

Result 5.2

Evaluation concept and report for innovation support and R&D projects carried out in SMEs



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Project Summary and Introduction

The word region is defined as “an area, especially part of a country or the world having definable characteristics but not always fixed boundaries”¹. The Baltic Sea region (BSR) is particularly unique. While the Baltic Sea is the pivotal point defining much of the region’s characteristics and challenges, the countries are also extremely different. Geographically, they are divided between Northern, Western and Central/Eastern Europe, historically, they have been shaped by the East-West divide after the second world war. Nevertheless, given their proximity to the Baltic Sea, they have much in common.

The EU has acknowledged this by issuing the very first macro-regional strategy, the EU Baltic Sea Region Strategy in 2009. As most countries boarding the Baltic Sea were by then EU member states, it can well be considered the EU’s inland sea. The challenges, such as saving the sea, i.e. ensuring clear water, rich and healthy wildlife as well as clean and safe shipping, and the opportunities for a prosperous region through cooperation measures to increase innovation, deepen the single market by improving transportation systems, connecting energy markets and fighting trans-border crime together, make the region very distinct from other parts of the world. Therefore, “BSR integration is best understood as the way that European integration has been translated into this region, further deepening and leveraging access to the rest of Europe and the markets that the EU provides”²

Over the past 25 years, this region has become a densely integrated, e.g. in the areas of trade, investment, labor mobility, transport and energy infrastructure as well as research collaboration. Furthermore, it demonstrates a broad landscape of robust cross-border organizations and collaborative efforts. Nevertheless, “companies do not look at the Baltic Sea Region as one integrated market in terms of their strategies. For most of them, the region remains a group of individually small markets within the EU, each with its different dynamics, rivals, and often even regulatory rules”³.

Keeping this in mind, the lack of comprehensive regional data collection is surprising. Therefore, as part of the Erasmus+ funded project “Promoting permeability through dual bachelor's programs with integrated initial and further vocational training” (BA&VET), an analysis of the region’s demography, economy, and labour as well as education market has been conducted. The majority of the data is taken from the Eurostat database of the European Union. When needed additional sources, such as the OECD database have been consulted as well.

Project summary

Objectives: What do you want to achieve by implementing the project?

- Increasing permeability between vocational and higher education
- Recruiting universities for tasks of further education in climate and environmental protection
- Providing excellently qualified entrepreneurs, managers and skilled workers and reducing the shortage of skilled workers to meet the challenges in climate and environmental protection

¹ Oxford Dictionary

² Skilling, David (2018). *The Baltic Sea Economies: Progress and Priorities*. Copenhagen: Baltic Development Forum, p.10.

³ Ibid., p.11

- Strengthening the productivity of SMEs through innovation support and R&D projects
- Promoting cooperation between SMEs and colleges/universities

Implementation: What activities are you going to implement?

- Analyses economy, education and labour markets and qualification needs
- Creation of solution models for 4 project countries
- Development and implementation of Train the Trainer program
- Development and implementation of 2 dual three-stage Bachelor's degree programs and 2 further trainings in climate and environmental protection
- Implementation of R&D projects in SMEs
- Quality assurance for training measures and project implementation
- Dissemination, transfer of results and implementation consultation

Results: What project results and other outcomes do you expect your project to have?

- Result report of the analyses of the economy, education and labour markets and qualification needs
- Solution models for four project countries
- Complete train-the-trainer program
- Module manuals with all documentation for two dual three-stage Bachelor's programs in climate and environmental protection
- Two further education programs in climate and environmental protection
- R&D projects implemented in SMEs
- Quality manual and results reports
- Manual, result videos and broad regional transfer of results

Objectives, results and target groups

The main objectives of the project are as follows:

- a) Increasing the permeability between vocational education and training and higher education and thus promoting the attractiveness of vocational education and training
- b) Strengthening the recruitment of colleges/universities for the important tasks of continuing education in climate and environmental protection
- c) Providing highly qualified entrepreneurs, managers and skilled workers who, in addition to good theoretical knowledge, also have practical competences, skills and professional experience in climate and environmental protection and reducing the shortage of skilled workers to cope with the very large tasks in the energy, climate and environmental sector.

- d) Attracting entrepreneurs and executives who have all the skills to successfully run a company and perform high-quality tasks in climate and environmental protection
- e) Strengthening the productivity and competitiveness of enterprises through knowledge and technology transfer, promotion of innovation and implementation of manageable R&D projects
- f) promoting cooperation between SMEs and colleges/universities, strengthening colleges/universities to implement dual courses of study on climate and environmental protection, and promoting entrepreneurship in higher education.

In pursuit of these objectives, the following results will be achieved:

1. Analysis results on the economy, demography, education and labour markets as well as qualification needs in climate and environmental protection
2. Curriculum, Teaching materials, implementation report and evaluation concept and report for teacher training
3. Module handbooks with integrated continuing education, teaching materials, examination regulations, implementation reports as well as evaluation concept and reports for a three-stage dual Bachelor's degree program
 - Business Administration and Sustainable Management for SMEs
 - Management of Renewable Energy Technology in Buildings
4. Concept for promoting innovation by SMEs and evaluation concept and report
5. Concept for innovation promotion of SMEs and R&D projects carried out for SMEs
6. Concepts and report for the evaluation and quality assurance of qualifications and

R&D subsidies as well as project implementation, transfer of results, implementations and implementation consultations

The primary target groups of the project are:

- a) school leavers who wish to combine vocational education and training with a bachelor's degree and thus receive excellent employment and professional career opportunities.
- b) students who are qualified in higher education and university and at the same time in a company and who are highly welcome in SMEs as managers and professionals or as independent entrepreneurs.
- c) owners, managers and specialists of SMEs who are qualified in continuing vocational training, acquire tailor-made competences and skills for high-quality activities in climate and environmental protection and achieve a recognized continuing vocational qualification.
- d) SMEs that attract suitably qualified young entrepreneurs, managers and specialists, receive innovation funding and carry out R&D projects together with colleges/universities.

The project addresses the following secondary target groups (beneficiaries):

- a) colleges and universities which, in order to expand their educational opportunities in climate and environmental protection, receive all the documents and materials for two new dual bachelor's degree programs in order to meet the labour market needs and the conditions of SMEs in particular.

b) chambers and other vocational training institutions which attract strong young people to vocational training, receive curricula for continuing vocational training modules for the qualification of SMEs and their staff, and cooperate intensively with colleges/universities in teaching and innovation promotion.

c) teachers, advisers and lecturers from chambers, other VET providers and colleges/universities who are qualified in Train the Trainer programs to provide high-quality further training, to carry out dual study courses in cooperation with companies as well as innovation promotion and R&D projects for SMEs at a high-quality level.

About innovation support and R&D projects

A specific concept was developed for the promotion of innovation and realization of manageable R&D projects in SMEs (see Result 5.1). In accordance with this concept, innovation promotion and R&D projects in SMEs were carried out in conjunction with the implementation of the dual (trial) Bachelor's degree courses during the project period. This funding was evaluated, and the funding concept was revised and finalized on the basis of the evaluation results.

Result 5.2 Evaluation concept and report for innovation support and R&D projects carried out in SMEs comprises summarized reports of the R&D projects carried out, the evaluation concept and an evaluation report.

Reports of the R&D projects carried out

The BA&VET project developed and agreed on a concept for technology transfer and the promotion of innovation in SMEs.⁴ In accordance with this concept, the BA&VET project provided innovation funding in connection with

the trials of the two continuing education programmes 'Commercial Specialist in Sustainable Management' and 'Energy Consultant'.

the trials of the two bachelor's degree programmes 'Business Administration & Sustainable Management' and 'Engineering in Management of Renewable Energy Technology in Buildings'.

The project application planned to provide innovation funding for 50 SMEs. In fact, 111 SMEs were included, namely:

A total of 56 SMEs participated in the trials of the two continuing education programmes in Estonia and Poland, in which innovations were implemented on specific topics related to continuing education. The participating companies insisted that the results of this work be treated as strictly confidential, so these innovation grants are not presented in the implementation reports or below.

As part of the bachelor's degree programmes, R&D projects were implemented in a total of 55 SMEs in Germany 15, Estonia 4, Finland 5 and Poland 31. Here, too, the participating companies in individual countries insisted on strict confidentiality, so that only the results of companies that have agreed to publication can be presented below. The lead partner has the implementation reports for all SMEs.

Finland⁵

In Finland, R&D projects were carried out in five SMEs as part of the BA&VET project. As all companies have agreed to the publication of the results, these are summarized below.

Introduction

The cases presented below are examples of normal co-operational thesis and research projects of Satakunta University of Applied Sciences, Finland. In our university, almost every thesis has a client, an enterprise or other organization that has ordered the development work, research, or review to be done by student. Our teachers and other personnel are also collaborating with other universities and companies, producing high quality studies in fields of our core competences. The project Aurisk is an example of this kind of project. The cases reported below are examples of this collaboration.

Total number of theses made at Satakunta University of Applied Sciences during the terms 2023-2025 exceeds 3000 (See <https://www.theseus.fi/handle/10024/14>). The number of theses made in the faculties of Technology and Logistics and Maritime, that have been connected to R&D-projects during the terms 2023-2025, has been 749 Bachelor's and 71 Master's theses. All the thesis processes are coordinated (See <https://www.samk.fi/en/for-students/instructions-for-written-assignments-and-theses/>) and supervised by teacher.

⁴ See Result 5.1 A coordinated approach to promoting innovation by SMEs

⁵ Prepared by Dr Kari Lilja and Dr Sirpa Sandelin, Satakunta University of Applied Sciences

Most of the theses have also another supervisor or coordinator at workplace. The Master's theses must have two supervisors, and at least one of them should be doctor or licentiate, and the other supervisor should have at least Master's degree. In cases where there are two supervisors, it is common that one of them has special knowledge in R&D processes, and the other one is specialist in topics the thesis is approaching. Generally, the thesis takes from 6 to 18 months. This means that most of our theses are following the process presented and tested during project BA&VET. Out of these theses the processes of 76 Bachelor's and 6 Master's theses can be counted to be directly in accordance with the process presented during the BA&VET-project.

