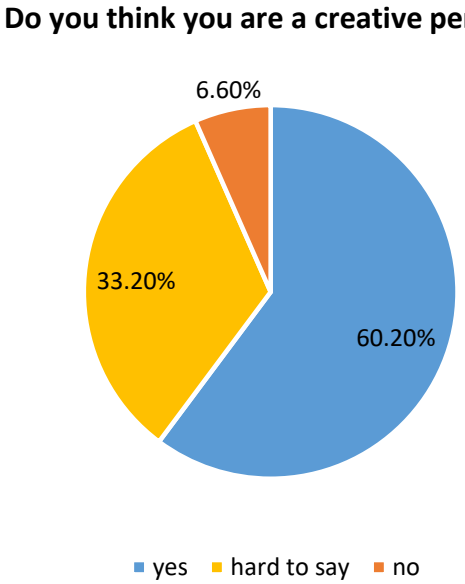

Figure 16. Creativity assessment.

Next, the respondents were asked if, with the right motivation, they could come up with a product idea (Figure 17). 7 out of 10 respondents admitted that with adequate motivation, they would be able to come up with a product. Every twentieth respondent did not give an unambiguous answer to this question. Only slightly over 5% answered negatively.

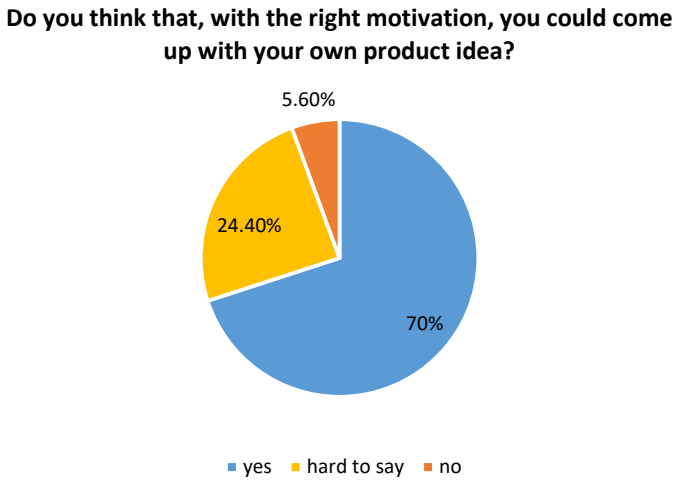

Figure 17. Motivation in terms of new product development.

According to Figure 18, over 35% of the surveyed students admitted that they managed to develop an item or product that could not be bought. Similarly, slightly more than 1/3 answered negatively, whereas 32% could not answer this question clearly.

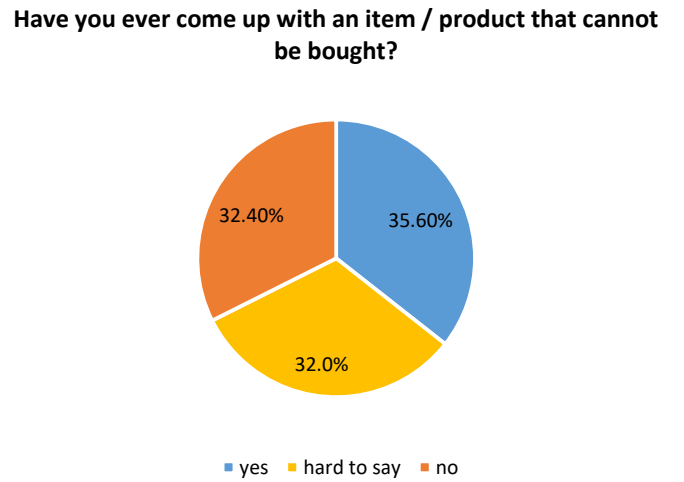

Figure 18. Idea for a product that cannot be bought.

In the last question, the surveyed students were asked if there was a portal to publish ideas for products, make money on them, and decide to use them Figure 19.

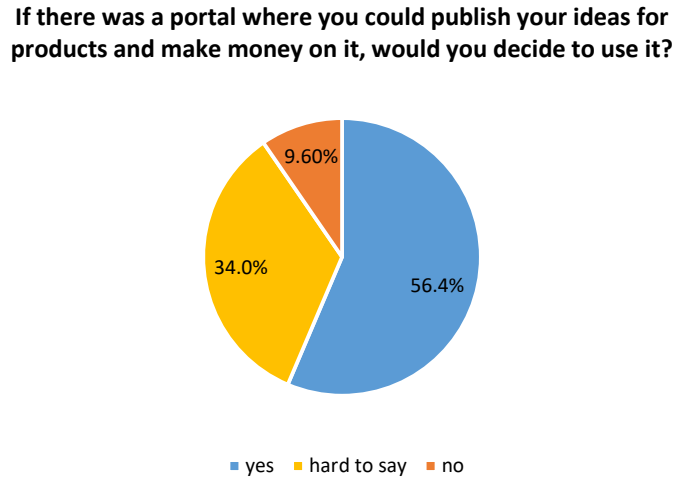

Figure 19. Possibility of using a portal where product ideas can be published to earn money.

More than half of the respondents admitted that if a portal was created where they could publish their ideas and earn money in return, they would decide to use it. Over 30% of the respondents had no opinion on this subject, while less than 10% answered negatively.

4.2. Initial Quantitative Analysis

The second part of the research was focused on a more quantitative analysis based on selected data-mining techniques. The authors, on the basis of the answers gathered within the survey, tried to investigate if it was possible to create a model that could somehow explain or predict when students participated in OI activities and, following that, if they participated actively, passively, or at all.

To do this, all the data gathered within the survey were initially analyzed to decide if they could be converted into a proper format for further quantitative analysis. After dedicated data treatment of the selected answers, mainly based on their transformation into binary values, a set of explanatory variables was created (Table 4).

Table 4. Initial set of explanatory variables.

x_i	Correlation With y	Explanation of Variables
x_1	−0.03	Sex (1-woman; 0-man)
x_2	0.04	City 20,000–100,000 inhabitants (1-yes; 0-no)
x_3	0,05	City over 500,000 inhabitants (1-yes; 0-no)
x_4	0.04	City 200,000–500,000 inhabitants (1-yes; 0-no)
x_5	−0.01	City 100,000–200,000 inhabitants (1-yes; 0-no)
x_6	0.003	City up to 20,000 inhabitants (1-yes; 0-no)
x_7	0.11	Higher education (1-yes; 0-no)
x_8	0.08	Working (1-working; 0-not working)
x_9	0.21	Knows a website where one can share their idea for a new product (1-yes; 0-no)
x_{10}	0.44	Knows the concept of open innovation (1-yes; 0-no)
x_{11}	0.33	Is familiar with the "crowdsourcing" term (1-yes; 0-no)
x_{12}	0.35	Is familiar with the "crowdfunding" term (1-yes; 0-no)
x_{13}	0.28	Is familiar with the "microworking/microtasking" terms (1-yes; 0-no)
x_{14}	0.32	Is familiar with the "sharing economy" term (1-yes; 0-no)
x_{15}	0.34	Is familiar with the "social product development" term (1-yes; 0-no)
x_{16}	0.21	Thinks they are a creative person (1-yes; 0-no)
x_{17}	0.07	Encounters language barriers in using open innovation tools and platforms (1-yes; 0-no)
x_{18}	0.04	Encounters thematic barriers in using open innovation tools and platforms (1-yes; 0 no)
x_{19}	0.04	Encounters technical barriers in using open innovation tools and platforms (1-yes; 0-no)
x_{20}	−0.05	Does not trust this form of innovation(1-yes; 0-no)
x_{21}	0.27	Rate of experience with crowdsourcing on a scale of 1 (completely negative) to 10 (completely positive) (>5-1; 5 or <5-0)
x_{22}	0.39	Rate of experience with crowdfunding on a scale of 1 (completely negative) to 10 (completely positive) (>5-1; 5 or <5-0)
x_{23}	0.31	Rate of experience with microworking/microtasking on a scale of 1 (completely negative) to 10 (completely positive) (>5-1; 5 or <5-0)
x_{24}	0.35	Rate of experience with sharing economy on a scale of 1 (completely negative) to 10 (completely positive) (>5-1; 5 or <5-0)
x_{25}	0.42	Rate of experience with social product development on a scale of 1 (completely negative) to 10 (completely positive) (>5-1; 5 or <5-0)

The first part of this analysis was based on regression. Therefore, the dependent variable y was defined as a binary variable. Values of the variable y were aggregated based on the answers related to the questions on active and passive usage of crowdsourcing (CS), crowdfunding (CF), microworking /microtasking (micro), the sharing economy (SE), and social product development (SPD). For the purpose of the regression analysis, variable y was defined as participation in open innovation activities. In the case of active or passive participation in any kind of OI area, y took a value of 1; in the case of no participation, it was 0. The sample size was n = 500, as 500 students answered the survey. The calculations

were made in RStudio (R language version-3.6.3). The code for the analysis is presented in Appendix B.

