

2023-10-10

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Recommended Citation

LOHBECK, Anke; STRAUCH, Karsten; and OESER, Markus, "Results Of Surveys Among Pupils, Students And Employers On Interests In And Contents Of Study Programmes In Civil Engineering, Geodesy, Environmental Sciences And Sustainable Mobility In Germany" (2023). *Research Papers*. 35.
https://arrow.tudublin.ie/sefi2023_respap/35

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**RESULTS OF SURVEYS AMONG PUPILS, STUDENTS AND
EMPLOYERS ON INTERESTS IN AND CONTENTS OF STUDY
PROGRAMMES IN CIVIL ENGINEERING, GEODESY,
ENVIRONMENTAL SCIENCES AND SUSTAINABLE MOBILITY IN
GERMANY**

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Conference Key Areas: *Engineering Skills and Competences, Lifelong Learning for
a more sustainable world*

Keywords: *Survey Sustainability Pupils Students Authorities*

ABSTRACT

The shortage of skilled workers in the engineering sector threatens the development and sustainable transformation of the economy in Germany. In this context, the current decline in the number of first-year students in civil engineering, environmental engineering, geodesy and traffic engineering appears all the more alarming. Surveys which can provide basic data for the elimination of the shortage of skilled workers in engineering and the increase in the number of first-year students in the above-mentioned degree programmes were started among pupils, students and representatives of state authorities in 2022. Furthermore, one of the surveys was used to analyse the potential for an additional course for “sustainable mobility”.

All three surveys were conducted under the overarching aspect of consistency in order to obtain a cross-stakeholder picture. A central focus was on the topics of sustainability and digitalisation, including the extent to which sufficient preparations are made in the educational environment and which requirements are really considered necessary (also in the future) in the respective activities.

Based on these results, among others, the orientation of a planned agency for reducing the shortage of skilled workers in the road and transport sector was adjusted accordingly. The aim is to establish a coordinating institution that focuses specifically on the gap between academical education and the requirements of innovative and modern employers.

1 INTRODUCTION

The shortage of skilled engineers threatens the development and sustainable transformation of the economy and mobility in Germany.

For example, 151,300 engineering positions are unfilled (VDI, Institut der deutschen Wirtschaft. 2022) and 7,400 positions per year are projected as demographic replacement needs in construction and energy (VDI. 2022). In contrast, the number of first-year students in engineering and computer science has dropped by 15% in the last 5 years (VDI, Institut der deutschen Wirtschaft. 2022) and 53% of all students drop out of STEM studies (Acatech, Joachim Herz Stiftung. 2022). The problem is further aggravated by the demographic development, according to which the group of 15-24-year-olds has fallen below 10% for the first time. (Statistisches Bundesamt. 2022) This equals to a shortage of 8 million young people in absolute figures. In addition, the current curricula cannot keep up with the exponential growth of technological development and the associated demands from business and public administration.

The "Academy for Sustainable Highway and Traffic Engineering" was founded in March 2022 as part of a departmental research institution¹ of the German Ministry of Digital Affairs and Transport. One of its central tasks is to develop a scientific foundation for research, evaluation and quality assurance of viable, innovative and feasible concepts for recruiting, securing and qualifying skilled workers for the mobility sector.

¹ *BAST = Bundesanstalt für Straßenwesen = Federal Highway Research Institute*

In this light, this paper deals with the central question of how a sustainable skilled labour force can be secured in the mobility sector if the needs of those actually involved are queried and correlated with each other. For that purpose, three nationwide surveys with more than 1,000 participants were conducted, which are the focus of this work.

2 METHODOLOGY

2.1 The procedure

After developing a comprehensive knowledge base on the topic of skilled labour shortage, skilled labour qualification and skilled labour assurance, as well as its verification and updating through the exchange with authorities and engineering associations, empirical research was conducted between May and December 2022 among school leavers (and thus future students), students and authorities in order to gain a contribution to a more comprehensive understanding of the possible complex causes of the societal problem of skilled labour shortage in Germany.

For this purpose, a total of 864 schools were contacted, after representative federal states had been selected beforehand due to the federal structure taking into account e.g. larger cities as well as rural areas and the geographical location. This preselection was made because of the great organisational effort, for example the required approval of the respective state ministries for education, as well as participating school committees and parents' associations involved.

Initially, 35 schools with about 4,500 pupils agreed to participate, but then, also due to a peek of the Corona situation in winter 2022, the survey took place at 28 schools with a total of 2,958 participants.

With regard to the student survey, we have used two large alliances of faculties: FTBGU² and FBT-BaU³ which represent a total of 120,000 and 47,000 students respectively.