Innovation Project: Aurisk

General Information

Country: Finland

Name of sending institution (BA&VET project partner): PP2 Satakunta University of Applied Sciences

Name of participant: Ylinen Marko, SAMK; Ylipaino Juho, TAMK; Kortetmäki Aki, TAMK; Mari Kujala, SAMK

Occupation of participant (trainee, student, employee, manager, etc): Teachers, researchers

Company name: Ordered and funded by Palosuojarahasto (PSR, Fire Protection Fund) and Sähkötekniikan ja energiatehokkuuden edistämiskeskus (STEK, the Finnish Centre for the Promotion of Electrical Technology and Energy Efficiency)

Short description of company (sector, number of employees, etc.): Both PSR and STEK are foundations, that aim to improve the fire and electrical safety in Finland by funding research and publications.

R&D/Innovation Project: Auriski

Context of project (within dual Bachelor program, study course, further training, etc.): The project was conducted in co-operation with Universities of Applied Sciences of Satakunta and Tampere, and vocational institutes of Satakunta (Sataedu) and Tampere (TREDU). SAMK was the leading partner due to our leading state in Finland in the area of fire safety of photovoltaic systems.

Short description of R&D/innovation project: Solar power systems are of interest to more and more small-scale homeowners. The trend has been growing strongly for years, but the sharp increase in the price of purchased electricity that began in 2022 has created an exceptionally high interest in energy efficiency measures. The share of solar power systems in Finland's annual energy production is still small, but their special feature is the small average unit size of the power plants and, therefore, many individual system deliveries that differ in many details. Often compared to large power plants, this is also an unusual client-contractor arrangement, in which a small-scale property owner operating without expertise in the field orders a small-scale delivery from a company with expertise in the field. The company, on the other hand,

may have long experience in the construction sector, but not necessarily experience in the special features of solar power systems.

The Finnish Safety and Chemicals Agency (Tukes) inspected a total of 45 installations across Finland due to several contacts and reports of consumers and contractors' uncertainty about incorrect, unprofessional or unlicensed electrical installation installations. Several shortcomings or omissions were observed in the implementation methods of the installations and in the commissioning inspections. This AURISKI project, funded by the Fire Protection Fund (PSR) and the Finnish Centre for the Promotion of Electrical Technology and Energy Efficiency (STEK), started in 2024, continues the work started by Tukes, and examined a total of 60 solar power system installations in Satakunta and Pirkanmaa. The project has been carried out in cooperation with Satakunta University of Applied Sciences (SAMK), Satakunta Education Association Sataedu (SATAEDU), Tampere University of Applied Sciences (TAMK) and Tampere Region Vocational College (TREDU), thus also creating new cooperation models between different levels of education and regions. In the project, it was found that hardly anyone of the installations was free of failures. Lucky enough, in most cases it was question about missing or deficit documentation or final inspection.

Organisation of the R&D/innovation project: Project took approximately one year, during which the installations were mapped, inspected, and analysed, and the report was written.

<https://www.theseus.fi/handle/10024/881266>

Results

Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.): Hardly anyone of the installations was free of failures. Lucky enough, in most cases it was question about missing or deficit documentation or final inspection. New instructions were given emphasizing the importance of following the regulation and instructions.

Innovation Project: Optimizing polymer feed in biogas plant digestate dewatering

General Information

Country: Finland

Name of sending institution (BA&VET project partner): PP2 Satakunta University of Applied Sciences

Name of participant: Mette Itämäki

Occupation of participant (trainee, student, employee, manager, etc): Student of the Bachelor programme

Company name: Nevel Oy

Short description of company (sector, number of employees, etc.): Nevel is an advanced utility infrastructure company. It offers future-proof, fit-for-purpose

industrial and real estate infrastructure solutions that benefit both their customers and surrounding societies. The solutions include, e.g., energy and material efficiency solutions, district heating, and partnerships and financial models. Nevel Ltd is committed to bring the industrial and real estate infrastructure solutions to the level that promotes climate positive future. Utility infrastructure is not a one size-fits-all solution. Nevel operates with all kind and size of organisations, e.g., with industrial companies, municipalities, real estates or households, and will help them to reduce CO2 and enhance living standards or competitiveness of any business.

<https://nevel.com/company/>

R&D/Innovation Project: Optimizing polymer feed in biogas plant digestate dewatering

Context of project (within dual Bachelor program, study course, further training, etc.): Thesis of the Bachelor's programme

Short description of R&D/innovation project: The study was conducted to improve the separation of digestate at Pori biogas plant owned by Nevel Oy by focusing on optimizing the polymer feed. The main goals were to improve the efficiency of the separation process and to optimize the usage of the polymer. The compatibility of the currently used polymer was tested by carrying out flocculation experiments, and the results were compared to previous tests. The study also aimed to identify risks in the preparation and use of the polymer solution and to find solutions for these. Flocculation tests with different polymer types were carried out in the laboratory to find out how they work with the digestate from the biogas plant. The findings proved that the currently used polymer is compatible with the digestate. The functionality of the polymer dissolution system was inspected by calculating the residence time, measuring solution concentrations, and analysing changes in the dilution water temperature by using trend curves. A test run with centrifuge was carried out to study the effect of the polymer solution feed point on the quality of the reject water. The results stated that the polymer currently in use, Superfloc C-492HMW, was the most applicable option among the tested ones. The concentration of the polymer was found to be higher than the set value, which might be due to dead zones in the dissolution equipment or inaccurate polymer dosing. The location of the polymer solution feed point was found to affect the content of the dry solids of the reject. The variations in the dilution water temperature were a problem during the start of centrifuge, which may possibly be caused by the thermal stratification of the water.

Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project took approximately one year, during which the work was done with the help and under the supervision of workplace instructor and supervisor of the thesis.

<https://www.theseus.fi/handle/10024/884234>

Results

Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.): It was found, that the currently used polymer, Superfloc C-492HMW, has the optimal properties and suits for the use. However, it was also found, that the concentration of the polymer rose higher than the set value, probably due to dead zones in the dissolution equipment or inaccurate polymer dosing. The polymer solution feed point was found to affect the content of the dry solids of the reject, and the variations in the dilution water temperature caused some problems during the start of centrifuge, which may possibly be caused by the thermal stratification of the water.

Innovation Project: Production FAT – design of the test bench

General Information

Country: Finland

Name of sending institution (BA&VET project partner): PP2 Satakunta University of Applied Sciences

Name of participant: Lauri Kurittu

Occupation of participant (trainee, student, employee, manager, etc): Student at Bachelor degree programme

Company name: Raumaster Paper Oy

Short description of company (sector, number of employees, etc.):

Raumaster Paper was founded in 2003 as a subsidiary of Raumaster to enhance specialisation in the paper finishing industry. The mission of Raumaster Paper is to be partner for all paper roll handling tasks in finishing, converting and printing. Raumaster Paper will increase productivity by delivering cost-efficient and operator-friendly finishing solutions. Company's vision is to be the most preferred supplier for paper finishing in the industry.

<https://www.raumasterpaper.fi/>

R&D/Innovation Project: Production FAT – design of the test bench

Context of project (within dual Bachelor program, study course, further training, etc.): Thesis of the Bachelor programme

Short description of R&D/innovation project: The objective of this thesis is to deepen the understanding of the equipment required for FAT testing (Factory Acceptance Test), the dimensioning of a separate FAT test bench, as well as its benefits and potential drawbacks. The work was carried out in collaboration with Raumaster Paper Oy, which operates in the field of equipment solutions for the paper and cardboard industry. The thesis also includes the creation of a comprehensive electrical plan to ensure the safe and compliant use of the equipment.

FAT testing is a crucial step in verifying the functionality of equipment and systems before their installation. The study examines which devices require testing, such as new equipment, complex automation systems, and non-standard applications. A separate test bench can help speed up the testing process, anticipate errors, and improve customer satisfaction, even though its design and maintenance involve additional costs.

The dimensioning of the test bench takes into account performance and safety requirements. Additionally, the thesis develops a detailed electrical plan, including circuit diagrams, component lists, cable lists, and other necessary documentation to ensure the safe and efficient operation of the equipment. The results of the study provide a comprehensive understanding of the requirements for FAT testing, the fundamentals of test bench design, and its advantages and disadvantages. The prepared electrical plan offers a practical tool for the reliable commissioning of equipment. The work emphasizes the importance of FAT testing in quality assurance and provides practical recommendations for the implementation of a test bench.

Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project took approximately one year, during which the work was done with the help and under the supervision of workplace instructor and supervisor of the thesis.

<https://www.theseus.fi/handle/10024/884135>

Results

Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.): As the results of the study a comprehensive understanding of the requirements for FAT testing, the fundamentals of test bench design, and its advantages and disadvantages were gained. The main outcome, an electrical plan, offers a practical tool to ensure the reliable commissioning of manufactured product. The results of the work emphasize the importance of FAT testing in quality assurance. Furthermore, practical recommendations for the implementation of a test bench were found.

[Innovation Project: Utilisation of low-temperature waste heat from industrial processes with heat pump technology](#)

General Information

Country: Finland

Name of sending institution (BA&VET project partner): PP2 Satakunta University of Applied Sciences

Name of participant: Joonas Ranki

Occupation of participant (trainee, student, employee, manager, etc): Student

Company name: Vahvacon Oy

Short description of company (sector, number of employees, etc.): Vahvacon Ltd has specialised in demanding and exceptionally demanding domestic and

international design projects in HVAC field. Over the years, the company has helped their customers achieving environmentally sustainable, energy-efficient, and well-functioning systems, ranging from small refurbishment in a coffee shop to major projects in heavy industry. The assignments of the company are not limited to technical consulting and design, but also extent to construction management site supervision tasks. They understand that HVAC design is multi-disciplinary, and it requires the active cooperation from other specialised designers and shareholders – like a jigsaw puzzle.