Initially, a correlation analysis was implemented to check the relation between target variable y and each explanatory variable x_i separately. The coefficients of Pearson's correlation r are presented in Table 4. It can be noticed that although none of the independent variables shows strong correlation with dependent variable y, some of the variables are correlated with y meaningfully—namely x_{10} (r = 0.44), x_{12} (r = 0.35), x_{22} (r = 0.39), x_{24} (r = 0.35), x_{25} (r = 0.42). Moreover, it seems that neither sex nor background nor working status are related to OI participation. Although very weak, a negative correlation can be found for trust in this form of innovation and participation, which may suggest that those who do not trust OI will not take part.

After correlation analysis, a regression model was built. For this purpose, data were split into a training set (70% of data, n= 357) and a testing set (30% of data, n = 143). Next, the Schwarz Bayesian information criterion (BIC) was applied to select the optimal subset of explanatory variables. An initial analysis showed that the model without intercept had a higher coefficient of determination R^2 (62.72%). Therefore the intercept was removed from the model. Results obtained from the analysis are presented in Figure 20. It can be noticed that only 6 out of 25 explanatory variables were included in the model. All of them are statistically significant (α = 0.05).

```
> model=lm(Y~.-1, data=training)
> set.seed(123)
> model_BIC=step(model,direction ="backward",trace=FALSE, k = log(nrow(training)) )
> model_BIC

Call:
lm(formula = Y ~ x9 + x10 + x12 + x16 + x24 + x25 - 1, data = training)

Coefficients:
    x9     x10     x12     x16     x24     x25
0.1428  0.2217  0.2177  0.1149  0.1341  0.2312

> summary(model_BIC)

Call:
lm(formula = Y ~ x9 + x10 + x12 + x16 + x24 + x25 - 1, data = training)

Residuals:
    Min      1Q  Median      3Q     Max
-0.9475 -0.2577  0.0000  0.3021  1.0000

Coefficients:
    Estimate Std. Error t value Pr(>|t|)
x9   0.14280    0.05113   2.793  0.00551 **
x10  0.22171    0.04574   4.848 1.88e-06 ***
x12  0.21768    0.04294   5.069 6.48e-07 ***
x16  0.11492    0.03550   3.237  0.00132 **
x24  0.13411    0.05462   2.455  0.01456 *
x25  0.23116    0.05351   4.319 2.04e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3938 on 351 degrees of freedom
Multiple R-squared:  0.6272,    Adjusted R-squared:  0.6208
F-statistic: 98.42 on 6 and 351 DF,  p-value: < 2.2e-16
```

Figure 20. Summary of the linear regression model obtained in RStudio.

The analysis of the obtained regression model shows that a student is likely to participate in open innovation activities—actively or passively—if they know a website where one can share their idea for a new product (x_9) and the concept of open innovation (x_{10}), if they are familiar with the "crowdfunding" term (x_{12}), if they think they are a creative person (x_{16}), and if they rate their experience with the sharing economy (x_{24}) and with social product development (x_{25}) as positive.

Table 5 presents the assessment of the regression model based on the misclassification rate. In terms of the training set, the accuracy of the model equals over 77%, which means that in 77 cases out 100 the model's responses are correct. The misclassification rate of the model for the training set is less than 23%. Similar results were obtained for the testing set—accuracy over 74% and a misclassification rate less than 26%—which means that there is no overfitting in the model. Next, five more regression models were built—in which, of these, the dependent variable y represented participation in one of the investigated areas of open innovation activities—respectively: crowdsourcing (y = 1 means active or passive participation in crowdsourcing; y = 0 lack of participation), crowdfunding (y = 1 means active or passive participation in crowdfunding; y = 0 lack of participation), microworking (y = 1 means active or passive participation in microworking; y = 0 lack of participation), sharing economy (y = 1 means active or passive participation in sharing economy; y = 0 lack of participation), and social product development (y = 1 means active or passive participation in social product development; y = 0 lack of participation). The way of calculation was identical to the previous presented. The results are presented in Table 6.

Table 5. Assessment of the regression model.

Model Assessment	Results
accuracy_training	77.31%
error_training	22.69%
accuracy_testing	74.13%
error_testing	25.87%

Table 6. Assessment of the regression model.

Model's Features	Crowdsourcing		Crowdfunding		Microworking		Sharing Economy		Social Product Development	
Accuracy training	84.87%		83.19%		80.95%		82.91%		82.35%	
Error training	15.13%		16.81%		19.05%		17.09%		17.65%	
Accuracy testing	86.71%		88.11%		84.62%		81.82%		79.02%	
Error testing	13.29%		11.89%		15.38%		18.18%		20.98%	
R^2	37.55%		45.71%		42.98%		45.22%		48.73%	
Variables	Var.	Coeff.	Var.	Coeff.	Var.	Coeff.	Var.	Coeff.	Var.	Coeff.
	x10	0.1296	x10	0.1667	x10	0.1424	x11	0.1665	x9	0.1487
	x11	0.1805	x12	0.1905	x13	0.1916	x14	0.1420	x15	0.1518
	x21	0.2318	x22	0.2857	x23	0.2930	x24	0.3472	x17	0.1138
									x25	0.3223

For each of the five regression models, the accuracy for the testing set is satisfactory (between 79% and nearly 87%). Accuracy for the training sets is similar, which means that there is no overfitting in the models. An interesting yet logical pattern can be noticed while interpreting selected explanatory variables to each of the models. It can be noticed that, according to the regression model explaining participation in crowdsourcing, a student will actively or passively participate if he/she knows the concept of open innovation (x_{10}), is familiar with the "crowdsourcing" term (x_{11}), and rated his/her experience with crowdsourcing above 5 (x_{21}). Similarly, a student will actively or passively participate in crowdfunding initiatives if they know the concept of OI (x_{10}), are familiar with the "crowdfunding" term (x_{12}), and rated their experience with crowdfunding above 5 (x_{22}). In terms of the regression model explaining participation in the microworking or microtasking, again, a student will actively or passively participate if he/she knows the concept of OI (x_{10}), is familiar with the "microworking" term (x_{13}), and rates his/her experience with microworking above 5 (x_{23}). A slightly different pattern can be observed for the sharing economy model—in this case, a student will actively or passively participate if he/she is familiar with the terms "crowdsourcing" (x_{11}) and "sharing economy" (x_{14}) and rates his/her

experience with SE above 5 (x_{24}). The results obtained for the regression model explaining participation in social product development present different dependencies compared to the other models. In this case, it can be assumed that a student will actively or passively participate in social product development if he or she knows a website where one can share their idea for a new product (x_9), is familiar with the "social product development" term (x_{15}), encounters language barriers in using open innovation tools and platforms (x_{17}) (which is rather inconsistent), and, obviously, rated his or her experience with SPD above 5 (x_{25}). All variables selected to the above-presented models as statistically significant.

Due to certain limitations of the regression modeling, further analysis was based on an artificial neural network model (ANN). The input layer of the neural network model was based on the set of 25 explanatory variables presented in Table 4. For the purpose of the ANN model, a variable y—meaning participation in the open innovation activities—was defined as a categorical variable with three levels: "Actively", "Passively", and "Not", meaning that either a person participates in OI activities actively, or passively, or not at all.

The code for the calculations is presented in Appendix B. Initially, the dataset was split into the training set (70% of data, n = 357) and the testing set (30% of data, n = 143). Next, a formula was written to create a loop that aimed at selecting the most appropriate number of neurons in the hidden layer. For each of the ANN models built, accuracy was calculated defined as the number of correct answers for the "Actively", "Passively" and "Not" responses of the model out of all responses. The summary of these results is presented in Table 7.

Table 7. Summary results of 14 considered ANN models.

