# R E F E R E N C E

**By**: Prof. D.Sc. Zhelyu Vladimirov
**To**: dissertation work of Prof. Dr Desislava Ivanova Yordanova on the topic "*Technology entrepreneurship among Bulgarian STEM students: the role of University*" for the acquisition of a scientific degree "Doctor of Sciences" in professional area 3.7. Administration and Management (Business Management)
**Reason for the review**: Order RD-38-462/26.7.2022 of the Rector of SU "*St. Kliment Ohridski*"

## 1. Short presentation of the candidate

Desislava Ivanova Yordanova is a graduate of the Faculty of Economics and Business Administration of the Sofia University "*St. Kliment Ohridski*", where she received a bachelor's degree in "Economic Management" in 1998 and a master's degree in "Strategic Management" in 2000. In 2009, she defended his doctoral thesis at the Autonomous University of Barcelona (Spain) on the topic "Gender Effects on entrepreneurship: empirical data from Bulgaria" with Cum laude.

From 2007 until now, she has been working in the Department of Business Administration at the University of "*St. Kliment Ohridski*", and in 2018 she acquired the academic position of "professor". She has read courses on Entrepreneurship, Entrepreneurship and Innovation, Management and Inheritance of a Family Firm, Creation of a New Enterprise, Family Business, Management and Development of New and Small Firms, Basics of Business Administration in Bachelor's and Master's Programs of Sofia University "*St. Kliment Ohridski*". She has given guest lectures at a number of foreign universities. She was the supervisor and reviewer of graduate students and two doctoral students. She worked as an expert for NAOA, Scientific Research Fund, Ministry of Education and Ministry of Economy. She participated in over 15 international, national and university projects.

She is a member of the expert council of the Center for Entrepreneurship of Sofia University "*St. Kliment Ohridski*", the international network Global Entrepreneurship Network (GEN), the international network Entrepreneurship Research and Education Network of Central European Universities (ERENET), and the international virtual community in support of research and education in international entrepreneurship (ie-scholars.net). The candidate fulfills the minimum requirements for a "Doctor of Science" by accumulating well above the required publication and citation points.

The publication activity of Prof. D. Yordanova is significant. She has a total of 82 publications (monographs, studies, articles, book chapters, reports), of which 17 are indexed in Scopus and Web of Science. The total number of citations according to Scopus is 261, according to Web of Science - 184, and according to Google Scholar - 748. Her h-index in Scopus is 7, h-index in Web of Science is 6 and h-index in Google Scholar is 10. She received a prize for the best report at the international scientific conference The Diana International Research Conference on Women's Entrepreneurship in 2017, organized by Babson College (USA). She is a guest-editor of a special issue on "Digital Technologies and the Internationalization of SMEs" of the international scientific journal *Sustainability*, indexed in Web of Science and Scopus (IF=3.251, Citescore=3.9).

## 2. General characteristics of the presented dissertation

The dissertation consists of an introduction, four chapters, a conclusion, a bibliography and two appendices with a total volume of 342 pages, and without the bibliography and appendices – 260 pages. The text contains 54 tables and 22 figures. A total of 470 information sources are used - all in English.

In the introduction, the author justifies the relevance of the chosen topic, which consists in the significant contribution of technological entrepreneurship to economic growth. At the same time, the field seems understudied, which justifies its selection.

The **object** of the study includes the attitudes, intentions and behavior for the development of technological entrepreneurship among Bulgarian STEM students, while the **research perspective** refers to the influence of university factors on these variables. The main **aim** of the dissertation is to identify the university factors that influence *the techno-entrepreneurial attitudes, intentions and behavior* of Bulgarian STEM students (p. 20). This goal is specified in five tasks. The defended thesis is that university factors influence the techno-entrepreneurial attitudes, intentions and behavior of Bulgarian STEM students. In support of the thesis, 23 hypotheses are tested. The data is based on a survey among STEM students in Bulgarian universities and other statistical sources. The limitations of the study are correctly given on pp. 26-27.

**3. Evaluation of the obtained scientific and scientific-applied results**

The **first chapter** consists of four main subtopics covering the theoretical framework of the dissertation. Sub-theme 1 (Entrepreneurship as a process) provides a brief history of the definitions of entrepreneurs and entrepreneurship, summarized in Table. 1 (pp. 30-32). The assumptions of different approaches in entrepreneurship are critically evaluated and several models of the process approach are presented.

Subtopic 2 of the first chapter is devoted to technological entrepreneurship. An overview of the existing definitions of technological entrepreneurship is presented in Table. 2 (pp. 72-74). Despite the differences, all definitions coincide in the understanding that technological entrepreneurship is a combination of two different concepts: entrepreneurship and technology.