<https://vahvacon.fi/yritys/in-english/>

R&D/Innovation Project: Utilisation of low-temperature waste heat from industrial processes with heat pump technology: Description of the design process

Context of project (within dual Bachelor program, study course, further training, etc.): Thesis of a Bachelors degree programme

Short description of R&D/innovation project: The thesis approached the design process of a heat pump system that utilises the heat of low-temperature waste from an industrial site. The client Vahvacon Oy wished to obtain generalisable information on the design of the system. The study was carried out as a case study with the aim of describing, reviewing and analysing the design process.

It was examined how waste heat from industrial processes can be used for heating with heat pump technology. The thesis was limited to low temperature lost heat, up to 55 °C, which in most cases cannot be utilised as it is. The study was also limited to waste heat from liquid cooling of the process and waste heat from the exhaust air. The work focused only on mechanical heat pumps of the closed system, as they are best suited to low heat sources.

The design is always a unique process, but similarities can be found. Generalisation of the design process is possible if an existing process is approached from an applying perspective that makes it possible to transfer the necessary knowledge to the current process. As a result of this project, the customer obtained a generalisable, comprehensive overview of the issues affecting the design of a heat pump system through review, analysis and data collection. The electrification of industry and the use of waste heat is a prerequisite for achieving environmental goals and improving energy efficiency.

Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project took approximately one year, during which the work was done with the help and under the supervision of workplace instructor and supervisor of the thesis.

<https://www.theseus.fi/handle/10024/886397>

Results

Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.): The customer obtained a generalisable, comprehensive overview of the issues affecting the design of a heat pump system through review, analysis and data collection. This helps them to improve the use of waste heat and energy efficiency of their own customers.

[Innovation Project: Light energy efficiency improvement plans for village community houses](#)

General Information

Country: Finland

Name of sending institution (BA&VET project partner): PP2 Satakunta University of Applied Sciences

Name of participant: Alekski Heikintalo

Occupation of participant (trainee, student, employee, manager, etc): Student of the Bachelor programme

Company name: Project "Kylätalot käyttöön" (Village community houses into use) funded by Satafood Development Association and SataKylät association.

Short description of company (sector, number of employees, etc.): Satafood is a cooperative network, the main goals of which are developing food entrepreneurship, providing environmental services and improving co-operation among companies, education and research. Satafood Development Association is located in Satakunta province in the Southern-Western part of Finland. Satakunta region is one of the country's major food-producing regions. Satafood, focuses on two primary areas of development. Firstly, to advance the food sector, encompassing everything from basic production to the creation of end-use food products for consumers. Secondly, Satafood is committed to environmental development, particularly in the field of bio-circular economy.

SataKylät ry is a regional village association whose purpose is to support local communities in Satakunta, develop the areas and strengthen their vitality. SataKylät ry acts as a guardian of the interests of village and residents' associations and promote voluntary and locally oriented activities in the region.

<https://www.satakylat.fi/> , <https://www.satafood.net/>

R&D/Innovation Project: Light energy efficiency improvement plans for village community houses

Context of project (within dual Bachelor program, study course, further training, etc.): Thesis of a Bachelor programme

Short description of R&D/innovation project: This bachelor's thesis focused on the inspection of four village community houses from Satakunta, their energy efficiency and their overall condition. The thesis was a part of a bigger development

project named “Kylätalot käyttöön”, led by SataKylät ry and Satafood kehittämisyhdistys ry (Satafood Development Association).

The aim of this subproject was to inspect village community houses from Satakunta, and design easy improvements for the found problems. The inspections contained photographing with a thermal camera, sensory assessments, and small interviews. Easy improvements were proposed based on the found faults and problems of the village community houses. All found problems were listed with their planned solutions for the client, to enable them to locate potential future problems in village community houses.

Many problems were found from the village community houses, but some were more common than the others. These problems were, e.g., water damages caused by leaking roofs, unsealed windows and doors, unsealed joints between the walls and the floors, uninsulated pipes, thermal bridges in the walls, lacking insulation in the roofs and energy consuming or inefficient heating systems. The solutions for problems listed above included more thorough inspections for the water damages, sealing for the doors, windows and joints, more insulation for the pipes and the roof, removal of the thermal bridges or installation of insulation for the thermal bridges, and installation of more energy-efficient heating systems. The found problems were typical for older buildings, and these buildings were built between 1800 and 1930. In conclusion, the village community houses were old and needed improvements to ensure that they could last longer and be more energy efficient.

Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project took approximately one year, during which the work was done with the help and under the supervision of workplace instructor and supervisor of the thesis.

<https://www.theseus.fi/handle/10024/884964>

Results

Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.): Many problems like, e.g., water damages caused by leaking roofs, unsealed windows and doors, unsealed joints between the walls and the floors, uninsulated pipes, thermal bridges in the walls, lacking insulation in the roofs and energy consuming or inefficient heating systems were found. The solutions included thorough inspections for the water damages, sealing for the doors, windows and joints, more insulation for the pipes and the roof, removal of the thermal bridges or installation of insulation for the thermal bridges, and installation of more energy-efficient heating systems.

Estonia⁶

ANALYSIS OF CONSTRUCTION TECHNOLOGY AND BUILDING SITE MANAGEMENT BASED ON THE CONSTRUCTION OF THE NATURE HOUSE

The Ministry of Climate designates the Nature House as nearly zero-energy reference building, which will be the largest timber framed building in Estonia during completion in 2026 (closed net area 24 660 m²). The Nature House complex will consist of a triangular-shaped museum, 5-storey dock and a 4-storey city building. Kavakava OÜ won the architectural competition out of 17 works in 2019. The main contractor is one of the largest construction enterprises, Nordecon, with the construction budget of 54.4 mil. €.

The aim of the master's thesis was to analyse the construction technology and site management of Nordecon of the Nature House in Tallinn. The thesis included architectural project of the building, structural types, construction cost, calculation for the technological process charts, structural element calculations, a comparison between the time estimates (based on RATU time rates) and the actual construction durations.

In the architectural section the building's plans, sections and elevations are presented and an overview of the building's location and source data. In the structural section, calculation were performed for a cross-laminated timber (CLT) column, confirming that the buckling resistance and axial load capacity of the column were sufficiently ensured.

MACHINE VISION-BASED QUALITY CONTROL SYSTEM

Students from TalTech's Tartu College developed a machine vision-based quality control system capable of automatically detecting knitting defects on a production line. In cooperation with the AI and Robotics Centre AIRE and the textile company Vikan AS, the students were tasked with automating defect detection on knitting lines. The task was complex, but the team – despite lacking professional work experience – proved that with enough determination and a willingness to learn, a student project can grow into a serious industrial innovation.

The work progressed in three main stages. First, it was necessary to understand what a defect means in the context of machine vision. To achieve this, a miniature knitting machine model was built at the college, allowing cameras, lighting solutions, and software to be tested without interrupting the production process.

Once the solution's architecture was ready, the system was taken to the factory, and the cameras were mounted on the actual equipment. Tests carried out under real working conditions provided valuable insights: detection accuracy could be affected by lighting, shadows, and even yarn tension. To ensure that the system would also recognize defects in real-life conditions, the students intentionally produced faulty fabrics and defects. This highly practical approach made it possible to collect the data needed to train the machine learning model.

The result was a camera- and machine learning-based system that monitors production on two lines simultaneously, detects possible defects, and displays their exact location on a screen. To make work easier, the system shows precise information on which line and at

⁶ Compiled by Mihkel Kiviste, Tallinn University of Technology, Estonia

what spot the issue has occurred. This enables factory workers to respond quickly and correct errors.

The value of the project went beyond just the technological solution. The students learned how to develop an idea from start to finish, how to communicate with industrial partners, and how to share responsibilities and roles within a team. For some, it was the first time working with real clients and real expectations. The practical experience gave them confidence and an opportunity to tackle real-world problems.

This project is a clear example of how involving students in solving real problems can benefit all parties – young professionals gain experience and confidence, while companies get innovative solutions. The three ingredients for success – using a lab model, working on-site in the factory, and consistent effort – demonstrate that the path from theory to practice begins with curiosity and ends with innovation.

3D NUMERICAL MODELING OF SCREW DISPLACEMENT PILE USING MIDAS GTS NX SOFTWARE

The thesis was conducted in collaboration with small enterprise IB Lehar Leetsaar OÜ.

Modelling a soil displacement pile is a complex geotechnical challenge due to the soil's behaviour during pile installation. As the pile is driven into the ground, surrounding soil layers are displaced and compressed into adjacent layers, resulting in heterogeneous effects: some layers become denser and stiffer, while the others may weaken due to the disturbance of their natural structure. The thesis focused on the numerical modelling of a Fundex-type displacement pile. The pile was installed in soft clay and silty, with its pile tip embedded in denser sandy strata. The modelling was based on geotechnical data acquired from construction sites at Ahtri 3, Tallinn.

The objective was to conduct FEM analyses using the MIDAS GTS NX software, employing a 3D solid-element model. The Mohr-Coulomb constitutive model- commonly used in engineering practice- was adopted to represent soil behaviour. The literature review provided a comprehensive overview of pile foundations, the installation process of a Fundex pile, static load testing procedures, and principles of 3D modelling in geotechnical applications. It also introduced the functionalities of MIDAS GTS NX software: assessing the applicability of FEM-based modelling in the context of soil-pile interaction.