Number of Hidden Neurons	Error	Accuracy Training	Error Training	Accuracy Testing	Error Testing
hidden: 5 thresh: 0.01 rep: 1/1 steps: 212,337	**error: 31.75086**	**93.56%**	**6.44%**	**68.53%**	**31.47%**
hidden: 6 thresh: 0.01 rep: 1/1 steps: 45,532	error: 22.72864	90.48%	9.52%	62.24%	37.76%
hidden: 7 thresh: 0.01 rep: 1/1 steps: 2735	error: 16.55145	93.56%	6.44%	62.94%	37.06%
hidden: 8 thresh: 0.01 rep: 1/1 steps: 2532	error: 23.72	92.16%	7.84%	58.74%	41.26%
hidden: 9 thresh: 0.01 rep: 1/1 steps: 4544	error: 12.21719	95.80%	4.20%	63.64%	36.36%
hidden: 10 thresh: 0.01 rep: 1/1 steps: 2434	error: 8.89941	96.36%	3.64%	57.34%	42.66%
hidden: 11 thresh: 0.01 rep: 1/1 steps: 1760	error: 10.30415	96.36%	3.64%	59.44%	40,56%
hidden: 12 thresh: 0.01 rep: 1/1 steps: 2313	error: 4.76932	98.60%	1.40%	63.64%	36.36%
hidden: 13 thresh: 0.01 rep: 1/1 steps: 1207	error: 7.38981	96.64%	3.36%	58.74%	41.26%
hidden: 14 thresh: 0.01 rep: 1/1 steps: 1711	error: 4.89199	98.04%	1.96%	66.43%	33.57%
hidden: 15 thresh: 0.01 rep: 1/1 steps: 713	error: 7.02209	98.04%	1.96%	64.34%	35.66%
hidden: 16 thresh: 0.01 rep: 1/1 steps: 925	error: 4.92829	97.76%	2.24%	62.94%	37.06%
hidden: 17 thresh: 0.01 rep: 1/1 steps: 553	error: 6.05068	97.76%	2.24%	63.64%	36.36%
hidden: 18 thresh: 0.01 rep: 1/1 steps: 704	error: 4.91805	98.04%	1.96%	64.34%	35.66%

Based on the analysis of the obtained results, a number of neurons in the hidden layer were selected (ANN model with the highest accuracy for the testing set 68.53%). Subsequently, the next loop was created to build the best ANN model with five hidden neurons out of 10 models considered. The results of these calculations are presented in Table 8.

Out of 10 ANN models, the best one in terms of the highest accuracy and lowest misclassification of the testing set is model 4, with 70.63% accuracy and a 29.37% misclassification rate. Although the accuracy of the testing set is satisfying, it is slightly different from the accuracy of the training set, which might suggest certain overfitting of the model, and it should be further investigated. The plot of the final ANN model is presented in Figure 21.

Table 8. Summary results of 10 considered ANN models.

ANN Model	Accuracy Training	Error Training	Accuracy Testing	Error Testing
ANN 1, rep = 1	77.59%	22.41%	55.94%	44.06%
ANN 2, rep = 2	90.76%	9.24%	63.64%	36.36%
ANN 3, rep = 3	87.96%	12.04%	65.73%	34.27%
ANN 4, rep = 4	**95.24%**	**4.76%**	**70.63%**	**29.37%**
ANN 5, rep = 5	91.88%	8.12%	60.84%	39.16%
ANN 6, rep = 6	87.39%	12.61%	60.14%	39.86%
ANN 7, rep = 7	93.28%	6.72%	69.23%	30.77%
ANN 8, rep = 8	87.11%	12.89%	60.84%	39.16%
ANN 9, rep = 9	77.03%	22.97%	58.74%	41.26%
ANN 10, rep = 10	85.43%	14.57%	63.64%	36.36%

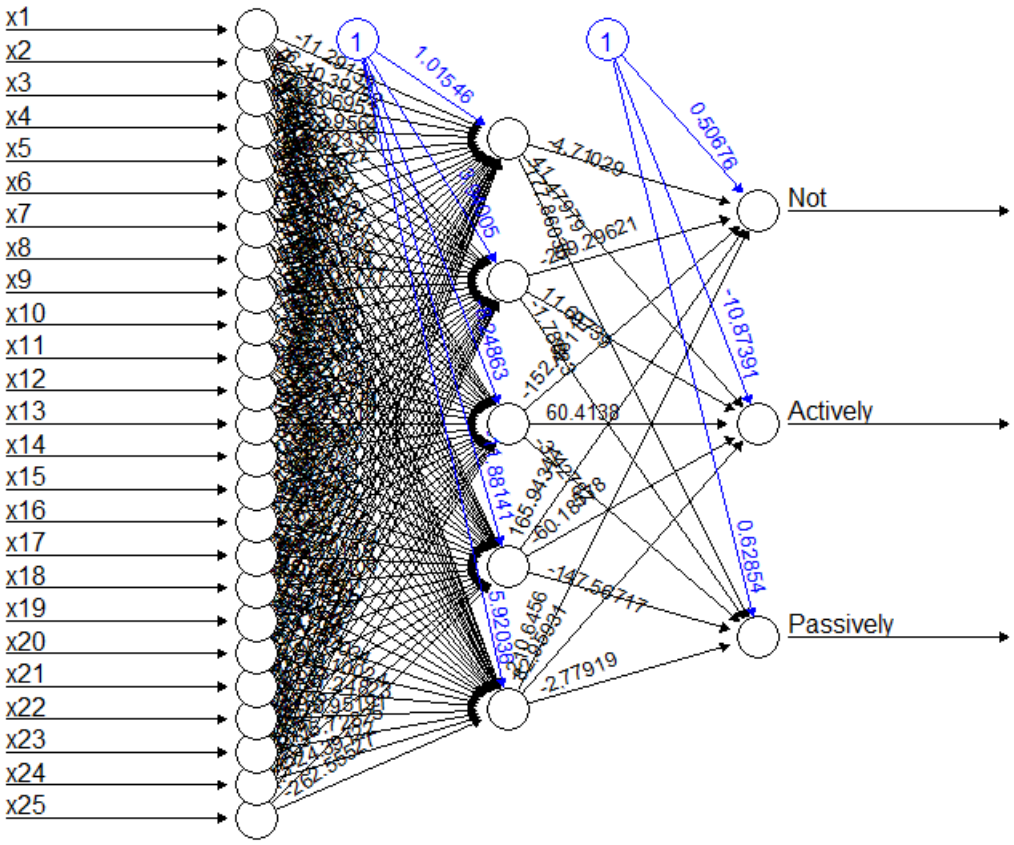

Figure 21. ANN plot—aggregated.

The obtained ANN model shows that with acceptable accuracy of over 70%, based on a certain set of initial information represented by the 25 explanatory variables (Table 4), it can be predicted whether a student will be participating in open innovation activities or not, and, if yes, whether actively or passively. Next, similarly to regression analysis, five more types of ANN models were built, in which, of them, the dependent categorical variable y represented participation in one of the investigated area's OI activities, which are, respectively:

- **social product development**—ANN SPD (y is a factor variable with three levels: "Actively", "Passively, and "Not"),
- **crowdfunding**—ANN CF (y is a factor variable with three levels: "Actively", "Passively, and "Not"),
- **crowdsourcing**—ANN CS (y is a factor variable with three levels: "Actively", "Passively, and "Not"),

- **microworking**—ANN micro (y is a factor variable with three levels: "Actively", "Passively, and "Not"),
- **sharing economy**—ANN SE (y is a factor variable with three levels: "Actively", "Passively, and "Not").

The results of these computations are presented in Table 9. In total, 120 ANN models were built and assessed in terms of accuracy and misclassification of training and test set.

Table 9. Summary results of 120 analyzed ANN models.

Output y	The Best Model Out Of:	Hidden Neurons	Rep.	Steps	ANN Error	Training Set		Testing Set	
						Accuracy	Error	Accuracy	Error
ANN SPD	initial 14 models	6	1/1	2839	1,478,024	94.68%	5.32%	75.52%	24.48%
ANN SPD	final 10 models	6	5/10	6153	107,658	97.48%	2.52%	**75.52%**	**24.48%**
ANN CF	initial 14 models	12	1/1	824	722,844	96.92%	3.08%	81.82%	18.18%
ANN CF	final 10 models	12	3/10	523	779,917	98.04%	1.96%	**81.82%**	**18.18%**
ANN CS	initial 14 models	5	1/1	120,664	984,409	97.76%	2.24%	**86.01%**	**13.99%**
ANN CS	final 10 models	5	2/10	3213	129,286	94.68%	5.32%	85.31%	14.69%
ANN micro	initial 14 models	17	1/1	286	604,069	98.60%	1.40%	79.72%	20.28%
ANN micro	final 10 models	17	2/10	496	356,057	98.88%	1.12%	**79.72%**	**20.28%**
ANN SE	initial 14 models	5	1/1	9324	2,038,719	94.40%	5.60%	**78.32%**	**21.68%**
ANN SE	final 10 models	5	5/10	112,887	1,425,886	94.68%	5.32%	77.62%	22.38%

The models with the best performance were marked in bold. The obtained results show a noticeable increase in the accuracy of the models for the testing sets compared to the aggregated approach represented by the first ANN model (Table 8). The accuracy of the models for particular OI areas—in terms of the testing sets—varied from 75.52% (ANN SPD) up to 86.01% (ANN CS). The authors assume that this performance can be improved by further optimizing the ANN models' parameters. As neural networks models work in a sort of a black box, it is not easy to interpret the direct impact of the explanatory variables on the output variable y, yet it can be noticed that the accuracy of the obtained models is satisfactory. Thus, they can serve as a predictive tool for forecasting whether, based on particular criteria represented by the values of the variables x_1–x_{25}, a student will—actively or passively—or will not participate in particular OI activities—namely SPD, SF, SC, micro, or SE. To sum up, in total, there were 144 ANN models built and assessed in terms of accuracy and misclassification based on training and test sets. The obtained results showed that for both types of models—regression and ANN—models explaining participation in particular OI activities in 5 analyzed areas were more adequate than aggregated models exploring participation in OI in general.

