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Management Education In An Engineering Environment. The Case Of BME

Mária SZALMÁNÉ CSETE
Budapest University of Technology and Economics, Faculty of Economic and Social Sciences, csete.maria@gtk.bme.hu

Emma LÓGÓ
Budapest University of Technology and Economics, Faculty of Economic and Social Sciences, logo.emma@gtk.bme.hu

Bence BODROGI
Budapest University of Technology and Economics, Faculty of Economic and Social Sciences, bodrogi.bence@gtk.bme.hu

See next page for additional authors

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MANAGEMENT EDUCATION IN AN ENGINEERING ENVIRONMENT. THE CASE OF BME.

Mária Szalmáné Csete [1]
Budapest University of Technology and Economics, Faculty of Economic and Social Sciences, Department of Environmental Economics and Sustainability
Budapest, Hungary
0000-0001-7170-9402

Emma Lógó
Budapest University of Technology and Economics, Faculty of Economic and Social Sciences, Department of Ergonomics and Psychology
Budapest, Hungary
0009-0002-6656-7635

Bence Bodrogi
Budapest University of Technology and Economics, Faculty of Economic and Social Sciences, Department of Finance
Budapest, Hungary

Tamás Koltai
Budapest University of Technology and Economics, Faculty of Economic and Social Sciences, Department of Management and Business Economics
Budapest, Hungary
0000-0001-6873-6944

Conference Key Areas*: Engineering Skills and Competences, Lifelong Learning for a more sustainable world, Addressing the challenges of Climate Change and Sustainability*

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[1] *Corresponding Author*
Mária Szalmáné Csete
csete.maria@gtk.bme.hu

Keywords*: management education, interdisciplinary skills and competences, sustainability transition, time-series analysis, decision support*

ABSTRACT

Engineering higher education institutes need to integrate new skills and competences into their practice and curricula to accelerate the sustainability transition.

This paper introduces the interdisciplinary upskilling of engineering students enrolled in engineering programs at the Budapest University of Technology and Economics (BME) and which has been provided by the Faculty of Economic and Social Sciences (GTK) since 1998. The BME GTK delivers an educational experience that fits into the environment defined by the engineering faculties at BME. The BME GTK has experience of more than a quarter of a century in engineering education related to socio-economic and management upskilling. This experience may contribute to the common knowledge of engineering education development solutions in the area of sustainability transition.

This study focuses on assessing the socio-economic and management related courses of engineering students at BME provided by the nine departments of the GTK. The analyses examine the non-engineering skills of BME engineering students over the past ten years. The sample includes all the compulsory and elective courses available for engineering students. Based on the assessment results, the most significant management and socio-economic courses, and the related non-engineering interdisciplinary skills, both in bachelor and master levels, between 2012 and 2022 can be identified. The analyses allows the monitoring of management education's role in an engineering environment in the last decade. Furthermore, considering sustainability challenges, it provides an excellent basis for strategic decisions on future educational development.

1 INTRODUCTION

1.1 Management education in an engineering environment

Due to the impact of several unsustainable socio-economic activities related to the natural environment, our present life is undergoing several reversible or irreversible transformations. Innovation can be one of the main drivers in implementing the necessary economic transition; thus, engineering has a crucial role in addressing sustainability challenges. Considering the roots of the radical changes and related challenges, engineering education can play a pivotal role in fostering the path toward a sustainable future (Annan-Diab and Molinari 2017). Modern engineering education needs to deal with multiskilling, disciplinary broadening, innovative problem-solving, and system-thinking educational solutions to be able to adapt to diverse challenges (Van den Beemt et al. 2017; Marques 2008) as expected by engineering practice (Lattuca et al. 2017). The Budapest University of Technology and Economics (BME) was founded in 1782, and ever since, it has continued to be Hungary's leading higher education institute; it's operation and high-standard academic achievement significantly contribute to the economic performance of Hungary through the engineers, scientists, and economic experts that graduate from the university. The BME Faculty of Economic and Social Sciences (GTK) delivers an educational experience that fits into the environment defined by the engineering faculties at BME. The close cooperation with the engineering and natural science faculties can enhance the synergies between technology, economics, and social sciences and also motivates the integration of innovative solutions into the curricula that can foster the practical implementation of interdisciplinary engineering education. BME GTK traces its roots back to a rich tradition through the work of several ground-breaking scientists and departments which focus on organisational and business studies, finance, production and operation management, sustainability, and engineering economics. This journey started with the launch of the postgraduate economic department in 1914 through the establishment of the Faculty of Economic and Social Sciences (GTK) in 1998, and up to 2000 since when the name of the university itself has been a sign of its commitment to university level economics and business education (BME GTK, 2022).