The methodological framework focused on 3D finite element modelling, wherein the pile was embedded in weak soils. Particular attention was paid to the influence of mesh density and element size on the accuracy and computational efficiency of the analyses.

The thesis emphasized that modelling mesh density significantly affects the numerical results: finer meshes facilitated a more accurate stress and deformation distribution but at the cost of increased computational demand. FEM analysis revealed that the stiffness of the soil layers at the pile tip critically influenced the overall settlement behaviour.

The load-settlement curves from all models exhibited nonlinear characteristics, with settlements accelerating under increased loading. The highest degree of nonlinearity occurred in models with finer mesh zones near the pile shaft and lower interactions factor ($R=0.7$). None of the simulated models fully replicated the curvature of the Chin's (1970)

extrapolation method at higher load levels, highlighting the limitations of the Mohr-Coulomb model in capturing elastoplastic soil behaviour.

HYGROTHERMAL BEHAVIOR OF MYCELIUM AS A INSULATION MATERIAL

The thesis was conducted in collaboration with small enterprise Myceen OÜ. Myceen is growing carbon-negative materials and design products combining mushroom mycelium and industrial byproducts.

The purpose of this thesis was to investigate the thermal and hygrothermal performance of walls insulated with mycelium composite. A 3 x 3 m test house was constructed at the initiative of the supervisors in collaboration with Estonian Academy of Arts based on the 3cycles system. The task was to develop and evaluate wall assembly solutions. Sensors were installed in the test house to measure relative humidity, temperature and heat flux. Data was collected during the three-month period in 2025. The data analysis included the evaluation of temperature and moisture regimes. The condensation risk using both the Glaser and water vapor partial pressures methods were assessed. Based on measured temperature and relative humidity data the risk for mold growth was evaluated using the Finnish mold risk model. Also, theoretical thermal transmittance densities through the walls were calculated and compared with measured thermal transmittance values.

The comparison of temperature data indicated that the thermal performance of mycelium composite-insulated assemblies was stable and did not significantly differ from those using conventional insulation materials. No mold growth was detected during the measurement period, and no condensation risk was observed. However, simulations indicated a potential risk of condensation, particularly in the layer before the vapor barrier and between the insulation and wind barrier. These results should be considered preliminary as the analysis did not account for the effects of solar radiation and air leakage.

Germany⁷

Abstract

This document summarizes research and innovation projects conducted within the dual study programs at the Berufliche Hochschule Hamburg (BHH) as part of the BA&VET project. The projects presented combine academic research with practical company-based experience, addressing various sectors such as crafts, industry, facility management, automotive services, and gastronomy. Each project illustrates how dual students apply scientific methods to real business problems—exploring leadership, teamwork, efficiency, and innovation within small and medium-sized enterprises (SMEs). The document provides valuable insights into how work-based learning fosters innovation, employee development, and sustainable business practices.

R&D Project 1

General Information

⁷ Compiled by Prof. Dr. Joachim von Kiedrowski, Berufliche Hochschule Hamburg, Germany

<p>Country: Germany Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg Name of participant: B.B. Occupation of participant (trainee, student, employee, manager, etc): Dual student Company name: N. N. Short description of company (sector, number of employees, etc.):</p> <p>The practice company manufactures highly complex sheet metal parts and assemblies—using laser cutting, punching, bending, welding, and rolling, among other processes. The company handles both individual and series production, including powder coating and assembly. The company is active in metal/thin sheet metal processing (sheet metal technology) – more specifically in the field of industrial sheet metal processing and manufacturing (laser cutting, bending, welding, powder coating) for various industries such as the food industry, mechanical engineering, medical technology, shop/exhibit construction, etc. According to its own information, the company employs approximately 80 people.</p>
<p>R&D/Innovation Project</p>
<p>Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises</p> <p>As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice</p> <p>Short description of R&D/innovation project: The project examines the impact of team structures on adherence to deadlines in a medium-sized company in order to better understand the effects of team composition on adherence to deadlines and other important parameters and, if necessary, to identify correlations.</p> <p>Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.):</p> <p>The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.</p>
<p>Results</p>
<p>Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.):</p> <p>The study showed that team composition and professional experience in particular have a statistically measurable influence on adherence to deadlines and the error rate in this regard. A negative correlation between professional experience and the error rate in adherence to deadlines was determined. This proves how important experienced employees are in ensuring that deadlines are reliably met.</p>

R&D Project 2

General Information

<p>Country: Germany Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg Name of participant: T. S. Occupation of participant (trainee, student, employee, manager, etc): Dual student Company name: N. N. Short description of company (sector, number of employees, etc.):</p> <p>The research relates to a company in the automotive industry. Its headquarters are in Hamburg, with several branches in northern Germany and a total of approximately 600 employees. The company employs numerous staff in the areas of vehicle service and sales, particularly in the workshop, service, new and used car, and key account management departments. Its core business includes vehicle inspections, diagnostics and repair work, vehicle sales, and customer service. Like many automotive companies, the respective one faces challenges due to a shortage of skilled workers, process digitization, and changes in the automotive industry (e.g., e-mobility, new sales models).</p>
<p><i>R&D/Innovation Project</i></p>
<p>Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises</p> <p>As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice.</p> <p>Short description of R&D/innovation project: The aim of the study was to examine the effect of team structures in workshop service on three key performance indicators: sales, working time efficiency, and sickness rate. Two existing teams—the “Key Accounts Team” and the “New and Used Cars Team”—were analyzed in comparison with the other, traditionally organized workshop groups. The innovative idea is to transfer the team concept from project management to everyday workshop life in order to make processes more independent and efficient. The basis for this is formed by models such as Tuckman's phase model of team development and approaches from traditional, agile, and hybrid project management. This is used to examine whether small, well-coordinated team structures can lead to higher productivity and lower stress levels.</p> <p>Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.</p>
<p><i>Results</i></p>
<p>Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.):</p> <p>The study revealed that the so-called “teams” in the workshop are not teams in the strict sense, but rather task forces, as they do not work on time-limited projects, but rather take on ongoing tasks. Nevertheless, there are clear differences in performance: The key accounts team achieved the highest turnover per order. The New and Used Cars team achieved the lowest. In terms of working time efficiency, the Key Accounts team achieved significantly higher “work values” on average, while the rest of the workshop was in the red.</p>

Overall, it was found that team structures can increase work efficiency, but do not have a clear impact on sick leave or sales. In practice, this means that well-coordinated teamwork promotes productivity but does not automatically guarantee health or financial benefits. For comparable automotive companies, however, the concept offers important ideas for making processes more flexible, improving internal communication, and creating autonomous work units in the service area.

R&D Project 3

General Information
<p>Country: Germany Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg Name of participant: F. M. Occupation of participant (trainee, student, employee, manager, etc.): Dual student Company name: N. N. Short description of company (sector, number of employees, etc.):</p> <p>The company is an owner-managed craft business and chain store that produces all kinds of baked goods and delicacies and sells them through its own specialty stores in northern Germany. The company is active in the craft sector, specifically in the bakery and confectionery trade, and employs a total of approximately 370 people at various locations.</p>
R&D/Innovation Project
<p>Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises</p> <p>As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice.</p> <p>Short description of R&D/innovation project: The study examines the impact of cross-hierarchical work on the agility of the company and answers the question: How does cross-hierarchical collaboration affect the agility of the company's team? The central assumption is that a decentralized decision-making structure increases the agility of the company.</p> <p>Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.</p>
Results
<p>Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.):</p> <p>A specific survey showed that after introducing agility principles in the organization, communication between employees and other hierarchical levels in the company became very open and the team was able to respond more flexibly to changes. Employees particularly appreciate the opportunity to work in a more self-directed and independent manner, make decisions more quickly, and be more capable of taking action. The positive</p>

effects relate to sales, guest numbers, task processing times, and the overall self-organization of the team.

R&D Project 4

General Information
<p>Country: Germany Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg Name of participant: J. H. Occupation of participant (trainee, student, employee, manager, etc.): Dual student Company name: N. N. Short description of company (sector, number of employees, etc.):</p> <p>The company operates in the field of facility management/real estate management (services related to buildings, properties, maintenance, and operation), thus offering services for real estate and building management. The industry can be described as “management of real estate on a fee or contract basis.” With approximately 150 employees, the company handles all facility and building management throughout the entire life cycle of a property—from planning and construction to renovation and sustainable management. It manages residential, commercial, school, and sports properties as well as public spaces.</p>
R&D/Innovation Project
<p>Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises</p> <p>As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice.</p> <p>Short description of R&D/innovation project: The study examines the organization's transition to a competency-based internal task allocation system and its impact on efficiency within the electrical engineering department. It examines the hypothesis that the transition to a competence-oriented internal order allocation system will lead to an increase in efficiency of at least 10% in all business areas, measured in terms of the reduction in processing time per order.</p> <p>Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.</p>

Results
<p>Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.):</p> <p>The study shows that the hypothesis put forward could only be partially confirmed. Although there was no decline in efficiency in any business area, a significant increase in efficiency of over 10% was only seen in the construction projects and maintenance business area. In the maintenance division, efficiency remained largely constant, which, according to experts, is primarily due to the high complexity of the orders and staff absences due to illness. Overall, the positive effects of the changeover – in particular the formation of an in-house construction team – clearly outweigh any potential weaknesses. However, existing communication problems between planning and technical execution remain. Digitalization and the use of AI are identified as particular opportunities, while illness and staff turnover represent key risks. In summary, the changeover led to a noticeable increase in efficiency, but at the same time made the department more vulnerable to staff shortages.</p>