5. Outlook on State-of-the-Art and Challenges—A Discussion

Based on the results of the study presented in the previous chapter, the following conclusions and observations in terms of the research questions can be formulated:

RQ1: Do the students know directly or indirectly the open innovation paradigm?

- Almost all respondents actively use social media, which is a firm base to facilitate open innovation 2.0 activities among students in Poland. Platforms where one can share their new product ideas are known to slightly more than 20% of the respondents. These respondents, however, most often mentioned social media, such as Facebook or Instagram, rather than platforms dedicated to SPD. This shows that the majority does not know about SPD platforms and that there is an urgent need to raise awareness about this kind of possibility. Most respondents do not consider participating in open innovation activities. However, some respondents who consider such activities most

often pointed to SPD and crowdfunding. Obtained answers show that over 50% of the surveyed students do not know the OI concept.

- What is more, the majority of respondents have never heard of the sharing economy, microworking, crowdfunding, and crowdsourcing; only slightly over 50% of the surveyed students have come across the term SPD. The vast majority of the surveyed students admitted that they had not participated in any of the surveyed activities in the field of open innovation. Again, this is information that the education process should enhance, with topics presenting the opportunities that OI brings.

RQ2: Do the students use OI platforms passively or actively?

- The respondents were asked to rate their experience in particular areas of OI (on a 10-point scale). In this case, the highest average score was obtained by social product development, where the average score for the respondents' experience was 4.6. The lowest average score was obtained by the experience gained in crowdsourcing, which was 3.9. The respondents rated highest the usefulness of activities in the field of social product development and the sharing economy as a research and innovation tool. The analysis of the obtained answers show that, from all of the investigated platforms—both international and Polish ones—only a few are used actively by a significant part of the surveyed students (Uber, BlaBlaCar, Bolt, Patronite, AirBnB, Amazon Mechanical Turk, zrzutka.pl, siepomaga.pl, pomagam.pl, patronite.pl, wspieram.to, polakpotrafi.pl, nextbike.pl and wspieramkulture.pl). It can also be seen that the overwhelming part of the respondents did not actively use the listed platforms at all—neither as a supporter, solution provider, nor as a project or campaign author. However, if the students use the OI platforms, they use them rather passively, especially as CF supporters or simply clients of these platforms, and especially those based on the sharing economy model. In terms of crowdfunding platforms, it can also be noticed that the students significantly support charity-oriented ones.

RQ3: What is the source of knowledge about OI?

- According to over 3/4 of the respondents, the most important source of knowledge about open innovation is the Internet. The vast majority of respondents learned about opportunities, tools, and portals related to open innovation from the Internet—only 1% of the surveyed students mentioned university as the source of knowledge about OI.

RQ4: How do students assess OI platforms, and what features do they find important?

- Most surveyed students positively assessed OI platforms, especially in terms of creativity, convenience, ease of use, and communicativeness. Less than half of the respondents could not clearly assess the issue of language barriers and the transparency of these websites. The respondents asked to rank how certain essential features of usage of OI tools and platforms were for them indicated that reasonable goal of the project, realistic goal of the project, description of the project, and trust in the authors of/ participants in the project were reasonably crucial for them. Personal acquaintance with the authors of or participants in the project was somewhat irrelevant for the majority of the respondents. Only slightly over 50% of the respondents found expected profits or other benefits significant.

RQ5: What are the barriers to using OI platforms?

- Half of the respondents admitted that they encounter technical and thematic barriers when using portals and tools in the field of open innovation. While assessing the OI platforms, only language barriers were assessed negatively more often than other investigated features. This is consistent with the fact that over 40% of the respondents admitted that they do encounter language barriers. Moreover, over 35% of the surveyed students admitted that they do not trust this form of innovation, which is a considerable amount and is worrying.

RQ6: Do the students find themselves creative and able to innovate/ develop new products?

- The answers to the last question are somewhat optimistic—6 out of 10 respondents consider themselves creative, while only less than 6% assess themselves explicitly as not creative people. 7 out of 10 respondents admitted that—with adequate motivation—they would be able to come up with a product idea. More than 1/3 of the respondents admitted that they managed to develop a product or thing that cannot be bought. More than half of the respondents admitted that if there were a portal where they could publish their ideas for products and earn money in return, they would use it. Over 30% of the respondents had no opinion on this subject, while less than 10% answered negatively.

The obtained answers to the research questions raised allow the conclusion that the put hypothesis was correct, which means that if Polish students use the OI-based platforms at all, they use them passively. In the context of low innovativeness in Poland and only fledging open innovation, it can be assumed that there is still considerable potential in this area. Innovation potential is definitely not fully utilized.

When comparing the obtained results to [58] it can be noticed that, according to our research, in Poland, nearly 56% of the surveyed students are not familiar with the concept of open innovation, whereas in the group of students investigated by Eroğlu and Ekmekçioğlu the number was over 86%. Although this difference is substantial, in both countries, the majority of students are not aware of OI. What is more, the developed regression models show that key factors related to the students' participation in OI activities are based on having knowledge in this area. Those students who participated, whether actively or passively, in particular OI activities were familiar with the concept of open innovation and related terms (e.g., "crowdsourcing" or "crowdfunding"). Moreover, those who took part in social product development processes at the same time knew a website where one can share an idea for a new product. These results, although based on initial data analysis with a number of limitations, show, however, that awareness about OI is fundamental for students to engage in OI-related activities. Therefore, it can be assumed that if the awareness about OI and its opportunities and dedicated platforms was raised, a number of students, based on their creativity, could probably contribute to the increase of the innovation capacity in Poland. Nevertheless, specific actions need to be undertaken within both top-down and bottom-up initiatives to make this possible. One of the potential paths in this direction could be incorporating OI-based subjects into curricula at the universities. The key issue here would be to include them not only in the directly related fields of study (e.g., management, economics) but also in other fields, especially technical ones. These subjects should be practice-focused, which means that students should not only learn about theory and case studies or success stories but especially be involved in the direct innovation process. This conclusion is very much in line with Oganisjana, who argues that "in the field of entrepreneurship education, traditional teaching and learning methods such as lectures, literature reviews, and examinations do not activate students' entrepreneurship" [55]. Therefore, the implementation of solutions directly engaging students in the innovation process is required. Authors believe that to achieve this, universities should use either available OI digital platforms or create a dedicated environment of their own. To obtain the best possible results and boost innovation, members of the HEIs' ecosystems, and companies in particular, should be involved in this process e.g. by creating innovation challenges, defining microworking tasks, or involving students in social product development processes. To obtain successful results of such a collaboration—within the universities' courses—proper governance should be ensured, as this collaboration is interdependent with the outcome being developed [69]. The active involvement of students within OI-related subjects is essential, bearing in mind that the vast majority of the respondents use open innovation platforms passively. In the longer perspective, the whole process should lead to a change of mindset. It is crucial that universities put a lot of attention and effort into developing an organizational culture that supports innovation development. It is vital to bear in mind the conclusions obtained by Yström et al., which state that "numerous studies have shown that creativity and innovation are influenced by the organizational

context" [70]. What is more, the Authors come to a similar conclusion as Guerrero et al., who state that "university managers should understand the most up-to-date higher education trends (e.g., monitor the digital learning market), as well as identify stakeholder needs and students' digital behaviors" [64]. Bearing in mind also the conclusions of Howells et al., who state that HEIs are treated by companies as poor providers of information on innovation and as poor collaborative partners in the innovation process [57], it is even more important to introduce activities that could help change these opinions. [54] highlights that "according to the students' vision, the open innovation community is pivotal to the relationship between academia and the company, but it depends on the characteristics of the participants and educators". This conclusion indirectly emphasizes the issue of trust. Indeed, to successfully participate in the OI process, trust is essential, according to Bogers et al.—who were exploring opportunities and challenges of OI in Brazil [53]—as well as to Oganisjana, who highlights that OI processes require collaboration based on trust [55]. The results of our survey show that over 1/3 of students do not trust this form of innovation. They list a lack of trust among key barriers that they encounter in using open innovation tools and an open innovation platform. In the authors' opinion, to build trust in certain concepts, a change of mindset is required. This change, again, can only be made based on raising awareness and obtaining corresponding knowledge. Moreover, it is the role of universities to deliver this knowledge in a convincing way. In our case, to start changing the perception of OI by students at our university, a bottom-up initiative was introduced. As a direct result of this study, a new course was introduced to the Faculty of Mechanical Engineering curriculum at the Wroclaw University of Science and Technology—"Social Product Development", taught both in Polish and in English. This course aims at stimulating creativity and enhancing the innovativeness of the participating students and, of course, to raise awareness about the topic. The OI platform used in this course is https://synergyplatform.pwr.edu.pl/ (accessed on 1 September 2021). The direct results of this course are 3D CAD models of designed prototypes of new products, ready to be printed with the usage of additive manufacturing technologies. This approach is consistent with the recommendations coming from HEInnovate, which is "a self-assessment tool for Higher Education Institutions who wish to explore their innovative potential" [71].