1.2 Interdisciplinary courses for engineering students

The BME GTK has provided interdisciplinary courses since the beginning. This study focuses on introducing and assessing the socio-economic and management-related courses of engineering students at BME provided by the nine departments of the GTK. Two GTK interdisciplinary clusters were developed based on the entire Bachelor and Master course list supplied for engineering students between 2012-2022. Fig.1. introduces the nine GTK interdisciplinary bachelor course clusters. Most bachelor courses can be grouped into four clusters (Sustainability and Climate Change, Psychology and Ergonomics, Business and Management and Communication).

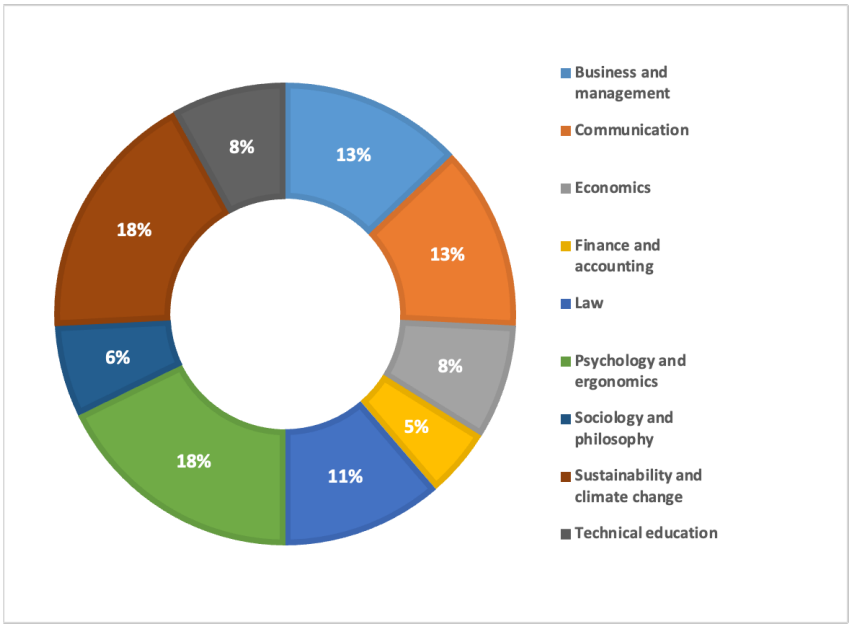

Fig. 1. Top 10 GTK BSc interdisciplinary courses between 2012 and 2022 (n=82446 students)

