

Determinants of Entrepreneurial Intentions at Universities. Warsaw University of Technology Case

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The aim of the article is to identify the main determinants of entrepreneurial intentions of technical university students at Warsaw University of Technology. The perspective of a leading technical university is crucial in view of the possibility to set up innovative businesses in the STEM sector. The research results were obtained from a quantitative survey conducted in 2018 among WUT students (N = 476). As a result, the hypotheses regarding the impact of 1) entrepreneurship classes, 2) professional experience, 3) views on the market, 4) stage of education, and 5) gender were verified. Therefore, the research outcomes provide argumentation for effective adjustment of the university's activities supporting the creation of innovative enterprises and entrepreneurial education.

Keywords: entrepreneurial education, entrepreneurial intentions, technical universities, quantitative research, students survey.

Determinanty przedsiębiorczości na uczelniach technicznych. Studium przypadku Politechniki Warszawskiej

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Celem artykułu jest zidentyfikowanie głównych czynników wpływających na intencje przedsiębiorcze wśród studentów uczelni technicznych na podstawie badań przeprowadzonych na Politechnice Warszawskiej. Perspektywa wiodącej uczelni technicznej jest kluczowa w kontekście możliwego zakładania firm w sektorze związanym z dyscyplinami nauki, technologii, inżynierii i matematyki (STEM). W pracy bazowano na wynikach ilościowej ankiety przeprowadzonej w 2018 roku wśród studentów PW (N = 476). W rezultacie zweryfikowano hipotezy dotyczące wpływu: 1) zajęć z przedsiębiorczości; 2) doświadczenia zawodowego; 3) poglądów na rynek pracy; 4) stopnia edukacji i 5) płci na zamiary przedsiębiorcze. Tym samym wyniki badania dostarczają argumentów za efektywnym dostosowywaniem zajęć akademickich, wspierających tworzenie innowacyjnych przedsiębiorstw i edukacji przedsiębiorczości.

Słowa kluczowe: przedsiębiorczość akademicka, edukacja w zakresie przedsiębiorczości, intencje przedsiębiorcze, uniwersytety techniczne, badania ilościowe, ankieta dla studentów.

JEL: A22, C12, C38, L26

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1. The Aim of the Study on Entrepreneurial Intentions

The subject of students' willingness to start up their own company (or entrepreneurial intentions) is an important challenge, among others in the context of the Lisbon Strategy, wherein the development of entrepreneurial attitudes among the young generation has been defined as a factor stimulating economic development and employment rates (Bacigalupo et al., 2010). Consequently, entrepreneurship has become an important part of the curriculum also in non-business schools and the number of programmes supporting business initiatives of young people has increased (European Commission, 2008; Mirowski, 2008). Universities tend to transform into 'international know-how hubs' dubbed third generation universities, or 3Gus (Wissema, 2009). Nevertheless, a number of available elaborations and evaluation studies indicate that targeting these programmes to all young people does not bring positive results, because success in business is associated with a certain mindset and skillset. Therefore, support for entrepreneurial attitudes brings wider social benefits in limited strategies (Kaczmarek & Kaczmarek-Kurczak, 2012). Hence, companies that succeed in the conditions of modern economy often operate in the fields associated with science and technology and for this reason, graduates of technical universities have a particularly higher chance of setting up successful and durable enterprises. Moreover, such businesses often operate within an innovative economy and have the capacity to contribute to the broadly understood modernization of the national economy (Kopczyński, 2017; Wojciuk, 2018).