R&D Project 5

General Information
<p>Country: Germany Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg Name of participant: J. E. Occupation of participant (trainee, student, employee, manager, etc.): Dual student Company name: N. N. Short description of company (sector, number of employees, etc.): The bakery in Schleswig-Holstein is engaged in the production and sale of high-quality baked goods and pastries, with a particular focus on regional raw materials, long dough fermentation times, and artisanal production. The company sees itself as a family business with a long tradition: baking and milling have been taking place in Schleswig-Holstein since 1859. The company is part of the food and baked goods manufacturing industry and the associated retail and chain store distribution sector. It employs over 400 people at around 30 locations in Hamburg and Schleswig-Holstein. In addition, the products are sold at various weekly markets.</p>
R&D/Innovation Project
<p>Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises</p> <p>As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice.</p> <p>Short description of R&D/innovation project: The study examines how teamwork, especially in production, can be optimally structured and what teamwork should look like in order to attract new employees. Approaches for improvement and factors that make teams attractive are explored, analysed, and interpreted in more detail in this work. It addresses the question of how teamwork in the bakery should be structured in order to position the company as an attractive employer for new skilled workers. Another interesting question for the study is whether improvements in teamwork can attract more new employees. The aim of the study is therefore to identify what makes a team attractive and what improvements are necessary to achieve this.</p>

<p>Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.</p>
<p>Results</p>
<p>Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.): The survey on teamwork in the bakery shows that the employees surveyed paint a mixed picture of cooperation overall. Although a representative cross-section of age groups and positions was surveyed, regular job changes make it difficult to conduct a differentiated analysis by sub-teams. The quantitative results indicate that one-third of employees perceive cooperation as rather weak, another third as partly good, and the remaining third as rather good. The role of the bakery manager was evaluated particularly critically—four out of six respondents see little support from team leadership. It is clear that 83% of respondents consider an improvement in teamwork to be necessary, especially in the areas of communication and mutual support, followed by conflict resolution, task distribution, and leadership. According to the majority, teamwork also plays a central role in recruiting employees: a good team atmosphere is considered a decisive factor in attracting talent. The qualitative statements underscore this trend – open communication, mutual support, and motivational leadership are cited as the most important starting points for improving and strengthening teamwork.</p>

R&D Project 6

<p>General Information</p>
<p>Country: Germany Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg Name of participant: K. F. Occupation of participant (trainee, student, employee, manager, etc): Dual student Company name: N. N. Short description of company (sector, number of employees, etc.): The study focuses on carpentry businesses that belong to the group of small and medium-sized enterprises (SMEs), which make up 99.6% of all German businesses and form the backbone of the economy. Many SMEs and the associated carpentry businesses are characterized by flat hierarchies, high flexibility, and a close connection between corporate management and operational business but are often heavily dependent on individual key personnel.</p>
<p>R&D/Innovation Project</p>
<p>Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice. Short description of R&D/innovation project: The study is based on a systematic literature review (SLR) that analyses scientific research on the topics of teamwork, SMEs, and business succession. Of the 661</p>

<p>publications identified, 29 relevant studies were selected and visually evaluated using the VOSviewer tool. What is innovative about this study is that it links three fields of research that have previously been considered largely separately, namely how teamwork can support generational change and succession processes in SMEs. The study thus takes an integrative approach that positions teamwork as a strategic success factor for sustainable succession planning.</p> <p>Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.</p>
<p>Results</p>
<p>Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.): The analysis shows that although there are many studies on SMEs and succession, only two publications combine all three topics (teamwork, succession, and SMEs). Recent research emphasizes the central role of teamwork in successful transfers, particularly through digitalization and cross-generational leadership. Teamwork promotes knowledge retention, communication, and integration of different generations, thereby stabilizing succession processes. For comparable companies, this means that successful succession depends not only on legal and financial aspects, but also requires strong, cross-generational teams that share responsibility and actively shape change.</p>

R&D Project 7

<p>General Information</p>
<p>Country: Germany Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg Name of participant: L. G. Occupation of participant (trainee, student, employee, manager, etc): Dual student Company name: N. N. Short description of company (sector, number of employees, etc.): The study was conducted at a company in the plumbing, heating, and air conditioning industry in northern Germany. The company employs around 36 people, including three apprentices and four dual students. Like many companies in the HVAC industry (plumbing, heating, and air conditioning technology), the company is strongly practice-oriented, regionally rooted, and affected by a shortage of skilled workers. Qualified journeymen play a decisive role in training by providing technical guidance and leadership to apprentices.</p>
<p>R&D/Innovation Project</p>
<p>Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice. Short description of R&D/innovation project: The aim of the study was to empirically analyse the relationship between the leadership behaviour of journeymen and the learning development of trainees. To this end, a quantitative survey was conducted among the company's trainees. The online</p>

questionnaire used Likert scales to measure perceived leadership styles (cooperative vs. directive) and individual learning development. The innovative idea behind the study is to systematically consider the role of journeymen—traditionally regarded as “skilled workers”—as leaders and learning process facilitators for the first time. The study thus provides practical insights into how leadership behaviour can be used specifically to improve the quality of training in the skilled trades.

Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.):

The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.

Results

Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.):

Statistical analysis using Spearman's rank correlation revealed a moderate positive correlation ($r = 0.533$) between a cooperative leadership style and the learning development of trainees. Directive leadership, on the other hand, showed only a weak correlation ($r = 0.297$). The results show that cooperative leadership—characterized by trust, communication, and personal responsibility—significantly strengthens trainees' motivation to learn and their independence, while directive elements create structure and security but are less conducive to learning.

For comparable craft businesses, this means that combining both leadership styles—with an emphasis on cooperative elements—can significantly increase the effectiveness of training. In practical terms, regular feedback discussions between journeymen and trainees as well as short leadership training courses for journeymen are recommended in order to strengthen their pedagogical and communication skills. In this way, training in the skilled trades can be made more sustainable, motivating, and of higher quality.

R&D Project 8

General Information

Country: Germany

Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg

Name of participant: N. M.

Occupation of participant (trainee, student, employee, manager, etc.): Dual student

Company name: N. N.

Short description of company (sector, number of employees, etc.):

The study was conducted at a family-run specialist system catering company in Schleswig-Holstein, which employs around 400 people at various locations. This company operates several specialist catering outlets in northern Germany and combines traditional bakery production with modern system catering concepts. The company is characterized by standardized work processes, high customer density, and clearly defined task structures—especially in the areas of sales, hygiene, and service. As in many companies in the industry, teamwork plays a central role in efficiency, product quality, and customer satisfaction.

R&D/Innovation Project
<p>Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises</p> <p>As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice.</p> <p>Short description of R&D/innovation project:</p> <p>The aim of the study was to investigate the causes of inefficient teamwork in a specialist restaurant chain, specifically using the example of loss of motivation and incorrectly established team norms in the area of hygiene. The starting point was the observation that, despite sufficient staffing levels, there were serious performance deficits. The innovative idea behind the work lies in the combination of game theory models with Bandura's social cognitive learning theory. This led to the development of the so-called “task dilemma” – a model that explains how neutral or absent consequences in task completion led to systematic free riding. The integration of psychological learning processes into an economic model represents a novel approach to analysing team inefficiency in practice.</p> <p>Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.):</p> <p>The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.</p>
Results
<p>Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.):</p> <p>The analysis showed that inefficient teamwork is primarily attributable to loss of motivation and undesirable team norms, which are reinforced by observation and imitation (“learning by example”). In the branch studied, the lack of rewards or consequences led to free-riding behaviour, which developed into a tacit norm in the long term. The “task dilemma” that developed illustrates that rational actors tend to minimize their individual effort when incentive structures are neutral, which leads to collective process losses. In practice, the study recommends the introduction of clear incentive and feedback systems that visibly reward positive behaviour and sanction undesirable behaviour. In addition, managers should strengthen their role awareness as behavioural models in order to actively exemplify desired norms. For comparable companies in the system catering or food craft sectors, the study shows that team culture and incentive systems are crucial for sustainable efficiency, quality assurance, and employee retention.</p>

R&D Project 9

General Information
<p>Country: Germany</p> <p>Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg</p> <p>Name of participant: S. F.</p> <p>Occupation of participant (trainee, student, employee, manager, etc): Dual student</p> <p>Company name: N. N.</p> <p>Short description of company (sector, number of employees, etc.):</p> <p>The study focuses on small and medium-sized enterprises (SMEs) in the skilled trades and manufacturing sector, particularly those in the plumbing, heating, and air conditioning (SHK) industry. The starting point was a practical company, a skilled trades business in the field of heating and plumbing installation with approximately 150 employees. SMEs in this</p>

<p>sector are characterized by flat hierarchies, close-knit team structures, and a high degree of dependence on effective cooperation. The operational context illustrates how strongly team atmosphere, trust, and communication influence the efficiency and quality of craftsmanship.</p>
<p>R&D/Innovation Project</p>
<p>Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises</p> <p>As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice.</p> <p>Short description of R&D/innovation project: The aim of the study was to empirically examine the relationship between psychological safety and team performance in SMEs. Psychological safety describes the confidence of team members to speak openly and admit mistakes without fear of negative consequences. The innovative idea is to systematically apply this theoretical concept—which has previously been studied mainly in large companies and research contexts—to SMEs and vocational school contexts for the first time. By combining validated psychological measurement instruments (Psychological Safety Check and Teamwork Questionnaire), the study examined whether and how psychological safety influences team performance in smaller, practice-oriented team structures.</p> <p>Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.</p>
<p>Results</p>
<p>Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.): The empirical analysis (Spearman correlation, N = 63) revealed a significant positive correlation between psychological safety and team performance ($r = 0.393$; $p < 0.001$). Teams in which members feel safe communicate more openly, share knowledge more frequently, and work together more efficiently. This confirms that psychological safety is a key factor in motivation, willingness to learn, and performance. In practice, this means that managers in SMEs should specifically promote trust, appreciation, and an open communication culture e.g., through regular feedback meetings, participatory decision-making processes, and tolerance for mistakes. These measures do not require complex programs but rather begin in everyday management. Comparable companies can conclude from the study that psychological safety is a strategic lever for increasing team performance, employee retention, and innovation in SMEs.</p>