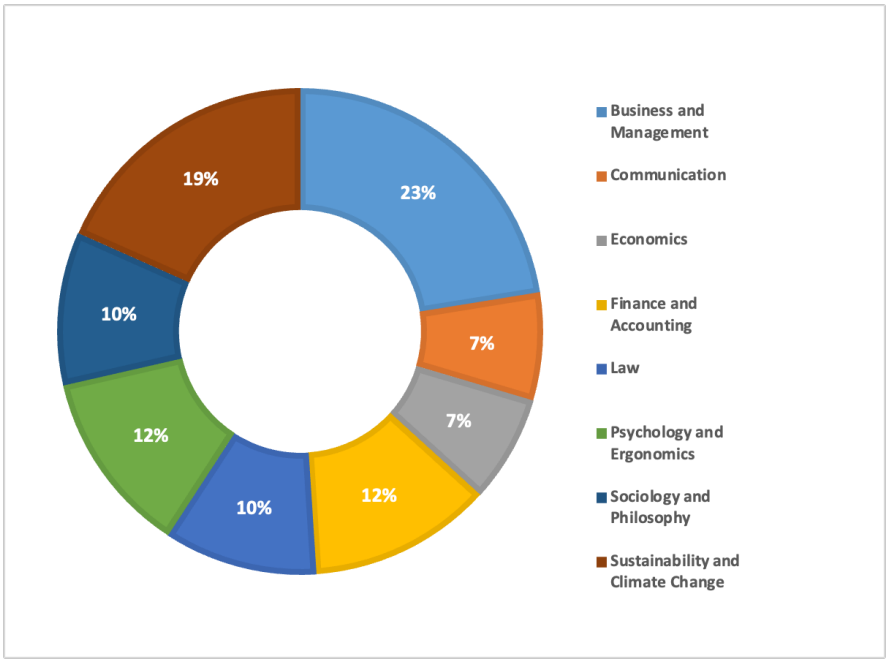

Fig. 2. Top 10 GTK MSc interdisciplinary courses between 2012 and 2022 (n=17196 students)

Fig.2. highlights the eight GTK's interdisciplinary master course clusters. More than half of the master courses available for engineering students belong to three clusters (Management and Business, Sustainability and Climate Change, and Psychology and Ergonomics). Six new master courses have been started and opened for engineering students in the last five years. Four of the courses belong to the Management and Business (e.g., Business Data Visualisation), and the other two to the Sustainability and Climate Change (Circular Economy) and Law (The Legal Framework of Autonomous Vehicles) course clusters.

2 METHODOLOGY

2.1 Quantitative analysis

The analysis examines the non-engineering skills of BME engineering students through GTK's interdisciplinary courses over the past ten years. This practice-oriented study aims to provide a quantitative analysis based on the related course data between 2012-2022. Descriptive statistics, ranking, and exploratory data analysis were used for the quantitative analysis. The data were retrieved from the Neptun system, which is an educational administration system and stores the required course and student-related data for the student's performance evaluation. The sample includes all the compulsory and elective courses available for engineering students at the bachelor and master levels. Considering the curricula on bachelor or master levels the compulsory courses mean the core units and in case of the elective courses the students may choose course units from the entire university portfolio. All eight BME faculties were involved in the analysis, namely the Faculty of Civil Engineering (ÉMK), Faculty of Mechanical Engineering (GPK), Faculty of Architecture (ÉPK), Faculty of Chemical Technology and Biotechnology (VBK), Faculty of Electrical Engineering and Informatics (VIK), Faculty of Transportation Engineering and Vehicle Engineering (KJK), Faculty of Natural Sciences (TTK), Faculty of Economic and Social Sciences (GTK). The students enrolled to GTK were involved and examined only in the case of Engineering and Management Bachelor and Master programs.

3 RESULTS

3.1 All courses provided by GTK for engineering students (2012-2022)

Based on the data retrieved from the Neptun system, nearly 3000 courses were analyzed between 2012 and 2022. The Neptun system is an online administration system that holds all academic data and personal information of the students, teachers, and courses, it is provided by the Central Academic Office of BME. 71% are Bachelor's and 29% are Master's courses out of the 2917 courses provided by GTK for engineering students in this period. Fig. 3. shows the number of students enrolled in non-engineering courses provided by GTK faculties. Over the ten years examined, this represents a total of 219 606 students of the engineering programs. More than 60% of the examined students study engineering in two faculties. 38% of the students pertains to the Faculty of Electrical Engineering and Informatics (VIK), and 26% of the students to the Faculty of Mechanical Engineering (GPK). Considering the course type, Fig.4. shows that most courses are elective (58%), and the proportion of compulsory courses is 42%. In the case of four faculties (VIK, GPK, ÉPK and TTK), the ratio of compulsory and elective courses is evenly balanced. The majority of compulsory courses are taken at the ÉMK and VBK. Two other faculties (GTK and KJK) can be characterized with most elective courses.