Moreover, research conducted among others at the Centre for Innovation and Technology Transfer Management of Warsaw University of Technology (CZiITT PW) indicates a systematic difference between entrepreneurial intentions of students and the actual number of companies established up to 5 years after graduation (Academic entrepreneurship, 2017¹; Parzych, 2017; Human Capital in Poland, 2013²; Górniak, 2014; *ibid.*, 2014; PARP³; Jelonek, 2015; MKZA⁴; Chojecki, 2018). Since the special role of technical universities in preparation of potential future elites of the modern economy is highlighted, it appears important to elaborate on entrepreneurial intentions of students of technical universities. The dominant approach in available studies includes analyses of a wide population only, e.g. entrepreneurship of all students in Poland (such as reports from BKL (Górski, 2013), Capgemini (Spitzer, 2016), Deloitte (2018)). Conclusions regarding a broad population lead to the formulation of recommendations that do not fit the specifics of national leading technical universities, the more so because universities in the context of entrepreneurship training are characterized by high heterogeneity (Huyghe, 2015).

Technical university graduates are characterized by high expected income (Górniak, 2015), high employability rates (Górniak, 2015; MKZA, 2017),

which leads to relatively few economic incentives to undertake entrepreneurial initiatives among graduates. Therefore, potential entrepreneurs undertake business initiatives because of “chances” (“pull”), not because of “coercive” (“push”) factors (see Amit & Muller, 2013).

As part of the study, we have considered the very entrepreneurial intentions as a necessary stage on the path towards creating an own enterprise (Kaczmarek & Kaczmarek-Kurczak, 2012), which is consistent with Ajzen’s theory of planned behaviour, which suggests that there is an intention-behaviour link (Ajzen, cited by Valencia, 2016). Although many other forms of entrepreneurship are also taken into account in the literature, e.g. within-the-organization entrepreneurship or non-profit social entrepreneurship, and not each small business is entrepreneurial in the strict sense of the term (Driessen, 2010), in further analyses we will focus only on entrepreneurship understood as establishing enterprises in order to get income. There is a special interest in setting up businesses because it is considered as an important success factor in the economy (Hornaday, 1992, cited by Olmos & Castillo, 2007). Also, the understanding of the behaviour of entrepreneurs was closely related to the understanding of entrepreneurial intentions and their configuration (Shane & Venkataraman, 2000; Fitzsimmons & Douglas, 2011).

1.1. Methodology

When scrutinizing entrepreneurial intentions, at the stage of formulating hypotheses, we included both those related directly to the intra-university environment and those related to non-university factors. For this study, we defined entrepreneurial intentions as a declared intention to set up a firm in the future. We were particularly interested in whether Warsaw University of Technology affects a component of entrepreneurial attitudes related to entrepreneurial intentions defined as such. Since many factors – demographic, cognitive, and institutional – influence entrepreneurial intentions (Farashah, 2015, pp. 452–476) in the context of a technical university, we examined:

1) whether the age and number of years spent at WUT affect entrepreneurial intentions, 2) if participation in entrepreneurship courses at WUT affects entrepreneurial intentions, 3) the differentiating nature of opinions on entrepreneurship, 4) the impact of gender, 5) professional experience on the labour market.

To verify the impact of the factors mentioned above, the data collected for the purpose of the #PowiedzPW student survey were used as the main source of knowledge. In the said survey, we included the question *Do you consider setting up a firm in the future?*, which is interpreted as a declaration of entrepreneurial intentions. The #PowiedzPW study, conducted by the computer-assisted web interviewing (CAWI) technique, includes answers