R&D Project 10

General Information

<p>Country: Germany</p> <p>Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg</p> <p>Name of participant: S. L.</p> <p>Occupation of participant (trainee, student, employee, manager, etc.): Dual student</p> <p>Company name: N. N.</p> <p>Short description of company (sector, number of employees, etc.): The study refers to a medium-sized craft business based in Hamburg-Harburg. The company employs around 50 people and has been active in the field of heating, sanitation, and air conditioning technology (SHK) since 1906. In addition to private customers, the company also handles commercial and industrial projects. The work organization is divided into customer service, large construction projects, and office departments. Permanent employees, trainees, and temporary workers work together on large construction sites, often in changing teams. This typical structure of the SHK industry, with project-based teamwork and a shortage of skilled workers, forms the central context of the study.</p>
<p>R&D/Innovation Project</p>
<p>Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises</p> <p>As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice.</p> <p>Short description of R&D/innovation project: The aim of the research was to analyse which factors influence the efficiency and organization of construction teams on large construction sites. The focus was on the question of whether targeted team composition based on criteria such as linguistic homogeneity, personal familiarity, and age diversity contributes measurably to increased efficiency. The innovative idea behind the work lies in combining practical construction site research with business management concepts of human resource management and team organization. By combining qualitative (expert interviews with construction and department managers) and quantitative methods (standardized employee survey), a new, action-oriented model was developed that directly links operational efficiency issues to team factors in construction practice.</p> <p>Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.</p>
<p>Results</p>
<p>Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.): The results show that linguistic homogeneity, mutual familiarity, and a mixed-age team structure contribute significantly to efficiency and organization on the construction site. Communication barriers and frequently changing temporary workers, on the other hand, make coordination more difficult and reduce productivity. Respondents rated a common language and personal acquaintance as particularly important factors for success, while age-diverse teams benefit from the exchange of experience between younger and older workers. In practice, this means that more conscious team composition—taking these three criteria into account—can significantly improve efficiency. At the same time, operational planning should remain flexible in order to cope with the dynamic conditions on large construction</p>

sites. For comparable skilled trades companies, the study thus provides practical advice on how personnel planning, communication, and team structuring can be used strategically to increase efficiency, quality, and employee satisfaction.

R&D Project 11

General Information
<p>Country: Germany Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg Name of participant: T. H. Occupation of participant (trainee, student, employee, manager, etc.): Dual student Company name: N. N. Short description of company (sector, number of employees, etc.): The study focuses on a traditional family business from Lüneburg that has been active in the sanitary, heating, and ventilation technology sector since the 1930s. With around 30 employees, the company is classified as a small to medium-sized enterprise (SME) in the skilled trades sector. In the wake of the energy transition, the company has expanded its service portfolio to include renewable energy systems, which has led to a significant increase in order complexity and planning effort. Like many skilled trades businesses, this company also faces challenges due to a shortage of skilled workers and generational change, making the composition and performance of construction site teams a decisive competitive factor.</p>
R&D/Innovation Project
<p>Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises</p> <p>As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice.</p> <p>Short description of R&D/innovation project: The aim of the research was to analyse the differences in efficiency between well-established and newly formed construction site teams. A target/actual comparison of the parameters of time, costs, and quality was carried out to examine how team structure and experience affect project performance. The innovative idea behind the work lies in the combination of classic business management methods—particularly the target/actual comparison from controlling—with team dynamic factors from construction site practice. This supplements the economic analysis with a practical consideration of the social and organizational interaction within the team. The aim is to identify optimization potential for personnel and project planning in skilled trades businesses.</p> <p>Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.</p>

Results
<p>Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.):</p> <p>The results confirm the hypothesis that well-established teams work significantly more efficiently than newly formed teams. A comparison of two identical construction projects showed that the new team required 27.5% more time and incurred higher material costs (+5%). In addition, the new teams had more quality defects (e.g., faulty installation, rework on bathtubs and heating systems). Overall, the total costs of the new teams were around €1,870 higher than those of the well-established team. Qualitative feedback from the foreman in charge confirmed that well-established teams require 30–40% less time and make fewer mistakes thanks to routine, trust, and well-established processes. In practice, this means that experience and stability in teams are decisive factors for efficiency. Craft businesses should therefore focus on specifically promoting new teams – e.g., through standardized processes, mentoring by experienced employees, and performance-based incentive systems. Comparable companies in the HVAC or construction industry can use these findings to reduce error rates, plan resources more efficiently, and ensure competitiveness.</p>

R&D Project 12

General Information
<p>Country: Germany Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg Name of participant: J. H. Occupation of participant (trainee, student, employee, manager, etc.): Dual student Company name: N. N. Short description of company (sector, number of employees, etc.): The company is a medium-sized craft business based in Hamburg with around 20 employees. It operates in the fields of construction and furniture carpentry, manufacturing both individual pieces of furniture and custom-made interior fittings. Its range of services includes the planning, manufacture, and installation of high-quality carpentry work for private and business customers. Like many craft businesses, the carpentry workshop faces the challenge of avoiding efficiency losses in production caused by unclear work instructions, missing information, and rework.</p>
R&D/Innovation Project
<p>Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises</p> <p>As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice.</p> <p>Short description of R&D/innovation project: The aim of the study was to analyse how clearly and completely tasks are assigned in production and how this process can be improved to increase manufacturing efficiency and effectiveness. The innovative idea is to view task assignment as a central business process and to systematically research it—a topic that has hardly been explored in the skilled trades sector to date. Qualitative expert interviews with journeymen and a work planner were used to examine the flow of information between planning and the workshop in order to identify weaknesses in communication and task distribution. The aim was to derive concrete measures to reduce queries, waiting times, and production errors.</p>

<p>Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.</p>
<p>Results</p>
<p>Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.): The results show that many tasks are assigned incompletely or unclearly. Dimensions, cuts, or current technical drawings are often missing, which leads to queries, delays, and, in some cases, multiple reworks. In addition, “difficult corners” (complex components) are often not explained sufficiently, and feedback processes after task completion hardly ever take place. Despite clear basic structures, there is therefore considerable potential for improvement in the communication and information process between work preparation and production. In practice, the author recommends the introduction of structured query and feedback loops, the creation of standardized transfer formats (checklists, drawing templates), and the definition of binding deadlines for tasks. Comparable craft businesses can learn from this that clear and complete task transfer is a decisive efficiency factor: it reduces rework, strengthens employee responsibility, and improves production quality in the long term.</p>

R&D Project 13

<p>General Information</p>
<p>Country: Germany Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg Name of participant: S.S. Occupation of participant (trainee, student, employee, manager, etc.): Dual student Company name: N. N. Short description of company (sector, number of employees, etc.): The study refers to a painting company, an owner-managed craft business based in Hamburg. The company employs around ten people and specializes in painting and varnishing work in the private customer segment. In addition to traditional renovation jobs, it also carries out special projects in Hamburg, Lübeck, and Berlin. Like many similar craft businesses in Germany, the company faces challenges due to high customer expectations, increasing order complexity, and limited human resources. Processing customer inquiries in particular proves to be time-consuming and error-prone, with negative effects on customer satisfaction and the company's image.</p>
<p>R&D/Innovation Project</p>
<p>Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice. Short description of R&D/innovation project: The aim of the research project was to develop an efficient organizational and team structure for processing customer inquiries and to analyse how this improves service quality and customer satisfaction. The study combined theoretical models of customer relationship management (CRM) and project management according to DIN 69901 with</p>

<p>practical team development methods based on the Tuckman model. The innovative idea lies in the introduction of a specialized team for customer inquiries, which replaces the previously uncoordinated processes with clearly defined roles, standardized processes, and checklists. This is intended to shorten processing times, reduce error rates, and professionalize customer communication.</p> <p>Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.</p>
<p>Results</p>
<p>Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.): The results show that analysing internal processes can reveal significant potential for improvement. The key findings and improvements relate to the following insights: Reduction in processing times for emails and quotations, as the average processing time for emails was 4 hours, for quotations 14 hours, and the error rate in quotations was 13%. Some complaints were only processed after 48 hours. The introduction of a specialized team with clear responsibilities, accompanied by checklists and feedback loops (PDCA cycle), led to measurable efficiency gains and higher customer satisfaction. In practice, standardization, clear role allocation, and continuous team development are key success factors for service-oriented skilled trades businesses. Comparable companies can significantly improve their response speed, error rate, and customer loyalty through similar organizational measures—and thus strengthen their competitiveness in the skilled trades sector in the long term.</p>

R&D Project 14

<p>General Information</p>
<p>Country: Germany Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg Name of participant: J.K. Occupation of participant (trainee, student, employee, manager, etc): Dual student Company name: N. N. Short description of company (sector, number of employees, etc.): The research relates to a building cleaning company, a medium-sized enterprise in the building cleaning industry based in Hamburg. The company offers a wide range of services from maintenance and construction to special cleaning and employs people of different ages, genders, and ethnic backgrounds. The industry is strongly characterized by labour-intensive activities, linguistic and cultural diversity, and a shortage of skilled workers. In an environment where many different teams work together at changing locations, diversity plays a central role in team performance, communication, and efficiency.</p>