To summarize, we conclude that a significant emphasis should be put on students' education in terms of OI and OI 2.0. As mentioned earlier, they represent a group of educated people who are open-minded and eager to test and use new ideas and solutions. They are the group that will soon enter the business/industry sector and will either become the staff of companies or will set up their own startups or SMEs. Therefore, they will directly bring new knowledge, new skills, and a changed mindset to new jobs. What is more, we agree with Vélez-Rolón et al., who put students at the center of the knowledge transfer process between university and industry [54]. Therefore, by engaging students and companies from the HEIs' ecosystems in the longer perspective, we can expect an increase in innovativeness performance and cooperation between academia and the business sector.

6. Conclusions

The main aim of this research was to explore students' attitude to and readiness for open innovation in Poland. This aim can be assessed as reached. In general, it can be stated that students are ready to enter OI 2.0 era, as nearly 99% of them use social media, and the vast majority of them draw their information from the Internet. The digitalized environment is natural for them, so it can be assumed that they should have no significant problems with using OI-related platforms. The key barriers identified within this study are: (1) a lack of knowledge about the open innovation paradigm, especially its elements, platforms, and the opportunities that OI brings; and (2) an issue of trust. Over 35% of survey students do not trust open innovation. Here, however, proper education should solve the problem. From the European perspective, Poland—belonging to the group of Emerging Innovators—is a country of relatively low innovativeness, which is caused by the low innovation capacity of Polish SMEs. In order to increase Polish innovation performance, OI

should be vastly investigated and implemented. However, in order to actively benefit from OI opportunities, several barriers have to be overcome in Poland, including bureaucracy, the issue of trust, a lack of flexibility, the exploitation of external knowledge, and internal resistance to ideas coming from outsiders or exploited by outsiders; proper employee autonomy should also be considered. These obstacles exist not only in companies but also at the universities, so the critical issue here is the change of mindset and innovation culture.

In the long term, the authors plan to extend the survey to other target groups, including SMEs, within future research. It is planned to design a study enabling a comparative analysis of Polish innovativeness with other countries, not only those on a similar level of development but also those that are more innovative such as Italy, Austria, Germany, Israel, Finland, and Sweden. In the short term, the authors would like to focus on the limitation of this research and explore other data mining techniques to extract as much knowledge from the performed survey as possible.

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Appendix A

A list of questions in the developed questionnaire:

(1) Do you actively use social media?
   (a) yes
   (b) no

(2) Do you know any website where you can share your idea for a new product?
   (a) no
   (b) if so, please mention the addresses of these sites

(3) Do you know the concept of open innovation?
   (a) yes
   (b) no

(4) Have you ever come across the following terms?

Table A1. Question 4—table of answers.

crowdsourcing	yes	no
crowdfunding	yes	no
microworking/microtasking	yes	no
sharing economy	yes	no
social product development	yes	no

(5) Can the following concepts be considered as elements of open innovation?

Table A2. Question 5—table of answers.

crowdsourcing	yes	hard to say	no
crowdfunding	yes	hard to say	no
microworking/microtasking	yes	hard to say	no
sharing economy	yes	hard to say	no
social product development	yes	hard to say	no

(6) Have you ever been a participant in the following open innovation activities?

Table A3. Question 6—table of answers.

crowdsourcing	no	yes, as a supporter	yes, as a solution provider	yes, as a challenge giver
crowdfunding	no	yes, as a supporter	yes, as a solution provider	yes, as a challenge giver
microworking/microtasking	no	yes, as a supporter	yes, as a solution provider	yes, as a challenge giver
sharing economy	no	yes, as a supporter	yes, as a solution provider	yes, as a challenge giver
social product development	no	yes, as a supporter	yes, as a solution provider	yes, as a challenge giver

(7) How would you rate your experience with open innovation on a scale of 1 (completely negative) to 10 (completely positive)?

Table A4. Question 7—table of answers.

crowdsourcing	1	2	3	4	5	6	7	8	9	10
crowdfunding	1	2	3	4	5	6	7	8	9	10
microworking/microtasking	1	2	3	4	5	6	7	8	9	10
sharing economy	1	2	3	4	5	6	7	8	9	10
social product development	1	2	3	4	5	6	7	8	9	10

(8) Are you considering taking part in any open innovation activities in the future? (f the answer is "yes", more than option may be indicated)

Table A5. Question 8—table of answers.

crowdsourcing	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
crowdfunding	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
microworking/microtasking	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
sharing economy	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
social product development	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no

(9) Do you think open innovation activities are useful as a research and/or innovation tool? Mark your opinion on a scale of 1 (completely useless) to 10 (totally useful)

Table A6. Question 9—table of answers.

crowdsourcing	1	2	3	4	5	6	7	8	9	10
crowdfunding	1	2	3	4	5	6	7	8	9	10
microworking/microtasking	1	2	3	4	5	6	7	8	9	10
sharing economy	1	2	3	4	5	6	7	8	9	10
social product development	1	2	3	4	5	6	7	8	9	10

(10) From the list below, indicate the international online platforms that you have ever used as a supporter, provider of solutions or as a project author

Table A7. Question 10—table of answers.

Experiment-www.experiment.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Kickstarter-www.kickstarter.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Indiegogo-www.indiegogo.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
NineSigma-www.ninesigma.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
InnoCentive-www.innocentive.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Chaordix-www.chaordix.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Hirebotics-www.hirebotics.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Envoi AI-www.envoyai.com/exchange	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Connect + Develop-https://www.pgconnectdevelop.com/	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Amazon Mechanical Turk-www.mturk.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Patronite.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Clickworker-www.clickworker.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
IdeaConnection-www.ideaconnection.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
PRESANS-www.presans.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Hypios CrowdInnovation-www.hypios-ci.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
OpenIDEO-www.openideo.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
CrowdSPRING-www.crowdspring.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
SYNERGY PLATFORM-https://synergyplatform.pwr.edu.pl/	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
AirBnB	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Uber	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Bolt	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
BlaBlaCar	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Other international platforms (which?)	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no

(11) From the list below, indicate Polish online platforms that you have ever used as a supporter, solution provider or as the author of a project or a campaign

Table A8. Question 11—table of answers.

https://polakpotrafi.pl/	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
https://wspieram.to/	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
http://wspieramkulture.pl/	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
http://www.wspolnicy.pl/	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
https://zrzutka.pl/	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
https://odpalprojekt.pl/	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
https://beesfund.com/	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
https://findfunds.pl/	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
https://www.traficar.pl/	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
nextbike.pl	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
bikeu.pl	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
https://www.acro.bike/	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Wspolnyprojekt.pl	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Megatotl.pl	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Stworzmistrza.pl	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Fans4club.com	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Pomagam.pl	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Siepomaga.pl	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Patronite.pl	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no
Other national platforms (which?)	yes, as a campaign supporter or a solution provider	yes, as the author of a project or a campaign	no

(12) Indicate what is, in your opinion, the most important source of knowledge about open innovations:

(a) advertisement
(b) press
(c) TV
(d) radio
(e) Internet
(f) friends/relatives
(g) own search
(h) other (what?)

(13) How did you find out about the opportunities, tools, or portals related to open innovation?

(a) advertisement
(b) press
(c) TV
(d) radio
(e) Internet
(f) friends/relatives
(g) own search
(h) other (what?)