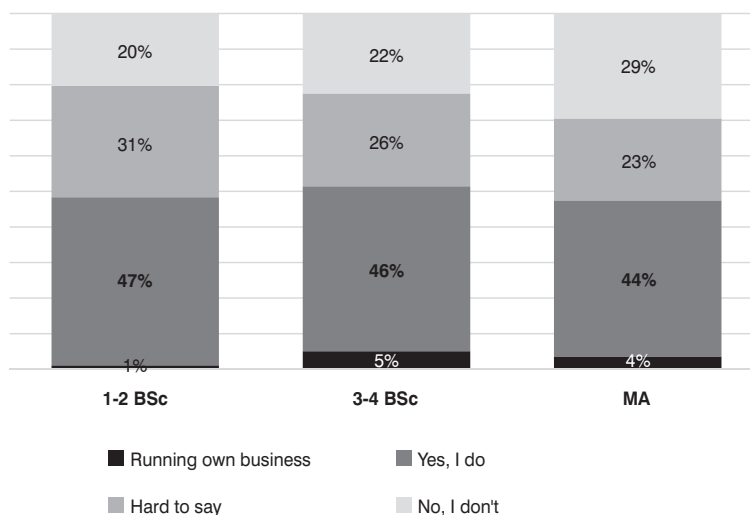
from 476 students of Warsaw University of Technology. In that study, network selection was used as the sample selection method, due to the inability to reach students by means of one of the random selection methods. The online questionnaire was posted on websites related to particular WUT departments or student science clubs, and in the case of some departments, the questionnaire was sent via email to students. The survey was available to be filled between March 5 and April 4, 2018. Among the 476 questionnaires collected, 38.6% were completed by females. 30.3% of the research sample attended master's studies and 39.7% were in the 1st or 2nd year of the first degree. The most numerous departments were: Faculty of Civil Engineering (18.3%), Faculty of Mathematics and Information Science (16.2%), Faculty of Automotive and Construction Machinery Engineering (13.9%), Faculty of Civil Engineering, Mechanics and Petrochemistry (11.5%) and in each of those four faculties the questionnaire was completed by at least 50 students, which made inference possible at the faculty level.

Inference was possible also due to datasets from other surveys conducted by the Research and Analysis Department at CZLiTT PW: 1) studies on MKZA 2017 (WUT Graduate Careers), which was carried out on a sample of 2017 respondents; 2) Academic Entrepreneurship study 2013-2017 – annual study of attitudes towards entrepreneurship among students, 3) Students database 2010 and 2013 which were parts of the Human Capital in Poland project (2014) (random sample N = 32,100, including 1,064 PW students).

2. Determinants of Entrepreneurship

H1: The impact of the stage of education on entrepreneurial intentions

The study did not have the characteristics of a longitudinal research, so the inference about the relationship between the stage of studies at the university and entrepreneurial intentions was made on the basis of cross-sectional data, which allows drawing approximate conclusions (Babbie, 2008, pp. 126–127). By having in the research sample both students who had just started their studies – they had just completed one semester of study – and those who were already studying in the fifth year, the inference was possible. Two probable hypotheses are taken into account: H1.1: The intention to become an entrepreneur is the domain of young people and decreases with age. A lack of experience and incomplete information about the functioning of enterprises within the framework of market competition could make students who are at the beginning of their studies pay attention to, first and foremost, the positive qualities of running their own business. H1.2: The desire to become an entrepreneur comes with age because people at the beginning of their studies do not think about professional positions, focusing on studying.



Note: Respondents were asked the question: Do you consider setting up a firm in the future?

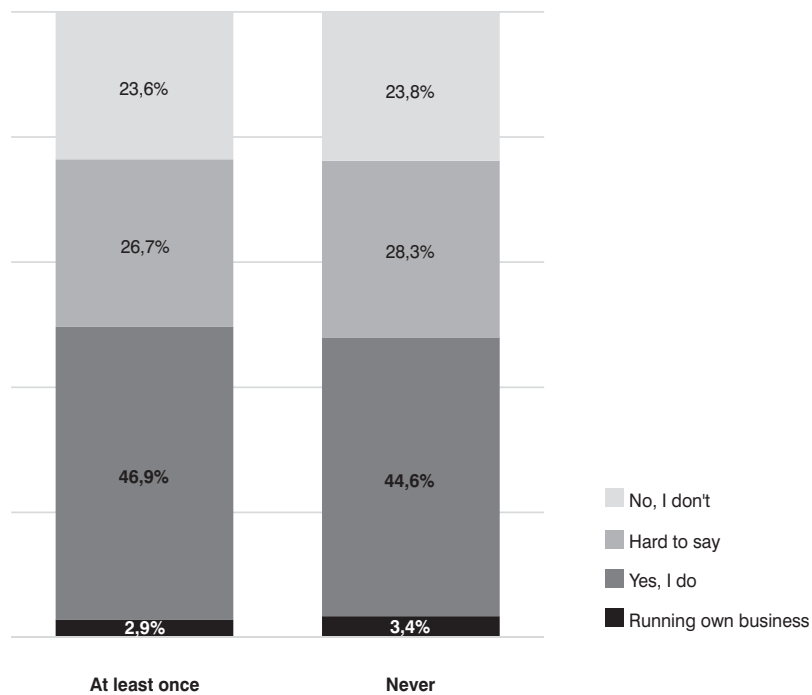
Fig. 1. Entrepreneurial intentions by educational level (N = 476). Source: Own elaboration based on #PowiedzPW survey.