R&D/Innovation Project
<p>Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises</p> <p>As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice.</p> <p>Short description of R&D/innovation project: The aim of the study was to examine the influence of diversity on the efficiency and innovative strength of work groups at different locations. The focus was on the diversity characteristics of ethnicity, age, and gender. The innovative idea was to apply complexity theory as a theoretical basis for understanding work groups as adaptive, learning systems. This concept makes it possible to explain both the positive effects (e.g., creativity, resilience, learning ability) and the challenges (e.g., communication barriers, conflicts) of diverse teams. This combined scientific models of organizational research with a practical analysis of real work groups in the building cleaning industry.</p> <p>Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.): The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.</p>
Results
<p>Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.): The study, based on international secondary studies (including McKinsey, Herring, Jehn et al.), showed that diversity in teams can have a positive impact on both efficiency and innovation, provided it is supported by acceptance, respect, and an open communication culture. Using the example of a building cleaning company, two working groups (construction and special cleaning as well as maintenance cleaning) were examined. Both teams were highly diverse in terms of ethnicity and age, which enabled them to achieve increased problem-solving skills, flexibility, and adaptability. Although language barriers did arise, they were overcome through nonverbal communication and collegial support. The result: diversity has a positive effect on efficiency and innovative strength when teams act as adaptive systems that learn from each other. For comparable companies in the cleaning and service industry, this means that diversity in practice – combined with targeted awareness-raising and cultural training – is a decisive success factor for productivity, employee satisfaction, and innovative ability.</p>

R&D Project 15

General Information
<p>Country: Germany Name of sending institution (BA&VET project partner): Berufliche Hochschule Hamburg Name of participant: M. M. Occupation of participant (trainee, student, employee, manager, etc.): Dual student Company name: N. N. Short description of company (sector, number of employees, etc.): The research relates to a company in the HVAC trade. It is a medium-sized craft business based in Hamburg that operates in the field of sanitary, heating, and air conditioning</p>

technology (HVAC). The company employs approximately 25 journeymen, master craftsmen, and apprentices and carries out modernization work, maintenance, and installations in residential and commercial buildings. The organization has a team-oriented structure and attaches particular importance to quality, efficiency, and a good working atmosphere. One focus is on the cooperation between experienced and younger employees in order to secure specialist knowledge and develop young talent in a practical manner.

R&D/Innovation Project

Context of project (within dual Bachelor program, study course, further training, etc.): Business Administration – Management of Small and Medium-Sized Enterprises

As part of the dual study program, students are required to carry out practical research projects that yield innovative findings by combining theory and practice.

Short description of R&D/innovation project:

The aim of the project was to compare the efficiency of a team of craftsmen in their current state with a target state defined by the company management in order to identify differences in time and cost management. The aim was to check whether the specified target values were realistic and to identify the factors causing deviations.

The innovative idea was to analyze operational efficiency not only on the basis of economic indicators, but also with the help of personnel controlling methods. This created a practical link between craft project work and business management. The process enables continuous optimization of team performance on the basis of measurable indicators.

Organisation of the R&D/innovation project (duration, time spent in company, assistance by sending institutions, etc.):

The project will be carried out over a period of approximately 12–16 weeks, mainly at the company. The contact persons at the company and the supervising lecturers at the university will support the students in their work.

Results

Short description of the results of the R&D/innovation project (assessment of the significance of the R&D project for the company, commitment of the management and the employees involved, observations, etc.):

The investigation showed that the team under review worked more efficiently than assumed in the target state. The work was completed faster (two hours less journeyman and apprentice time than planned), while material consumption corresponded exactly to the calculations. There were no communication problems – on the contrary, the well-coordinated team benefited from good coordination and experience. The analysis also showed that the company management tended to calculate time buffers too generously in order to avoid risks and errors. This makes the target state appear less efficient than it actually is. In practice, the author recommends regularly reviewing the efficiency of teams through personnel controlling in order to identify specific optimization potential and improve the use of resources. Comparable craft businesses can conclude from this that realistic time targets, team stability, and communication contribute significantly to cost control and performance improvement.

Conclusion

In conclusion, the R&D projects presented demonstrate the strong potential of dual study programs to drive innovation and organizational learning in SMEs. Across industries,



common findings include the positive impact of teamwork, communication, and leadership on efficiency and employee satisfaction. Many projects reveal that structured collaboration, psychological safety, and competency-based management significantly enhance performance and knowledge transfer. Furthermore, digitalization, diversity, and intergenerational collaboration emerge as key drivers for sustainable business transformation. The BA&VET initiative thus highlights how integrating academic and vocational education can foster innovation capacity, strengthen regional economies, and prepare future professionals for complex, rapidly evolving work environments.

Poland

In Poland, R&D projects were carried out in 31 SMEs as part of the BA&VET project. All participating companies insist on strict confidentiality regarding the results, so no publication can be made at this point. The lead partner has summary implementation reports available.

Evaluation Concept⁸

Introduction

The climate change, lack of fossil combustibles, and pollution, particularly in the form of the greenhouse gas emissions, and the increasing use of renewable energy and improved energy efficiency as solutions to reach the climate goals of Agenda 2030 of UN, as well as goals of respective Agenda of EU, have been topics of discourse for years. In the beginning of 2022, the Russian attack to Ukraine has brought the dependency of EU on Russian energy products – gas, oil, coal, and electricity – as an emerging topic of European energy discourse. In the spring 2022, the European Commission, as a response to the hardships and global energy market disruption caused by Ukrainian war, launched REPowerEU programme. This programme supports activities aiming to save energy, to produce clean energy, and to diversify energy supplies of the European Union (European Commission, 2023).

In addition to REPowerEU -programme, European Commission has in December 2021 launched a proposal for revision of the Energy Performance of Buildings Directive. This revision has not yet taken effect, thus, the revision 2018 of the directive is still valid. (European Commission, 2023a). When writing this document, the formal adoption process is still ongoing. In July 2021, the European Commission launched a proposal to renew Energy efficiency Directive, as part of the 'Fit for 55' package. This proposal was supplemented by an additional proposal as part of the REPowerEU plan in May 2022. (European Commission, 2023b). The revised directive took effect on 20th September 2023.

The updated energy efficiency directive aims to establish legally binding goal to reduce the final energy consumption by 11.7% by 2030 compared to the 2020 reference scenario. This includes for each member of the European Union the requirement to define indicative national contribution based on objective criteria which reflects national circumstances. If the national contributions do not match to the EU target, an ambition gap mechanism is applied by the Commission. Each country should also increase annual energy savings step by step from 0.8 per cent (at present) to 1.3 per cent (2024-2025), then 1.5 per cent (2026-2027) and 1.9 per cent from 2028 onwards. This means an average of 1.49 per cent of new annual savings during the period from 2024 till 2030. When planning the savings and activities, vulnerable customers and social housing should be prioritised within the scope of their energy savings measures. In addition to this, an annual energy consumption reduction goal of 1.9% for the public sector should be introduced, including the obligatory annual 3% buildings renovation duty extended to all the levels of public administration. Directive also introduces a new approach, based on energy consumption, for business to have an energy management system or to carry out energy audits. Furthermore, a new obligation to monitor the energy performance of data centres, with an EU-level database collecting and publishing data, has been launched. Municipalities are enhanced to promote local heating and cooling plans, particularly in larger municipalities, and to increase the efficient energy use in heat and cold supply, also in district heating and cooling systems. (European Commission, 2023b).

⁸ Compiled by Dr Kari Lilja and Dr Sirpa Sandelin. Satakunta University of Applied Sciences

As a part of the *Clean energy for all Europeans* package, that aims to help EU to meet the emissions reduction commitments stated in the Paris Agreement, the Renewable Energy Directive (2018/2001/EU) took effect in December 2018. The directive, that has been legally binding since June 2021, sets an overall European renewable energy target of 32 per cent by 2030. The directive also contains rules to ensure the use of renewable energy in the transport sector, and in heating and cooling. Common principles and rules for renewable energy support schemes, sustainability criteria for biomass and the right to produce and consume renewable energy and to establish renewable energy communities are set in the directive that, in addition to those, includes rules to remove barriers, to increase investments and to achieve cost reductions in renewable energy technologies, and to empower private citizens and organizations to participate in the move towards clean energy. Due to the Ukrainian war and attempts to break away from dependence on Russian energy, and on fossil combustibles, the Commission has on 2022 proposed to raise the target to 45 per cent by 2030. On 30 March 2023, a temporary agreement to raise the target to at least 42.5 per cent by 2030 but aiming for 45 per cent was reached. After having completed this process, the new legislation should become formally adopted and take effect.

SMEs are needing support

The directives and programmes presented above are not only challenging the people and companies, but also giving inspiration for new research and opportunities to new innovations and development projects. However, particularly among the SME-companies the lack of resources, e.g., skilful people, knowledge and funding are restricting their abilities to innovate and conduct successful R&D-projects (see e.g., Ortega-Argilés & Voigt (2009)). To overcome these restrictions, SMEs must build partnerships and co-operate with partners who have resources that SMEs are missing. One natural party for this kind of partnership and collaborating are educational institutions like vocational and higher education institutes, e.g., vocational schools, universities of applied sciences and scientific universities (Paiva;Ribeiro;& Coutinho, 2020). Collaboration between enterprises and schools benefits both parties. Educational institutes and their students gain practical experience, get information on what's going on, and have an opportunity to test new ideas and results of their research in practice. Enterprises, on their part, gets the latest knowledge and results of research on their branch, and – which mostly is the most important – skilful students to solve their problems and innovate new applications and solutions.

Supporting models will be developed and evaluated

In this project, one of the goals was to develop a Development and coordination Concept for the innovation promotion of SMEs (WP5 A1) to create a working model for supporting and promoting the innovation processes among the SMEs. The models tested will be further presented in the implementation reports written after test phases. The evaluation process presented in this evaluation concept is created to measure the success of the supporting process, and to find out the possible needs for improvements and changes in the development and coordination concept created.

Evaluation concept

The aim of the evaluation concept presented here is to collect data concerning innovation and development projects realized during the project BA&VET- in which the partners of the project have co-operated with an enterprise. The evaluation process aimed to be followed

during this evaluation consists of designing the evaluation concept and questionnaire, collecting the data and feedback from each partner and participant of the collaboration, evaluating the data and finally, reporting the results. Due to the fact that funding of the evaluation projects may come from many different sources and via many routes, and is not in the agenda of project BA&VET, the issues concerning the funding have not been included in the evaluation.