Sub-theme 3 reveals the links between institutional factors and entrepreneurship, mainly based on D. North's institutional economics. The author agrees that institutional theory provides an appropriate conceptual framework for examining the impact of environmental characteristics on entrepreneurship (p. 83).

Universities represent a special institutional environment for entrepreneurship (subtopic 4). Various formal and informal factors that facilitate entrepreneurial activity within universities are indicated (Fig. 15, p. 95). The main definitions of the term "entrepreneurial university" are presented in Table. 4 (pp. 99-102), and the elements of an entrepreneurial university are given in Table. 5 (pp. 110-112).

The **second chapter** includes a review of the literature on the determinants of entrepreneurial *attitudes, intentions and behavior*. The first part examines the individual determinants of entrepreneurial attitudes, intentions and behaviour, while the second part reveals the university determinants. The analysis is based on the results of a number of previous empirical studies on these premises and determinants.

Entrepreneurship education for science and engineering students is seen as an important university factor influencing their entrepreneurial attitudes, intentions and behaviour. Several positive effects have been identified among participants in entrepreneurship education (pp. 132-138).

Universities have a rich set of technological capabilities that can be used to stimulate the creation of new technological ventures. In particular, research-intensive universities are more likely to provide students with better knowledge and skills to create and commercialize complex ideas. Other university factors relate to academic composition, availability of successful entrepreneurial role models, networking and interaction with industry. Based on the literature review, the conceptual model of the study is drown (Fig. 22, p. 260). The model includes 5 stages of the entrepreneurial process, 6 university factors and 23 hypotheses. Essentially, these are 4 separate models with corresponding hypotheses (10 hypotheses for the

first model; 5 for the second; 4 for the third; and 4 for the fourth) that are tested in chapter four (pp. 147-151).

The **third chapter** contains the research methodology. The context of the research, which refers to the environment for entrepreneurship in our country, is presented; data on entrepreneurial activity; entrepreneurial education and entrepreneurial transformation of Bulgarian universities. The author concludes that the Bulgarian entrepreneurial ecosystem is very unevenly developed in different regions. It is also shown that comprehensive information on entrepreneurship education at the university level in Bulgaria is not available.

The data was collected through the survey among students of STEM majors in 15 Bulgarian universities in 2015 and 2016. The database consists of 1061 STEM students (Table 8, page 167). The questionnaire contains questions related to respondents' demographic characteristics, attitudes toward entrepreneurship, entrepreneurial intentions, entrepreneurial behavior, participation in entrepreneurship education, and perceptions of university factors. It was tested in a pilot study with 15 students.

The dependent and independent variables used in the study are well explained (Table 11, p. 174; Table 12, p. 176-178). The study also controlled for individual differences related to social network support, role models, gender, age, willingness to take risk, and previous experience at a technology company (Table 13, pp. 179-180). Some variables indicating the career motives of STEM students are also used (Table 14, pp. 180-181). Data are processed using binary logistic regression, chi-square test and Kramer's V coefficient.

The **fourth chapter** presents the results of the research. First, the distribution of responses to the *perceived desirability and feasibility* of technological entrepreneurship among STEM students is given, then the characteristics of students with high desirability and high feasibility of technological entrepreneurship are described (Table 17, pp. 187-188). Also presented are the relationships between desirability and feasibility and other variables such as: gender, educational level, type of education, presence of role models, support from social networks, entrepreneurial education, career motives, challenge, autonomy, authority, self-actualization and participation in the whole process.

Following the same structure of presenting the results, the author finds that there are many similarities in the profiles of STEM students who report *technopreneurial goal intentions and technopreneurial performance intentions* (Table 22, pp. 197-198), including their career motives (Table 23, p. 199) and perceptions of support from their universities (Table 24, p. 200; Table 25, p. 201). Next, the relationships between technopreneurial goal intentions and implementation intentions and other demographic variables mentioned above are given. Similarly, the characteristics of STEM students participating in *emerging technological and intrapreneurship* are shown in Table 26 (pp. 207-208). The sample contains 29 STEM students who are *active entrepreneurs* and 26 STEM students who are *active intrapreneurs*. The characteristics of these students are given in Table 36 (p. 219), as well as their perceptions of university support (Table 37, p. 220; Table 38, p. 221), and their career motivations (Table 39 and Table 40, p. 221- 222).

Following are the empirical results of a *binary logistic regression* on the influence of university factors on the level of desirability in a subsample of 879 students who did not take steps to start a business and did not create their own business. The model correctly predicts the dependent variable desirability in 66.1% of the cases. Several university factors with a statistically significant and positive effect on the *desirability of entrepreneurship* are commented on Table 41 (pp. 224-225).