Despite the fact that the research sample contains more students from the first years of first degree studies with entrepreneurial intentions than second degree students and (as expected) more students are not yet able to answer this question unambiguously, the hypothesis about greater entrepreneurial intentions among people at the beginning of studies should be considered as not possible to confirm according to available data. Moreover, the lack of a significant relation with the stage of studies was observed in the context of such variables as associations with entrepreneurship as well as the perception of success factors in business. The data make the hypothesis that attitudes towards entrepreneurship are fixed at an earlier stage of life and the university does not use an available toolset that may influence or modify them probable.⁵

H2: Impact of entrepreneurial education on entrepreneurial intentions

Entrepreneurship education is (by assumption and definition) a tool for the creation of entrepreneurial attitudes among students, which may result in higher entrepreneurial intentions through, among others, searching for and designing activities aimed at value creation (Neck, Brush & Greene, 2014). As Greene (Greene, 2015) points out, over the past three decades, entrepreneurship education has grown dramatically, from 600 colleges and courses in 1986 to more than 5,000 courses at 2,600 schools today. Nevertheless, due to different teaching models, entrepreneurship education

has been shown to contribute to the development of students' entrepreneurial intentions, although the findings are not entirely conclusive (Lüthje & Franke, 2002; Cieřlik et al., 2011). In Poland, despite some reluctance to introduce non-technical subjects into technical study programmes, more and more often STEM students are educated in the field of entrepreneurship (Kopczyński 2017, pp. 107–118). As reported by *Entrepreneurship in higher education, especially within non-business studies* (European Commission, 2008), Poland saw a great interest in entrepreneurship in higher education after 1990, which was reflected in new private business schools bearing “entrepreneurship” in their names. Courses on entrepreneurship were launched, and in some business schools, students were able to choose a specialization in that topic. However, according to the EC report (ibid.), entrepreneurship education in non-business schools is almost non-existent and is considered as a low-priority subject compared with “the hard” sciences.



Note: Respondents were asked the question: Do you consider setting up a firm in the future?

Fig. 2. Entrepreneurial intentions by educational classes attendance (N = 476). Source: Own elaboration based on #PowiedzPW survey.

The study of Academic Entrepreneurship at Warsaw University of Technology (Wycisk, 2016) states that many of these courses were facultative (elective subjects). According to the #PowiedzPW study, at Warsaw University of Technology 62% of students of the last year of the second degree studies had at least one entrepreneurship course. The study also shows that the said courses were assessed as unhelpful by the students (according to our study, only 37% of WUT students found such courses useful in the context of starting their own enterprises).