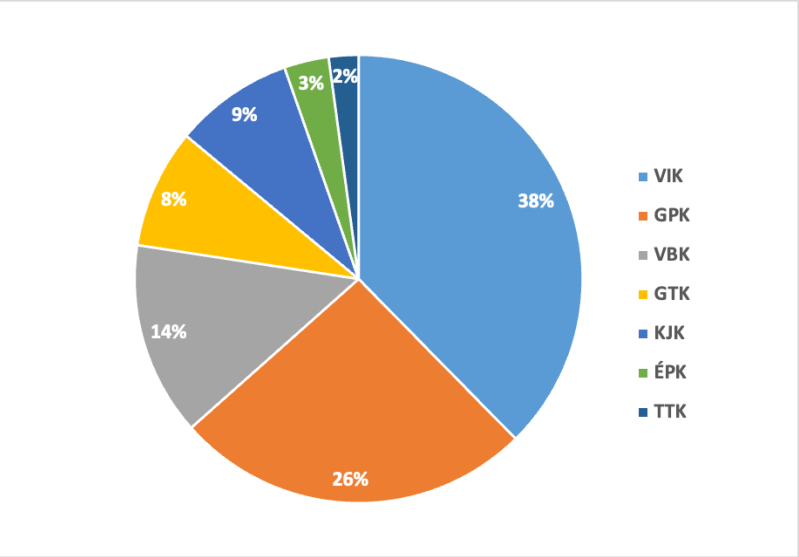

Fig. 3. Percentage of students enrolled in non-engineering courses provided by GTK between 2012 and 2022 by faculties (n=219606 students)

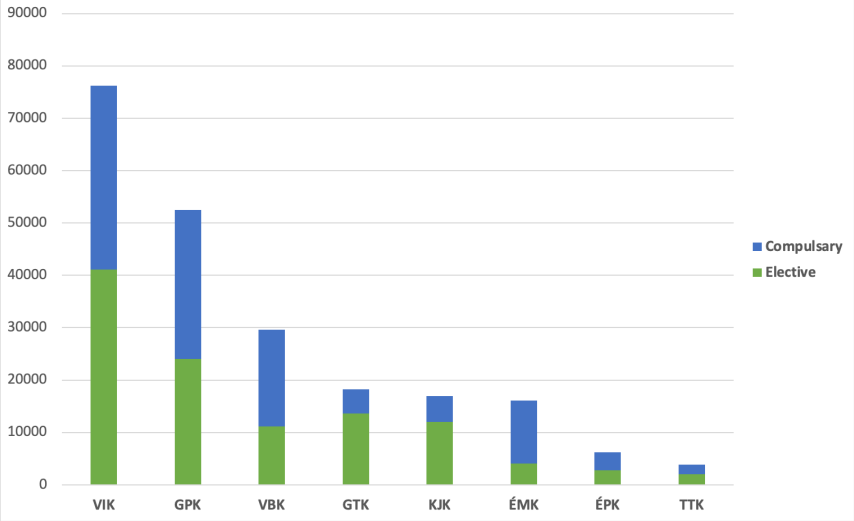

Fig. 4. Percentage of students enrolled in non-engineering courses provided by GTK between 2012 and 2022 by faculties and by course type (n=219606 students)

Fig.5. highlights the non-engineering courses provided by GTK at bachelor (BSc) and master (MSc) levels by faculties. The number of students in bachelor non-engineering courses is significantly higher than in master level. 76% of the enrolled students study for a Bachelor degree, and 24% study for a Master degree. These data contain only those GTK students who study engineering and management, the only engineering program at GTK. Most of the Faculty of Electrical Engineering and Informatics (VIK) students participate in both levels of education. Figure 5 shows that taking into account the Faculty of Mechanical Engineering (GPK), the negative change is proportionally more significant for the selected subjects in the Master's programs compared to the Bachelor's programs. In the case of the Faculty of Architecture (ÉPK), students tend to prefer the Master's courses at the GTK.