(14) How do you rate the use of tools and portals related to open innovation due to:

Table A9. Question 14—table of answers.

credibility	definitely positive	rather positive	neither positively nor negatively	rather negative	definitely negative
creativity	definitely positive	rather positive	neither positively nor negatively	rather negative	definitely negative
convenience	definitely positive	rather positive	neither positively nor negatively	rather negative	definitely negative
ease of use	definitely positive	rather positive	neither positively nor negatively	rather negative	definitely negative
language barriers	definitely positive	rather positive	neither positively nor negatively	rather negative	definitely negative
communicativeness	definitely positive	rather positive	neither positively nor negatively	rather negative	definitely negative
transparency	definitely positive	rather positive	neither positively nor negatively	rather negative	definitely negative

(15) Which of the following do you consider important in using open innovation tools and platforms? On a scale of 1-completely irrelevant to 5-definitely significant:
(a) description of the project
(b) language (way) of the description
(c) personal acquaintance with the authors of or participants in the project
(d) confirmed knowledge about the authors of or participants in the project
(e) trust in the authors of or participants in the project
(f) credible goal of the project
(g) realistic goal of the project
(h) the potential of the project
(i) expected profits or other benefits

(16) What kind of barriers do you encounter in using open innovation tools and platforms?
(a) Language barriers (yes/no)
(b) Thematic barriers (yes/no)
(c) Technical barriers (yes/no)
(d) I do not trust this form of innovation (yes/no)
(e) Other, what kind?

(17) Do you think you are a creative person?
(a) yes
(b) hard to say
(c) no

(18) Do you think that, with the right motivation, you could come up with your own product idea?
(a) yes
(b) hard to say
(c) no

(19) Have you ever come up with an item/product that cannot be bought?

(a) yes
(b) hard to say
(c) no

(20) If there was a portal where you could publish your ideas for products and make money on it, would you decide to use it?

(a) yes
(b) hard to say
(c) no

Appendix B

```
# regression model
library(MASS)
mydata<-read.table("OI29varLM.txt", header=T)
attach(mydata)
str(mydata)
head(mydata,15)
summary(mydata)
class(mydata$Y)
cbind(as.matrix(cor(mydata))[,1])
set.seed(123)
def_sets<-sample(2, nrow(mydata), replace = T, prob = c(0.7,0.3))
training<-mydata[def_sets==1,]
testing <-mydata[def_sets==2,]
model=lm(Y~.-1, data=training)
set.seed(123)
model_BIC=step(model,direction ="backward",trace=FALSE, k = log(nrow(training)) )
model_BIC
summary(model_BIC)
Y_fitted_train=predict.lm(model_BIC, data=training)
Y_fit_train=ifelse(Y_fitted_train>0.5,1,0)
tab1<-table(training$Y,Y_fit_train)
accuracy_training<- sum(diag(tab1))/sum(tab1)
accuracy_training
error_training<- 1-accuracy_training
error_training
Y_fitted_test=predict.lm(model_BIC, newdata=testing)
Y_fit_test=ifelse(Y_fitted_test>0.5,1,0)
tab2<-table(testing$Y,Y_fit_test)
accuracy_testing<- sum(diag(tab2))/sum(tab2)
accuracy_testing
error_testing<- 1-accuracy_testing
error_testing

# artificial neural network model
library(neuralnet)
mydata<-read.table("OI25var.txt", header=T)
attach(mydata)
str(mydata$Y)
head(mydata,15)
summary(mydata)
class(mydata$Y)
#Not - 2 Passively - 3 Actively - 1
set.seed(123)
def_sets<-sample(2, nrow(mydata), replace = T, prob = c(0.7,0.3))
```

```
training<-mydata[def_sets==1,]
testing <-mydata[def_sets==2,]
set.seed(123)
for(i in 5:18)
{
ANN1<-neuralnet(Y~.
data=training,
hidden = i,
err.fct = “sse”,
algorithm = “rprop+”,
stepmax = 10000000,
linear.output = FALSE,
lifesign = ‘minimal’)
print(ANN1$result.matrix[1,1])

forecast_train<- compute(ANN1,training[,-1])
forecast_train$net.result
Y_A=ifelse(training$Y==“Actively”,1,0)
f_train_A=ifelse(forecast_train$net.result[,1]>0.5,1,0)
Y_A
f_train_A
tab1<-table(Y_A, f_train_A)
tab1
Y_P=ifelse(training$Y==“Passively”,1,0)
f_train_P=ifelse(forecast_train$net.result[,3]>0.5,1,0)
Y_P
f_train_P
tab2<-table(Y_P,f_train_P)
Y_N=ifelse(training$Y==“Not”,1,0)
f_train_N=ifelse(forecast_train$net.result[,2]>0.5,1,0)
Y_N
f_train_N
tab3<-table(Y_N, f_train_N)
tab3
Atrain=ifelse(max(f_train_A)==0,0,tab1[2,2])
Atrain
Ptrain=ifelse(max(f_train_P)==0,0,tab2[2,2])
Ptrain
Ntrain=ifelse(max(f_train_N)==0,0,tab3[2,2])
Ntrain
#TESTING
forecast_test<- compute(ANN1,testing[,-1],)
forecast_test$net.result
Y_A=ifelse(testing$Y==“Actively”,1,0)
f_test_A=ifelse(forecast_test$net.result[,1]>0.5,1,0)
Y_A
f_test_A
tab4<-table(Y_A, f_test_A)
tab4
Y_P=ifelse(testing$Y==“Passively”,1,0)
f_test_P=ifelse(forecast_test$net.result[,3]>0.5,1,0)
Y_P
f_test_P
tab5<-table(Y_P, f_test_P)
```

```
tab5
Y_N=ifelse(testing$Y==“Not”,1,0)
f_test_N=ifelse(forecast_test$net.result[,2]>0.5,1,0)
Y_N
f_test_N
tab6<-table(Y_N, f_test_N)
tab6
Atest=ifelse(max(f_test_A)==0,0,tab4[2,2])
Atest
Ptest=ifelse(max(f_test_P)==0,0,tab5[2,2])
Ptest
Ntest=ifelse(max(f_test_N)==0,0,tab6[2,2])
Ntest
accuracy_training<- sum(Atrain, Ptrain, Ntrain)/length(training$Y)
accuracy_training
error_training<- 1-accuracy_training
error_training
accuracy_testing<- sum(Atest, Ptest, Ntest)/length(testing$Y)
accuracy_testing
error_testing<- 1-accuracy_testing
error_testing
print(i)
print(accuracy_training)
print(error_training)
print(accuracy_testing)
print(error_testing)
plot(ANN1)
}
ANN1<-neuralnet(Y~.
data=training,
hidden = 5,
rep=10,
err.fct = “sse”,
algorithm = “rprop+”,
stepmax = 1000000,
linear.output = FALSE,
lifesign = ‘minimal’)
print(ANN1$result.matrix[1,1])


set.seed(123)
for(i in 1:10)
{
forecast_train<- compute(ANN1,training[,-1], rep=i)
forecast_train$net.result
Y_A=ifelse(training$Y==“Actively”,1,0)
f_train_A=ifelse(forecast_train$net.result[,1]>0.5,1,0)
Y_A
f_train_A
tab1<-table(Y_A, f_train_A)
tab1
Y_P=ifelse(training$Y==“Passively”,1,0)
f_train_P=ifelse(forecast_train$net.result[,3]>0.5,1,0)
Y_P
```

```
f_train_P
tab2<-table(Y_P,f_train_P)
tab2
Y_N=ifelse(training$Y==“Not”,1,0)
f_train_N=ifelse(forecast_train$net.result[,2]>0.5,1,0)
Y_N
f_train_N
tab3<-table(Y_N, f_train_N)
tab3
Atrain=ifelse(max(f_train_A)==0,0,tab1[2,2])
Atrain
Ptrain=ifelse(max(f_train_P)==0,0,tab2[2,2])
Ptrain
Ntrain=ifelse(max(f_train_N)==0,0,tab3[2,2])
Ntrain
#TESTING
forecast_test<- compute(ANN1,testing[,-1], rep=i)
forecast_test$net.result
Y_A=ifelse(testing$Y==“Actively”,1,0)
f_test_A=ifelse(forecast_test$net.result[,1]>0.5,1,0)
Y_A
f_test_A
tab4<-table(Y_A, f_test_A)
tab4
Y_P=ifelse(testing$Y==“Passively”,1,0)
f_test_P=ifelse(forecast_test$net.result[,3]>0.5,1,0)
Y_P
f_test_P
tab5<-table(Y_P, f_test_P)
tab5
Y_N=ifelse(testing$Y==“Not”,1,0)
f_test_N=ifelse(forecast_test$net.result[,2]>0.5,1,0)
Y_N
f_test_N
tab6<-table(Y_N, f_test_N)
tab6
Atest=ifelse(max(f_test_A)==0,0,tab4[2,2])
Atest
Ptest=ifelse(max(f_test_P)==0,0,tab5[2,2])
Ptest
Ntest=ifelse(max(f_test_N)==0,0,tab6[2,2])
Ntest
accuracy_training<- sum(Atrain, Ptrain, Ntrain)/length(training$Y)
accuracy_training
error_training<- 1-accuracy_training
error_training
accuracy_testing<- sum(Atest, Ptest, Ntest)/length(testing$Y)
accuracy_testing
error_testing<- 1-accuracy_testing
error_testing
print(i)
print(accuracy_training)
print(error_training)
print(accuracy_testing)
```

```
print(error_testing)
}
plot(ANN1, rep=4)
```