Knowledge about the functioning of enterprises should reduce the uncertainty associated with starting a business and thus increase the proportion of students intending to be entrepreneurs. Nevertheless, as the data have shown, 47% of students who attend management courses intend to be entrepreneurs and similarly 45% of students do not. Therefore, the impact of management classes appears insignificant. Moreover, any systematic impact of entrepreneurship classes on other components of attitudes related to entrepreneurship have not been noticed either. However, many studies have shown that not every entrepreneurship education programme is adequately effective. For instance, comparative studies conducted simultaneously at universities in the US and Germany indicate there is a stronger interest in starting up high-tech growth companies after graduation among US students, which is largely explained by the teaching methods at American technical universities (Lüthje & Franke, 2002). Davey (Devey et al., 2013), in turn, have emphasized the impactful role of workshops led by market practitioners in terms of entrepreneurial intentions. Jagiełło-Rusiłowski (2011) has pointed to the benefits of network learning in entrepreneurial education in the Finnish model. Summarizing, a lack of impact of entrepreneurial classes on students' attitudes can be read as a premise for the need to change the existing model.

H3: Impact of entrepreneurial mindset on entrepreneurial intentions

Many researchers taking up the subject of entrepreneurial intentions were focused on the differences in personality traits between people who are considering and not considering becoming entrepreneurs. This subject is often raised in the context of the so-called Big Five (a five-pronged personality model) enabling the examination of personality traits in five basic dimensions. These features also reflect the same attitude towards understanding entrepreneurship (Valencia, 2016).

Association with entrepreneurship	To be entrepreneur?		Diff. [in pp.]
	NO	YES	
Ability to make decisions	51%	54%	3.0
Creativity	45%	47%	1.9
Ability to solve problems	43%	45%	1.4
Ability to identify market needs	45%	45%	-0.2
Ability to work systematically	32%	43%	11.4
Passion and vision	33%	43%	9.3
Self-discipline	35%	43%	8.1
Ability to build a network of contacts	44%	42%	-2.3
Openness to new ideas	29%	39%	10.8
Openness to cooperation	29%	36%	6.6
Ability to persuade	31%	33%	2.1
Ability to create trust	22%	30%	8.0
Team work skills	20%	28%	8.0
Ability to listen	10%	26%	15.9
Constant improvement of professions	21%	25%	3.4
Activity	20%	23%	3.4
Willingness to lead my own life	12%	23%	11.0
Readiness for compromise	10%	18%	7.5
Calm and emotional stability	15%	18%	2.7
Willingness to trust others	4%	9%	5.2

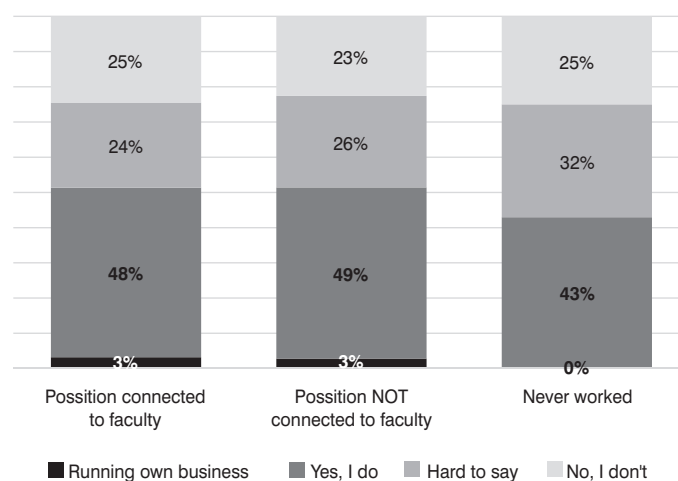
Fig. 3. Agreement with statements on entrepreneurship by entrepreneurial intentions. Source: Own elaboration based on #PowiedzPW survey.

The figure above shows that people who are considering becoming entrepreneurs firstly exhibit on average more attributes related to entrepreneurship. Secondly, students who would like to be entrepreneurs and those who would not differ in views on entrepreneurship in general, especially in such dimensions as: ability to listen, ability to work systematically, willingness to manage their own life, openness to new ideas. Because this relationship occurs both among people at the beginning and at the end of studies, the relationship between personality traits and the tendency

to become an entrepreneur may be permanent. This type of inference seems legitimate in the context of meta-analyses carried out by Kaczmarek and Kaczmarek-Kurczak (2012), as a result of which the authors point to “the existence of systematic, statistically significant, but moderate or weak relationships with both intentions and entrepreneurial achievements”. The study conducted by a team of researchers led by Zhang (Zhang et al., 2009) should be considered the most influential in this context. It showed that the phenomenon of entrepreneurship is in fact partly attributable to genetic factors and that a genetic component exists in the relationship between personality traits and entrepreneurship. Nevertheless, environmental factors have a dominant impact and hence the conclusion that the impact of education and training on entrepreneurship may be effective.