The scientific network of the federal research institutions of the Federal Highway Research Institute was used for the survey of the authorities.

One basis of our survey is based on the hypothesis that previous measures in the field of education modernisation do not lead to a significant improvement in the shortage of skilled workers in the field of engineering and in particular that

- the increase in specialised courses of study has not brought an increase in experts
- an expanded range of studies does not lead to sufficient competences of graduates
- there is a low level of satisfaction among students and employers with regard to success-oriented criteria (connectivity)

² FTBGU = *Fakultätentag Bauingenieurwesen, Geodäsie und Umweltingenieurwesen* = Faculty Association for Civil Engineering, Geodesy and Environmental Engineering e.V

³ FBT-BaU = *Fachbereichstag Bau- und Umweltingenieurwesen* = German Association of Departments of Civil Engineering and Environmental Engineering at Universities of Applied Sciences (GADCEE)

- up-to-date knowledge that needs to be constantly adapted is no longer expert knowledge for a few, but relevant and necessary for all graduates and that
- there is no target-oriented coordination between the stakeholders involved in this area

A central focus of the surveys was therefore on the extent to which sufficient preparation is provided in the educational environment of schools and universities (of applied sciences) and which requirements are actually considered necessary in the respective activities (also in the future).

For this purpose, the *Pupils'* survey (Lohbeck, Strauch, Oeser. 2022 a) mainly focused on aspects of career choice and choice of studies. The survey of the *students* (Lohbeck, Strauch, Oeser. 2022 b) mainly provided aspects of study satisfaction and evaluation of the contents as well as possible missing contents. *Public authority representatives* (Lohbeck, Strauch, Oeser. 2022 c) were asked about future needs and requirements for current and future employees, in order to identify a possible gap between the undergraduate educational content and the real requirements in the work environment.

2.2 The Data Basis

The data basis is based on responses from 691 final-year students from 28 schools throughout Germany, 244 Bachelor's and Master's students at technical universities (60%), universities (37%) and technical colleges or universities of applied sciences (3%) throughout Germany. Of these, 63% were Bachelor's students and 37% Master's students. Furthermore, 97 participants were interviewed in 25 federal research institutions, where a disproportionately high number of scientific activities are to be found. Two thirds of them have personnel responsibility.

3 RESULTS

3.1 Pupils

Asked about their educational aspirations, 54% of the participants answered that they would like to start university after graduation, 17% chose dual studies, 7% opted for vocational training, 3% for studies after vocational training. 18% said they were still unsure.

Asked in which field - irrespective of the type of education⁴ - they would like to work, construction/architecture came 10th and engineering 11th out of 23 selectable fields with three possible answers. In free text fields, specific courses of study could be indicated; here, engineering received the most frequent mentions.

Asked what was particularly important to them when choosing a career, about a third of respondents said they wanted to "make a positive contribution to society". 10% said they wanted to "make a positive contribution to the environment".

⁴ In Germany, in addition to a degree course, there is the option of vocational training - usually lasting three years - which may also be offered on a dual basis, i.e. combined with higher education. Higher education studies can be taken up at a university of applied sciences or (technical) university. These can be state or private.

As possible difficulties in choosing a course of study or a career, the pupils named "the multitude of possibilities difficult to grasp." (69%). About half of the respondents said it was "difficult to get helpful information" (54%) and "don't know what the requirements are for [their] desired profession" (47%) or "don't know if [their] school performance is sufficient for [their] desired profession (52%).

Although 20% of the young people were still undecided about what their career path should look like, it is clear that they want to make a contribution to society and the environment, but are uncertain about their skills and opportunities and feel hindered rather than supported by the (too) wide range of options.

3.2 Students

The students we surveyed indicated that they were predominantly satisfied with their degree programmes in civil engineering, transport engineering, environmental engineering, geodesy and geoinformatics, and industrial engineering.⁵ However, when asked about a possible desired expansion of their degree programmes, 2/3 of the students indicated *practical relevance* and 1/3 *Socially Responsible Engineering*, among others.⁶ When asked what was particularly important to them when choosing a career, 44% said they wanted *to make a positive contribution to society*; 33% wanted *to make a positive contribution to the environment*,⁷ which shows a primarily content-related engagement with the field of study.