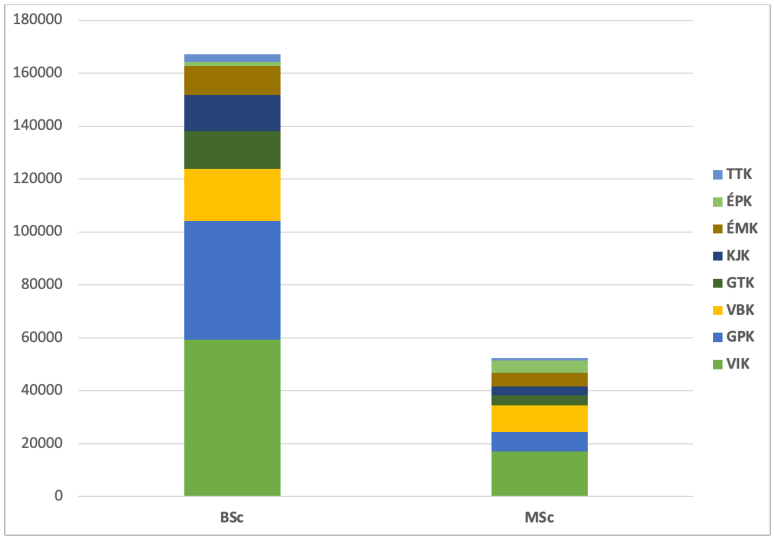

Fig. 5. Number of students enrolled in non-engineering courses provided by GTK on BSc and MSc level between 2012 and 2022 by faculties (n=219606 students)

3.2 Top 5 interdisciplinary courses on Bachelor and Master levels (2012-2022)

After evaluating the entire sample, courses unavailable in each academic year of the 2012-22 period were excluded. The Bachelor and Master courses were ranked based on the total number of enrolled students in the whole examined period. The rankings were developed separately for the two levels of education, and the top 5 interdisciplinary courses were defined on BSc (n=82446 students) and MSc level (n=17196 students).

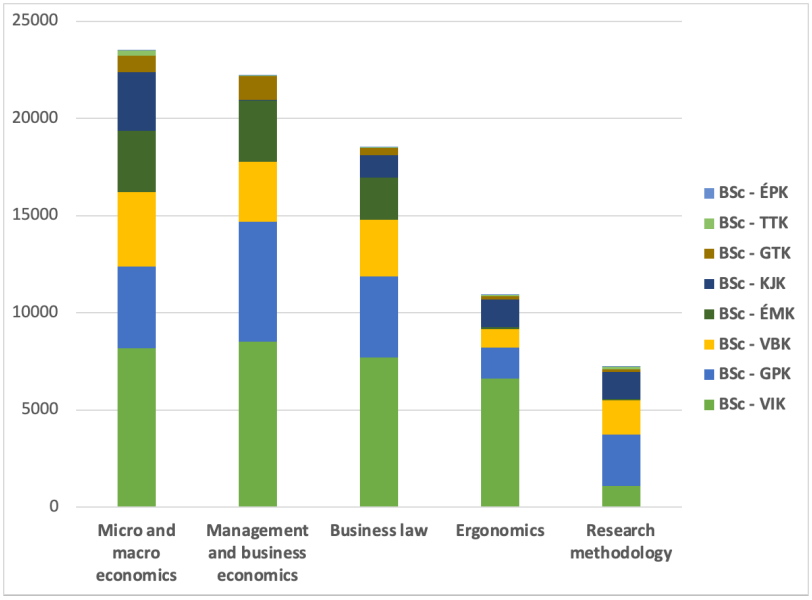

Fig. 6. Top 5 GTK BSc interdisciplinary courses between 2012 and 2022 (n=82446 students)

Fig.6. highlights the top 5 bachelor courses (1. Micro and macroeconomics; 2. Management and business economics; 3. Business law; 4. Ergonomics; 5. Research methodology) which pertain to four different GTK bachelor interdisciplinary clusters (Economics, Business and Management, Psychology and Ergonomics).