H4: Impact of professional experience on entrepreneurial intentions

We also tested the hypothesis related to the impact of experience on the labour market on the intention to become an entrepreneur. Students of Warsaw University of Technology are characterized by high employability (MKZA, 2017), despite their relatively high financial expectations (Górniak, 2015). Therefore, students of Warsaw University of Technology as desirable employees have a good situation in the current labour market. Given that entrepreneurship is understood as the ability to exploit market opportunities, entrepreneurial WUT graduates may make a sub-optimal use of these opportunities by accepting a lucrative position of highly qualified specialists in an enterprise.



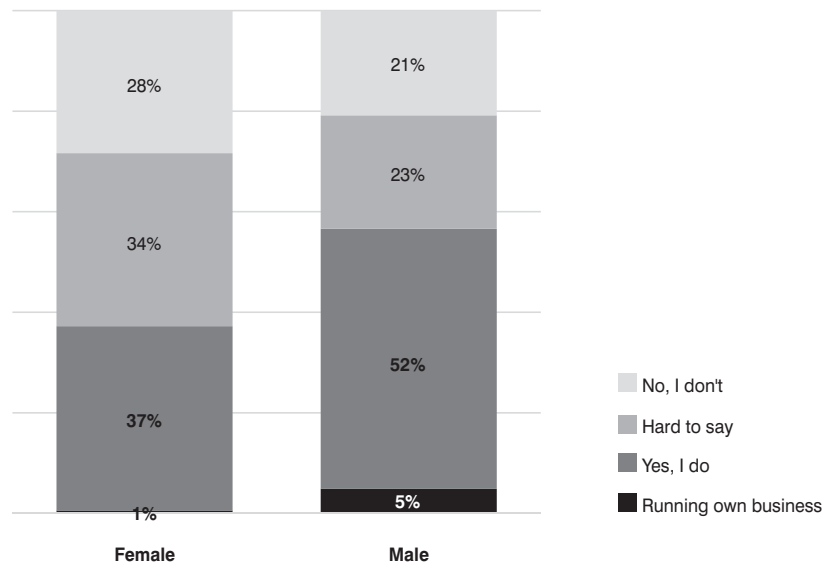
Note: Respondents were asked the question: Do you consider setting up a firm in the future?

Fig. 4. Entrepreneurial intentions by work experience (N = 476). Source: Own elaboration based on #PowiedzPW survey.

Nevertheless, as the data presented above show, people without any professional experience (30% of the research sample) significantly less often intend to become entrepreneurs. We assume that people who start their experience with the labour market at a relatively early age show greater entrepreneurial characteristics. Probably these people are more resourceful at an early stage of life, they are guided by the will to manage their own lives and persistence in pursuing the goals set (similar conclusions are drawn among others in the First Steps into the Labour Market report). Therefore, we can observe the lack of differences between experience in work related and not related to the field of study.

H5: Gender and entrepreneurial intentions

Entrepreneurial intentions are strongly related to gender. The significant percentage of the variability of entrepreneurial intentions can be explained using a variable such as a gender. Figure 5 shows that male students more often have entrepreneurial intentions than females. This tendency is present at all faculties where the research sample allows for such inference. The same tendency can be observed in data from the Human Capital in Poland students database (2013), where male students of technical universities more often intend to set up their own enterprise in 3 years after graduation (44% agree or rather agree) than females (33%).