References

1. Mubarak, M.F.; Petraite, M. Industry 4.0 Technologies, Digital Trust and Technological Orientation: What Matters in Open Innovation? *Technol. Forecast. Soc. Chang.* **2020**, *161*, 120332. [CrossRef]
2. Obradović, T.; Vlačić, B.; Dabić, M. Open Innovation in the Manufacturing Industry: A Review and Research Agenda. *Technovation* **2021**, *102*, 102221. [CrossRef]
3. Raghavan, A.; Demircioglu, M.A.; Orazgaliyev, S. COVID-19 and the New Normal of Organizations and Employees: An Overview. *Sustainability* **2021**, *13*, 11942. [CrossRef]
4. Marullo, C.; Ahn, J.M.; Martelli, I.; Di Minin, A. Open for Innovation: An Improved Measurement Approach Using Item Response Theory. *Technovation* **2021**, *109*, 102338. [CrossRef]
5. European Commission. Directorate General for Communications Networks, Content and Technology. In *Open Innovation 2.0 Yearbook 2017–2018*; European Commission Publications Office: Luxembourg, 2018.
6. Curley, M. The Evolution of Open Innovation. *J. Innov. Manag.* **2015**, *3*, 9–16. [CrossRef]
7. Hollanders, H.; Es-Sadki, N. *European Innovation Scoreboard 2021*; Publications Office of the European Union: Luxembourg, 2021.
8. Chesbrough, H.W.; Vanhaverbeke, W. Open Innovation and Public Policy in the EU with Implications for SMEs. In *Researching Open Innovation in SMEs*; World Scientific: Singapore, 2018; pp. 455–492. ISBN 978-981-323-096-5.
9. Usman, M.; Vanhaverbeke, W. How Start-Ups Successfully Organize and Manage Open Innovation with Large Companies. *Eur. J. Innov. Manag.* **2017**, *20*, 171–186. [CrossRef]
10. Rosienkiewicz, M.; Helman, J.; Cholewa, M.; Molasy, M.; Krause-Juettler, G. Analysis and Assessment of Bottom-Up Models Developed in Central Europe for Enhancing Open Innovation and Technology Transfer in Advanced Manufacturing. In *Sustainable Design and Manufacturing 2020*; Scholz, S.G., Howlett, R.J., Setchi, R., Eds.; Smart Innovation, Systems and Technologies; Springer: Singapore, 2021; Volume 200, pp. 119–128. ISBN 9789811581304.
11. Rosienkiewicz, M.; Helman, J.; Cholewa, M.; Molasy, M. SYNERGY Project: Open Innovation Platform for Advanced Manufacturing in Central Europe. In *Intelligent Systems in Production Engineering and Maintenance*; Burduk, A., Chlebus, E., Nowakowski, T., Tubis, A., Eds.; Springer International Publishing: Cham, Switzerland, 2019; Volume 835, pp. 306–315. ISBN 978-3-319-97489-7.
12. McAdam, M.; Debackere, K. Beyond 'Triple Helix' toward 'Quadruple Helix' Models in Regional Innovation Systems: Implications for Theory and Practice: Beyond 'Triple Helix' toward 'Quadruple Helix' Models. *RD Manag.* **2018**, *48*, 3–6. [CrossRef]
13. Inauen, M.; Schenker-Wicki, A. Fostering Radical Innovations with Open Innovation. *Eur. J. Innov. Manag.* **2012**, *15*, 212–231. [CrossRef]
14. Wu, S.; Ding, X.; Liu, R.; Gao, H. How Does IT Capability Affect Open Innovation Performance? The Mediating Effect of Absorptive Capacity. *Eur. J. Innov. Manag.* **2019**, *24*, 43–65. [CrossRef]
15. Zhou, F.; Liu, Y.; Chen, R. Research on Collaborative Innovation of Intelligent Connected Vehicles Industry Based on Test Field: Embedded Case Study from the Perspective of Open Innovation. *Sustainability* **2021**, *13*, 5880. [CrossRef]
16. Klofsten, M.; Urbano, D.; Heaton, S. Managing Intrapreneurial Capabilities: An Overview. *Technovation* **2021**, *99*, 102177. [CrossRef]
17. Xie, X.; Wang, H. How to Bridge the Gap between Innovation Niches and Exploratory and Exploitative Innovations in Open Innovation Ecosystems. *J. Bus. Res.* **2021**, *124*, 299–311. [CrossRef]
18. Adnan, H.R.; Hidayanto, A.N.; Kurnia, S. Citizens' or Government's Will? Exploration of Why Indonesia's Local Governments Adopt Technologies for Open Government. *Sustainability* **2021**, *13*, 11197. [CrossRef]
19. Kitsios, F.; Kamariotou, M.; Grigoroudis, E. Digital Entrepreneurship Services Evolution: Analysis of Quadruple and Quintuple Helix Innovation Models for Open Data Ecosystems. *Sustainability* **2021**, *13*, 12183. [CrossRef]
20. Available online: ec.europa.eu/digital-single-market/en/open-innovation-20 (accessed on 29 July 2021).
21. Curley, M.; Salmelin, B. *Open Innovation 2.0: A New Paradigm*; European Commission: Luxembourg, 2013.
22. Jarvenpaa, S.L.; Wernick, A. Paradoxical Tensions in Open Innovation Networks. *Eur. J. Innov. Manag.* **2011**, *14*, 521–548. [CrossRef]
23. Chiaroni, D.; Chiesa, V.; Frattini, F. Investigating the Adoption of Open Innovation in the Bio-pharmaceutical Industry: A Framework and an Empirical Analysis. *Eur. J. Innov. Manag.* **2009**, *12*, 285–305. [CrossRef]
24. Santos, R.S.; Soares, J.; Marques, P.C.; Navas, H.V.G.; Martins, J.M. Integrating Business, Social, and Environmental Goals in Open Innovation through Partner Selection. *Sustainability* **2021**, *13*, 12870. [CrossRef]
25. Brabham, D.C. *Crowdsourcing*; The MIT Press essential knowledge series; The MIT Press: Cambridge, MA, USA; London, UK, 2013; ISBN 978-0-262-51847-5.
26. What Is Crowdsourcing? Available online: https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/Innovation/deloitte-uk-crowsourcing-what-is-crowdsourcing.pdf (accessed on 29 July 2021).
27. Forbes, H.; Schaefer, D.; Han, J.; De Oliveira, F.B. Investigating Factors Influential on the Success of Social Product Development Initiatives. *Procedia CIRP* **2020**, *91*, 107–112. [CrossRef]