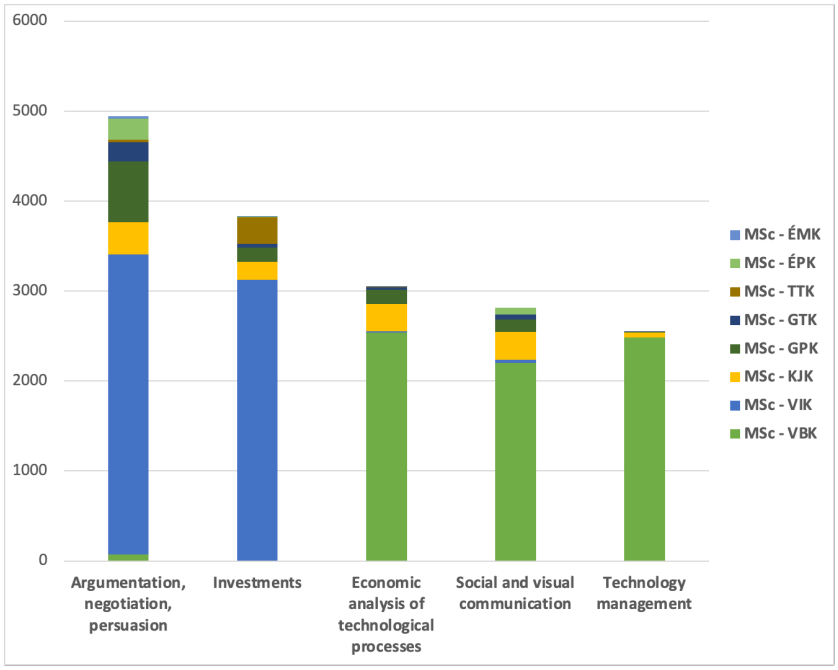

Fig. 7. Top 5 GTK MSc interdisciplinary courses between 2012 and 2022 (n=17196 students)

Fig.7. shows the top 5 master courses (1. Argumentation, Negotiation, Persuasion; 2. Investments; 3. Economic Analysis of Technological Process; 4. Social and Visual Communication; 5. Technology Management) which pertain to three different GTK master interdisciplinary clusters (Communication, Finance and Accounting, Economics and Business and Management). The most popular courses are Argumentation, Negotiation, Persuasion, and Investment for the students of the Faculty of Electrical Engineering and Informatics (VIK). The Faculty of Chemical Technology and Biotechnology (VBK) students are more interested in Economic Analysis of Technological Processes, Technology Management, and Social and Visual Communication. Considering the GTK's MSc and BSc interdisciplinary course clusters (see 1.2) it shows that a wide range of Sustainability and Climate Change related courses are available in both evaluated categories; none of them can be found in the top 5 courses. Further evaluation is necessary to assess how sustainability skills are embedded into the course content and how course units related to the sustainability transition can be supported to enhance sustainability skills in engineering education.

4 SUMMARY AND ACKNOWLEDGMENTS

Engineering and non-engineering higher education institutes (HEIs) need to integrate new skills and competences into their practice and curricula to accelerate the transition to a greener economy and society. The recent practice-oriented study introduced how a one-decade-long management education in engineering could enhance the inter and multidisciplinary skill and competence development of the engineering and natural science students at the Budapest University of Technology and Economics. Based on the results, it can be stated that the BME GTK has made relevant progress in developing an inter- and multidisciplinary educational portfolio

development over the past decade. The analysis, which embraces all relevant courses and engineering specializations, allowed monitoring of the management education's role in an engineering environment. The results can also provide solid foundations for strategic decisions on future educational development and for the successful adaptation to the emerging challenges and opportunities of our changing world. In the long term, BME GTK aspires to support the approach of engineering education to be transformed to prepare future engineers to face successfully sustainability challenges.

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