Shown are the results of a *binary logistic regression* for the effects of several university factors on the probability of feasibility of technology entrepreneurship in the same subsample (Table 42, pp. 226-227). The results reveal that some university factors significantly influence the probability of high desirability and high feasibility of technology entrepreneurship among

these students. On this basis, hypotheses 1, 3, 4, 8, and 10 are supported, while hypotheses 2, 5, 6, 7, and 9 are rejected. Surprisingly, *participation in entrepreneurship education* is not associated with the odds of high desirability and high feasibility of technology entrepreneurship among STEM students (p. 229)

*Binary logistic regression results* for the effects of the independent variables on technopreneurial implementation intentions in the same subsample are presented in Table 44 (p. 232), while Table 45 (p. 234) shows the effects of university factors on the likelihood of technopreneurial implementation intentions in the subsample a sample of 299 STEM students.

The effects of university factors on the *transformation* of technopreneurial implementation intentions into nascent entrepreneurial or intrapreneurial activities in a sub-sample of 200 students who either exhibited technological entrepreneurial intentions (149 STEM students) or are engaged in nascent technological entrepreneurial or intrapreneurial activities (51 STEM students) are presented in Tab. 47 (pp. 240-241). Again, some of the hypotheses were supported (such as hypotheses 12, 13, 14, 17, 22, and 23) and others were rejected (hypotheses 11, 15, 16, 18, 19, 20, 21, and 23).

The role of the university in the development of *active technological and internal entrepreneurship* among STEM students is presented in Tables 49, 51, 52, 54 (pp. 245-250). About one third of active entrepreneurs claim that their studies at the university contributed significantly to increasing sales volume, number of employees or improving financial performance of the technology business in the last 12 months.

The **Conclusion** summarizes the results of the analysis and draws relevant conclusions. Some fields for future research in this area are also outlined.

**4. Evaluation of scientific and scientific-applied contributions**

Based on the obtained results, seven contributions were formulated, which are the author's personal achievement. The **scientific and theoretical contributions** can be summarized as follows: (1) Definitions of concepts, theoretical approaches and models in the field of entrepreneurship have been systematized and critically analyzed; (2) A conceptual model of university factors influencing STEM students' technopreneurial attitudes, intentions, and behaviors is developed; (3) The model highlights the role of techno-entrepreneurial implementation intentions as a missing link between techno-entrepreneurial goal intentions and techno-entrepreneurial behaviour; (4) An analytical tool was developed to investigate techno-entrepreneurial attitudes and behaviors of STEM students. (5) New knowledge about technological entrepreneurship among Bulgarian STEM students has been generated and the role of university factors for techno-entrepreneurial attitudes, intentions and behavior among them has been revealed.

The **scientific-applied contributions** refer to the fact that: (6) The obtained results can help the development and implementation of policies and measures to stimulate technological entrepreneurship among Bulgarian STEM students; (7) These results show the need to improve the content and methods of entrepreneurship training for STEM students in Bulgarian universities. Corresponding recommendations have been made to the management of the universities for their transformation into entrepreneurial universities and to the teachers of entrepreneurship.

**5. Evaluation of publications on dissertation topic**

There are 14 publications on the topic of the dissertation, mostly journal articles, one monograph chapter and three collections of reports. All featured publications are in English. Three of the published articles are in journals indexed in Scopus and Web of Science, and another three are in conference proceedings submitted for indexing in Web of Science. The majority of the dissertation is tested in these publications.

**6. Evaluation of the summary of dissertation**

The abstract of the dissertation has a volume of 44 pages, reveals the main points of the dissertation work in a synthesized form and as such meets the requirements.

**7. Critical note, recommendations and questions**

I have no specific comments on the text provided.

**8. Conclusion**

The presented dissertation is an extremely serious and significant work that fills a significant gap in the literature in this field. An in-depth and critical review of publications by leading authors on the subject was made. A very good knowledge of the researched issues, accuracy in the presentation of the theoretical approaches, correctness in referring to the used sources have been demonstrated. A complex approach is proposed for the analysis of the university factors that influence the techno-entrepreneurial attitudes, intentions and behavior of STEM students in Bulgaria. The approach is validated by the author's empirical research, as well as based on numerous statistical and other research data. The results obtained are extremely relevant and add value to the available knowledge on the subject. They reveal a realistic picture of the influence of universities on the techno-entrepreneurial attitudes, intentions and behavior of STEM students. The contributions made are the personal achievements of the author. With this dissertation, Prof. D. Yordanova demonstrates the qualities of a leading researcher in the field of entrepreneurship and contributes significantly to its development.

All this gives me the reason to propose to the respected scientific jury to award Prof Dr Desislava Ivanova Yordanova the scientific degree "Doctor of Economic Sciences" in professional direction 3.7 "Administration and management" (Economic management).

08.08.2022
Sofia

Reviewer:
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