Note: Respondents were asked the question: Do you consider setting up a firm in the future?

Fig. 5. Entrepreneurial intentions by gender (N=476). Source: Own elaboration based on #PowiedzPW survey.

Therefore, entrepreneurship in the context of culture turns out to be more often a domain of men. Differences between female and male in terms of entrepreneurial intentions according to the latest wave of the Global Entrepreneurship Monitor study (2015) appear in almost all countries of the world. Furthermore, 5 out of 7 Central and Eastern Europe countries available in the sample are in the quartile of countries with the largest gender gap. Poland is in the 10th place out of 70 countries surveyed – 23.1% of males and 14.7% of females are considering setting up a company in the next 3 years. However, if we take into account people with the highest level of education, it turns out that intentions to become entrepreneurs are much higher and in many countries (especially developing countries) the gender gap disappears, but in Central and Eastern European countries it remains at a relatively high level (ibidem).

The problem is pointed out in many aspects of the scientific field. Researchers point out many factors behind women being allowed in but not fully partaking in technical sciences, a symptom of which may be a lower tendency to start their own innovative companies (Santos, Roomi, & Linan, 2016). The cultural lag results in women in science having generally become a personal support structure for male scientists at home and then in the lab (Etzkowitz et. al., 2008, p. 406). A lack of social capital among women in science and business is accentuated by traditional gender roles that impede scientific networking and interaction. Men, on the other hand, had greater external contacts through education and professional travel.

The Role of Faculty

It is also worth noting that students' entrepreneurial intentions vary from one faculty to another. Despite a relatively large research sample ($N = 476$), separate inference for each of the 20 WUT faculties is impossible. Nevertheless, in the case of 4 faculties, more than 50 responses were collected. For the Faculty of Automotive and Construction Machinery Engineering, 64.6% of students ($n = 65$) are considering setting up a company, while at the Faculty of Mathematics and Information Science this proportion stands at only 33.8% ($n = 78$).

Most Impactful Factors: The Random Forest Model

Since many of the variables tested in the study are closely related, it was necessary to jointly test their impact on the dependent variable, i.e. entrepreneurial intentions. These variables are, for instance, gender and work experience. The percentage of working females is lower than that of males and so are their entrepreneurial intentions. Therefore, in order to determine which variables have the most significant impact, the random forest algorithm was applied. The algorithm allows for simultaneous testing of all variables present in the database as well as for identifying and selecting variables with the greatest potential to improve the accuracy of predictions.

The random forest algorithm based on the bootstrap sample produced 20,000 decision trees (in our case). Each decision tree was randomly drawn with the return of N objects, and then the influence of each variable in each decision tree could be determined.

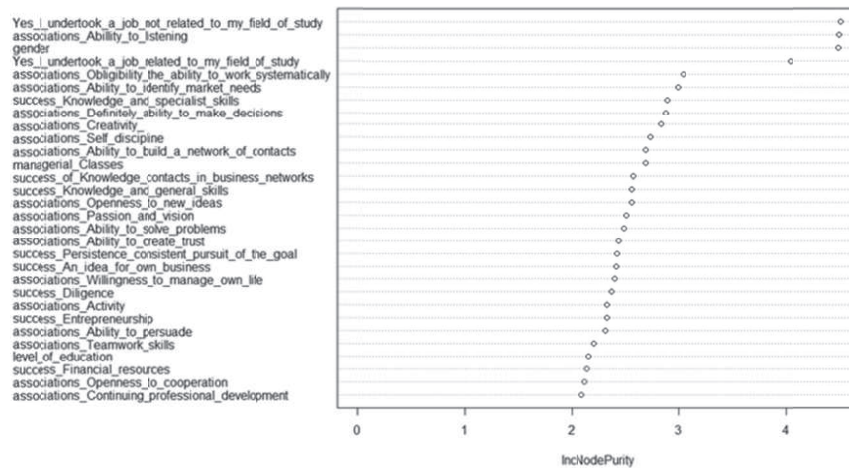


Fig. 6. Significance of variables determining entrepreneurial intentions. Source: Own elaboration based on #PowiedzPW survey.