However, only just under a third feel well or very well "*prepared for [his/her] career goal*". In terms of preparation for starting a career, 51% lack "*completed internships*" and 41% lack "*specialist knowledge*". The area of "*knowledge of the work culture at potential employers*" as the top answer is not to be taken into account here, as it does not concern possible study contents or their goals.⁸

3.3. Authorities

52% of the public authority representatives state that they will have an additional need for Bachelor engineers in the next 5 years. 92% indicate an additional need for Master engineers. Skills needed in the future were named as follows⁹ : "*knowledge of new/digital techniques*" (70%), "*combination of classical engineering sciences and digitalisation*" (68%), "*social skills such as rhetoric, moderation skills etc.*" (45%), [...], "*practical experience*" (41%) and "*knowledge of sustainability / life cycle management*" (36%). Difficulties mentioned in filling positions are, in addition to too few permanent positions and too low earnings, lack of connectivity or skills of the graduates.

3.4 Summary of the results

The results of the surveys have shown that the expectations of all respondent groups are not completely fulfilled. The expectation gap between the choice of study and study is apparently not being filled at present, just as the students' expectation gap is not being filled with regard to the content of their studies and the employers' expectation gap is not being filled with regard to the competences of their future employees.

⁵ 56% of students on a scale of 1-6 rate their programme as a 2, 25% as a 3 and 10% as a 1, 1 being the best and 6 the worst in the scale.

⁶ Up to three answers were possible here.

⁷ Up to three answers were possible here.

⁸ Up to three answers were possible here.

⁹ Up to five answers were possible here.

Pupils are mainly looking for orientation and an overview. They find the multitude of options hard to grasp, often have difficulties in obtaining helpful information and are not sure whether their school performance is sufficient.

Students miss the practical relevance and the problem-solving skills taught in their education. Soft skills such as rhetoric, communication skills, etc. are also in demand.

Public authorities need exactly these mentioned competences (practical experience, soft skills) and especially knowledge of new / digital technologies, the connection of these with the classical engineering sciences as well as knowledge in project management and also miss these among the graduates.

4 DISCUSSION

The rapid development of technology has created completely new requirements in the labour market, which none of the stakeholders - the education sector with schools and universities as well as employers - can meet with sufficient solutions. The necessary changes cannot be achieved by using existing established methods.

The establishment of further degree programmes, as they continue to be primarily basic, does not lead to the necessary teaching of special, up-to-date learning content. On the contrary, the offer of 20,951 degree courses in Germany, 3,888 of which are engineering courses (Hochschulrektorenkonferenz. 2021), leads to selection difficulties for graduating pupils. In addition, only a small number of higher education institutions have begun to teach specialist topics of the future, e.g. BIM¹⁰ or digital twin¹¹. Interdisciplinary orientations, which could provide a more precise connection of the chosen profession, are only just being established in some cases.¹²

Lifelong learning has been gaining in importance for years, but is not yet comprehensively reflected in traditional education systems, although continuing education is also anchored as a mandate of higher education institutions in German higher education laws. At the same time, the gap between the competences taught on the one hand and the competences required on the other is widening. A coordinated exchange between the stakeholders of the topic has not yet taken place sufficiently. A possible approach to the teaching of small, assessed knowledge units (microcredentials), also taking into account the third educational pathway and lifelong learning, is just emerging in the German higher education landscape.

Based on the results presented so far, the establishment of an *Academy* as coordinator of a structural network of all stakeholders is planned. These are: business, administration, universities, students, lateral and re-entry students and graduates as well as internationals, in order to take into account the decreasing demographic figures.

The *Academy* is to survey both current and future requirements of employers in business and administration and match these with the educational offers of the universities. The resulting gap is to be comprehensively analysed on an ongoing basis and corresponding learning content defined. These are then to be imparted in

¹⁰ BIM = Building Information Modeling

¹¹ Evaluation of various module handbooks from universities (of applied sciences) as part of the Academy's internal BIM Radar project.

¹² Cf. TUM Schools at the University of Munich, URL: <https://www.tum.de/forschung/schools-forschungszentren>, last accessed on 25.4.23

the third educational pathway - and in consultation with the employers - on a part-time basis. The educational providers in this concept are, on the one hand, the universities themselves, which are currently evaluating their state-mandated continuing education programmes and their engineering educational approaches, and, on the other hand, private providers and other stakeholders in the network. Microcredentials that have already been launched in the higher education sector could possibly be considered as a tool here. In addition to national and international students, lateral entrants and re-entrants should also have access in order to fill the demographic gap as far as possible.

Here experts should enable required educational content to be made available to future experts without a renewed, comprehensive additional course of study for university graduates, in order to promote willingness to continue training and to provide the labour market with qualified personnel as quickly as possible.

The *Academy* explicitly does not see itself as an educational alternative, because this is neither needed nor does it have sufficient competence in it, but rather as a coordinator in a central network that develops and analyses department-specific solutions for the field of mobility in cooperation with all stakeholders and taking into account scientific analyses.

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