28. Belk, R. You Are What You Can Access: Sharing and Collaborative Consumption Online. *J. Bus. Res.* **2014**, *67*, 1595–1600. [CrossRef]
29. Hwang, J. Managing the Innovation Legitimacy of the Sharing Economy. *Int. J. Qual. Innov.* **2019**, *5*, 1. [CrossRef]
30. Chabbouh, H.; Boujelbene, Y. Open Innovation in SMEs: The Mediating Role between Human Capital and Firm Performance. *J. High Technol. Manag. Res.* **2020**, *31*, 100391. [CrossRef]
31. Hossain, M.; Kauranen, I. Open Innovation in SMEs: A Systematic Literature Review. *J. Strategy Manag.* **2016**, *9*, 58–73. [CrossRef]
32. Liu, L.; Zhang, H. How Does Inter-Organizational Relational Governance Propel Firms' Open Innovation? A Conditional Process Analysis. *Sustainability* **2021**, *13*, 10209. [CrossRef]
33. Van de Vrande, V.; de Jong, J.P.J.; Vanhaverbeke, W.; de Rochemont, M. Open Innovation in SMEs: Trends, Motives and Management Challenges. *Technovation* **2009**, *29*, 423–437. [CrossRef]
34. Ebersberger, B.; Bloch, C.; Herstad, S.J.; Van De Velde, E. Open Innovation Practices and Their Effect on Innovation Performance. *Int. J. Innov. Technol. Manag.* **2012**, *9*, 1250040. [CrossRef]
35. Parida, V.; Westerberg, M.; Frishammar, J. Inbound Open Innovation Activities in High-Tech SMEs: The Impact on Innovation Performance. *J. Small Bus. Manag.* **2012**, *50*, 283–309. [CrossRef]
36. Hervas-Oliver, J.-L.; Sempere-Ripoll, F.; Boronat-Moll, C. Technological Innovation Typologies and Open Innovation in SMEs: Beyond Internal and External Sources of Knowledge. *Technol. Forecast. Soc. Chang.* **2021**, *162*, 120338. [CrossRef]
37. Popa, S.; Soto-Acosta, P.; Martinez-Conesa, I. Antecedents, Moderators, and Outcomes of Innovation Climate and Open Innovation: An Empirical Study in SMEs. *Technol. Forecast. Soc. Chang.* **2017**, *118*, 134–142. [CrossRef]
38. Brunswicker, S.; Vanhaverbeke, W. Open Innovation in Small and Medium-Sized Enterprises (SMEs): External Knowledge Sourcing Strategies and Internal Organizational Facilitators. *J. Small Bus. Manag.* **2015**, *53*, 1241–1263. [CrossRef]
39. Chen, Y.; Vanhaverbeke, W.; Du, J. The Interaction between Internal R&D and Different Types of External Knowledge Sourcing: An Empirical Study of Chinese Innovative Firms: Interaction between Internal R&D and Different Types of External Knowledge Sourcing. *RD Manag.* **2016**, *46*, 1006–1023. [CrossRef]
40. De Marco, C.E.; Martelli, I.; Di Minin, A. European SMEs' Engagement in Open Innovation When the Important Thing Is to Win and Not Just to Participate, What Should Innovation Policy Do? *Technol. Forecast. Soc. Chang.* **2020**, *152*, 119843. [CrossRef]
41. Kapetaniou, C.; Lee, S.H. Geographical Proximity and Open Innovation of SMEs in Cyprus. *Small Bus. Econ.* **2019**, *52*, 261–276. [CrossRef]
42. Leckel, A.; Veilleux, S.; Dana, L.P. Local Open Innovation: A Means for Public Policy to Increase Collaboration for Innovation in SMEs. *Technol. Forecast. Soc. Chang.* **2020**, *153*, 119891. [CrossRef]
43. Radicic, D.; Pugh, G. Performance Effects of External Search Strategies in European Small and Medium-Sized Enterprises. *J. Small Bus. Manag.* **2017**, *55*, 76–114. [CrossRef]
44. Radziwon, A.; Bogers, M. Open Innovation in SMEs: Exploring Inter-Organizational Relationships in an Ecosystem. *Technol. Forecast. Soc. Chang.* **2019**, *146*, 573–587. [CrossRef]
45. Verbano, C.; Crema, M.; Venturini, K. The Identification and Characterization of Open Innovation Profiles in Italian Small and Medium-Sized Enterprises. *J. Small Bus. Manag.* **2015**, *53*, 1052–1075. [CrossRef]
46. Vanhaverbeke, W. *Managing Open Innovation in SMEs*; Cambridge University Press: Cambridge, UK, 2017; ISBN 978-1-139-68098-1.
47. Yi, R.; Wang, H.; Lyu, B.; Xia, Q. Does Venture Capital Help to Promote Open Innovation Practice? Evidence from China. *Eur. J. Innov. Manag.* **2021**. [CrossRef]
48. Aleksić, D.; Rangus, K.; Slavec Gomezel, A. Microfoundations of SME Open Innovation: The Role of Help, Knowledge Sharing and Hiding. *Eur. J. Innov. Manag.* **2021**. [CrossRef]
49. Bigliardi, B.; Ivo Dormio, A.; Galati, F. The Adoption of Open Innovation within the Telecommunication Industry. *Eur. J. Innov. Manag.* **2012**, *15*, 27–54. [CrossRef]
50. Urbinati, A.; Landoni, P.; Cococcioni, F.; De Giudici, L. Stakeholder Management in Open Innovation Projects: A Multiple Case Study Analysis. *Eur. J. Innov. Manag.* **2021**, *24*, 1595–1624. [CrossRef]
51. Dong, J.Q.; Netten, J. Information Technology and External Search in the Open Innovation Age: New Findings from Germany. *Technol. Forecast. Soc. Chang.* **2017**, *120*, 223–231. [CrossRef]
52. Gewald, H.; Birkle, M. Open Innovation in the German SME Sector—Development and Test of a Diffusion Model. *Prog. Mach. Syst.* **2012**, *1*, 11.
53. Bogers, M.; Burcharth, A.; Chesbrough, H. Open Innovation in Brazil: Exploring Opportunities and Challenges. *Int. J. Innov.* **2019**, *7*, 178–791. [CrossRef]
54. Vélez-Rolón, A.M.; Méndez-Pinzón, M.; Acevedo, O.L. Open Innovation Community for University–Industry Knowledge Transfer: A Colombian Case. *J. Open Innov. Technol. Mark. Complex.* **2020**, *6*, 181. [CrossRef]
55. Oganisjana, K. Promotion of University Students' Collaborative Skills in Open Innovation Environment. *J. Open Innov. Technol. Mark. Complex.* **2015**, *1*, 18. [CrossRef]
56. Bogers, M. *Student-Oriented Teaching by Using an Open Innovation Game*; University of Southern Denmark: Sønderborg, Denmark, 2011; p. 15. ISBN 978-1-4709-1566-7.
57. Howells, J.; Ramlogan, R.; Cheng, S. Universities in an Open Innovation System: A UK Perspective. *Int. J. Entrep. Behav. Res.* **2012**, *18*, 440–456. [CrossRef]

58. Eroğlu, I.; Ekmekçioğlu, D. Exploring the Relation between Students' Research Behaviours in Project Courses and Open Innovation. *Des. Technol. Educ. Int. J.* **2018**, *23*, 45–60.
59. Stanisławski, R.; Lisowsk, R. The Relations between Innovation Openness (Open Innovation) and the Innovation Potential of SMEs. *Procedia Econ. Financ.* **2015**, *23*, 1521–1526. [CrossRef]
60. Sachpazidu-Wójcicka, K. Open Innovation and Technology Transfer in Polish Enterprises. *J. Manag. Financ. Sci.* **2016**, *9*, 179.
61. Runiewicz-Wardyn, M. Towards Building Open Innovation Ecosystem in Poland: Challenges and Opportunities. *Kwart. Nauk. Przedsiębiorstwie* **2020**, *2*, 15–27. [CrossRef]
62. Dziurski, P.; Sopińska, A. Does Industry Matter? Drivers and Barriers for Open Innovation in High-Tech and Non-High-Tech Industries—Evidence from Poland. *Int. J. Manag. Econ.* **2020**, *56*, 307–323. [CrossRef]
63. Baron, M. Open Innovation Capacity of the Polish Universities. *J. Knowl. Econ.* **2021**, *12*, 73–95. [CrossRef]
64. Guerrero, M.; Heaton, S.; Urbano, D. Building Universities' Intrapreneurial Capabilities in the Digital Era: The Role and Impacts of Massive Open Online Courses (MOOCs). *Technovation* **2021**, *99*, 102139. [CrossRef]
65. Gyamfi, S.; Sein, Y.Y. Determinants of Sustainable Open Innovations—A Firm-Level Capacity Analysis. *Sustainability* **2021**, *13*, 9088. [CrossRef]
66. Isaac, S.; Michael, W.B. *Handbook in Research and Evaluation: A Collection of Principles, Methods, and Strategies Useful in Planning, Design, and Evaluation of Studies in Education and the Behavioral Sciences*, 3rd ed.; Educational and Industrial Testing Services: San Diego, CA, USA, 1997.
67. Questionnaire Survey. Available online: https://www.sciencedirect.com/topics/earth-and-planetary-sciences/questionnaire-survey (accessed on 28 July 2021).
68. Marketing Research and Information Systems. (Marketing and Agribusiness Texts-4), Chapter 4: Questionnaire Design. Available online: http://www.fao.org/3/w3241e/w3241e05.htm (accessed on 28 July 2021).
69. Cavallo, A.; Burgers, H.; Ghezzi, A.; van de Vrande, V. The Evolving Nature of Open Innovation Governance: A Study of a Digital Platform Development in Collaboration with a Big Science Centre. *Technovation* 2021, *in press*. [CrossRef]
70. Yström, A.; Aspenberg, H.; Kumlin, A. Exploring the Creative Climate in an Open Innovation Arena: Identifying Challenges and Possibilities. *Eur. J. Innov. Manag.* **2015**, *18*, 70–85. [CrossRef]
71. Available online: https://heinnovate.eu/en (accessed on 30 July 2021).