As the result of the random forest analysis, the figure above presents 30 variables with the highest average impact on the dependent variable – entrepreneurial intention measured by the Mean Decrease Gini (IncNodePurity). The quality (Node Purity) of a split for every variable (node) of a tree is measured by means of the Gini Index. Every time a split of a node is made on a variable, the Gini impurity criterion for the two descendent nodes is less than the parent node. A higher IncNodePurity value represents a higher variable importance, which means nodes are “purer”.

The analyses have also shown that four of these variables have a higher impact on entrepreneurial intentions than others: professional experience not related to the field of study, gender, agreement with the statement that entrepreneurship is associated with the ability to listen and professional experience related to the field of study. Therefore, to predict entrepreneurial intentions as the dependent variable, these 4 variables are sufficient and adding more variables to the predictive model increases the precision of the model to a relatively small extent. Thus, variables such as those related to attending entrepreneurship classes or the number of years spent at WUT are variables that are not related to entrepreneurial intentions.

3. Conclusions: University Searching for Entrepreneurial Meaning

The conducted study has indicated the existence of systematic differences between male and female students as well as between students with and without professional experience. The occurrence of these dependencies in the case of the influence of gender has been confirmed earlier by a number of authors (see Valencia et al., 2017; Shinar et al., 2017; Etkowitz et al., 2008) and has been documented, among others, in data (e.g. Human Capital in Poland database) which show lower entrepreneurial intentions of girls especially at technical universities. However, the impact of professional experience can be explained in two ways: people who work during studies have certain characteristics that are correlated with the will to be entrepreneurial (resourcefulness, willingness to manage their own life) or the labour market entry socializes to think about becoming an entrepreneur. However, both of these variables are independent of the university.

Nevertheless, what seems to be an important conclusion from the point of view of decision-makers at technical universities is that Warsaw University of Technology (according to the current educational model) does not affect the attitudes of students towards entrepreneurship. Neither the stage of studies nor the education for entrepreneurship affects the views on entrepreneurship, the factors guaranteeing success in business, and finally the intentions of becoming an entrepreneur. Thus, at the current stage of entrepreneurship education at Warsaw University of Technology, the potential promised by the third generation university (3gu) model (Wissema, 2001) is certainly not fully utilized. The teaching method is extremely important because, as demonstrated by the Multiannual Programme for Enterprise and Entrepreneurship (2001–2005) coordinated by the European Commission's Directorate-General for Enterprise and Industry, "[t]raditional educational methods (like lectures) do not correlate well with the development of entrepreneurial thinking" (European Commission, 2008).

The large diversity of dimensions and ranges of teaching programmes at technical universities in Poland, observed in many studies, indicates the lack of a coherent strategy of implementing subjects in the field of entrepreneurship. A coherent strategy is important because, as is evident from the good practices of European and American universities quoted in this article, subjects related to entrepreneurship implemented in synergy with the whole ecosystem supporting the process of creating new companies in a given region or country bring tangible benefits from the point of view of creating new enterprises.

Endnotes

- ¹ The research conducted at WUT focuses on the following areas: the evaluation of the educational offer in terms of entrepreneurship, needs and expectations considering support in running a business, and barriers preventing the development of academic entrepreneurship.
- ² The main objective of the study is to monitor the demand for certain competencies on the Polish labour market, research conducted periodically since 2009.
- ³ Report on the situation of young people in the labour market.
- ⁴ Monitoring Karier Zawodowych Absolwentów PW (MKZA) is aimed at acknowledging and understanding the alumni's opinion on the quality of learning at WUT, as well as acquiring information on their situation on the labour market.
- ⁵ Strategies and factors which could change students' attitudes were broadly described in Farashah (2015, pp. 452–476).

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