Target of the evaluation

In this evaluation, the target is not facilitations of course, teaching methods or how teachers and students experienced each other, but development project, its success, and experiences of each participant group. Thus, information to be collected for the evaluation differs from the data collected during the common course evaluation process, and so does the questionnaire too.

Evaluation process

In best cases, the evaluation survey and the report cover the evaluated development process and collaboration as a whole. This is not always possible, because e.g., the process has taken long time, some of the key persons have been changed, or even some of the partners have been changed or dropped out. In such cases, it is recommendable to conduct the evaluation using the data available and noting the situation in the report.

This evaluation concept covers different types of supporting, promoting, and development processes. In principle, all of these can be evaluated as a whole, but in the beginning of the project to be evaluated, one cannot be sure of that. However, even if there were changes during the projects, the evaluation method and tools must be kept similar in each case to ensure the comparability of results. The evaluation will be conducted using the online survey system E-lomake, which enables the anonymity of the respondents, and – if needed – follows the sent invitations and sends reminders to those who have not responded. However, to guarantee the feeling of anonymity, it is common that reminders are sent as mass mails, particularly if the samples are small. In this case the samples will be small.

The questionnaire will be prepared in English and saved (Appendice A). Only one common questionnaire will be used, thus all the data will be collected to only one dataset which makes it easier to manage the data, although the analysing phase will require a bit more work. The prepared survey will be tested to see if the questionnaire is working, and if the reporting will be possible in a desired way. (Figure 1)

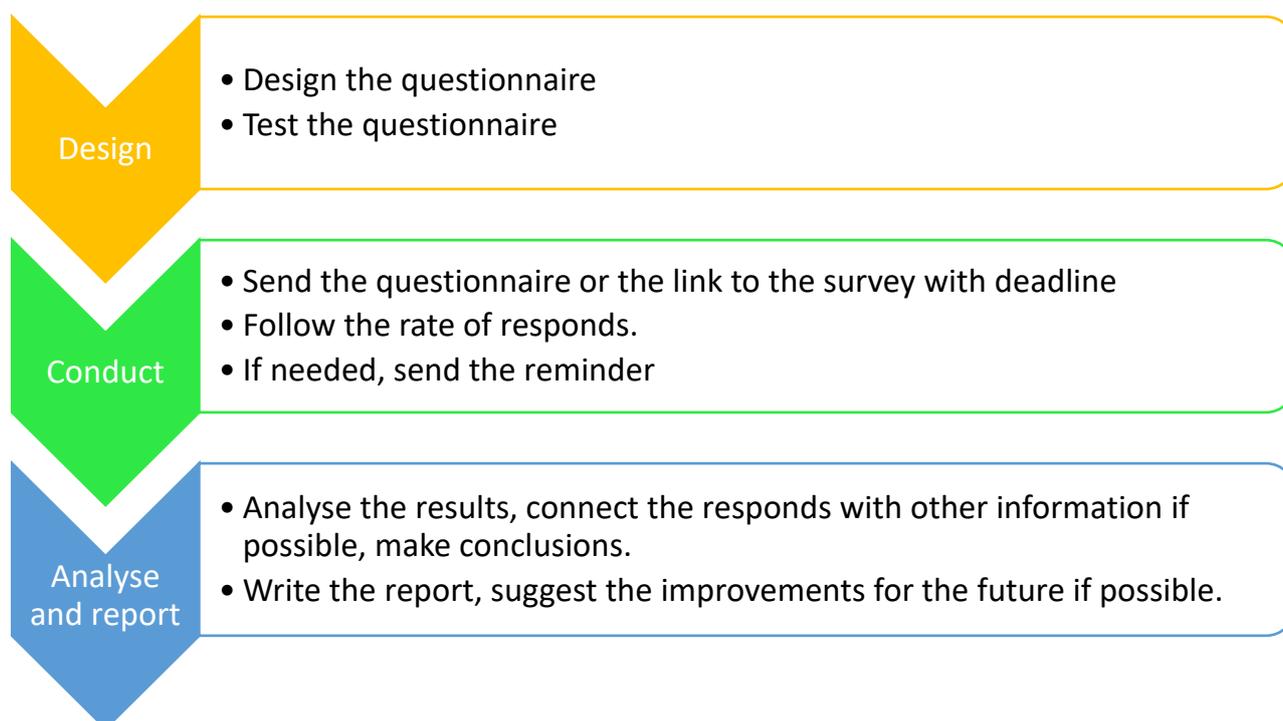


Figure 1: Phases of the evaluation.

If there is a need to follow the responds and to send reminders, an invitation to participate to the survey and a link will be sent by e-mail or delivered in other way. At the same time, the deadline for responding will be announced. The BA&VET project partner participating the support and promotion project is responsible for delivering the link to all potential responders.

Target groups of the evaluation

The main target group is those participating the support and promotion projects, i.e., students, teachers, coaches, consultants, supervisors, employees of the company as well as managers, directors, and entrepreneurs. Each target group will use the same questionnaire in which there are both common questions, and questions for just one group.

Online questionnaires and duties of each project partner of BA&VET

The online questionnaire will be prepared SAMK will send the link to questionnaire to the project partners of BA&VET involved in the development projects (facilitators). Project partner delivers the link to other partners of the development project latest when the project is finished and instructs the target groups to complete the questionnaire immediately after the end of the project. If the link has been delivered earlier, facilitator should remind the target groups to complete the survey, and if needed, send the link once again.

Needs to translate the questionnaire?

It has been agreed with LP, that the survey will be conducted only in English. If the questionnaire needs to be translated to domestic language, a facilitator should announce this at least a month before the project to be evaluated starts. If LP accepts this, SAMK will then send a preliminary questionnaire to be translated. Facilitator will send the translated (Or proofed, if SAMK has made the translation) version to SAMK latest two weeks before the planned test course starts.

When the development project starts

In the beginning of project, the facilitator informs, that the project will be evaluated, and that participants will receive a link to the evaluation questionnaire that should be completed in the end of the project. Participants should be informed that the evaluation helps the facilitators to develop and improve the promoting and supporting process in the future.

When the course ends

In the end of the project, if not earlier delivered, facilitator sends the link to the survey to target groups involved in the project, reminding them that each answer is important, and informs the period when the evaluation survey is active. In common, this period is one week, if there are no needs for longer responding period.

After the responding period has finished, SAMK will collect the results from the system, analyse them and write a report.

Table 1: Summary of the duties, process, and schedule of the test

Deadline and responsible party	Task
Latest one (1) month before the start of the development project facilitator should	<ul style="list-style-type: none"> Inform LP and SAMK IF the questionnaires should be translated. If translation is needed, return the questionnaires included with translations written on the form.
Within one (1) month calculated from receiving the information listed above, SAMK will	<ul style="list-style-type: none"> Translate the questionnaire – If needed, and if LP has approved – according to given instruction. Send the link to translated survey to the facilitator and inform the deadline for the responding.
When the development project starts, facilitator will Inform the participants, that	<ul style="list-style-type: none"> the project will be evaluated, the link to the evaluation survey will be given or sent in the end of development project if not earlier, and that it is important for developing the promoting and supporting process that everyone complete the questionnaire.
When the course or phase of the course ends, facilitator will	<ul style="list-style-type: none"> Deliver the links to survey to each group of respondents either by e-mail or in other acceptable way if not delivered earlier or if there is a need to resend the link. The link to the common questionnaire is: https://elomake.samk.fi//lomakkeet/15587/lomake.html Inform the respondents about the deadlines. Remind them about the importance of the evaluation.
When the given deadline has been passed, SAMK will	<ul style="list-style-type: none"> Open the database and collect and analyse the results. Write a report.

- | | |
|--|---|
| | <ul style="list-style-type: none"> • Send the report to be discussed. Note: In this case the final report will be compiled after the last development project has been finished. |
|--|---|

The report

In the report, following issues will be reported:

- A rough description of the respondents, have they been satisfied with results of the project and with promoting and development process, do they believe that the process has been beneficial, and what could have been made in other way.
- A rough description of conducted project and its success.
- A rough description of experiences gained from the process per each participant group.

In the end of each report there will be a concluding section that summarizes the findings and gives some suggestions concerning the opportunities to improve and develop the process. All the evaluations will be summarized together.

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Appendix: Evaluation questionnaire



Innovation
promoting and fundir

Evaluation Report

Introduction

The climate change, lack of fossil combustibles, and pollution, particularly in the form of the greenhouse gas emissions, and the increasing use of renewable energy and improved energy efficiency as solutions to reach the climate goals of Agenda 2030 of UN, as well as goals of respective Agenda of EU, have been topics of discourse for years. In the beginning of 2022, the Ukrainian war has brought the dependency of EU on imported energy products – gas, oil, coal, and electricity – as an emerging topic of European energy discourse. In the spring 2022, the European Commission, as a response to the hardships and global energy market disruption caused by Ukrainian war, launched REPowerEU programme. This programme supports activities aiming to save energy, to produce clean energy, and to diversify energy supplies of the European Union (European Commission, 2023).

In addition to REPowerEU -programme, European Commission has in December 2021 launched a proposal for revision of the Energy Performance of Buildings Directive. The newest revision took effect on 24th April 2024, and the member countries need to transpose the regulation into national laws by 29 May 2026. (European Commission, 2025). In July 2021, the European Commission launched a proposal to renew Energy efficiency Directive, as part of the 'Fit for 55' package. This proposal was supplemented by an additional proposal as part of the REPowerEU plan in May 2022. (European Commission, 2023a). The revised directive took effect on 20th September 2023. The deadline for EU member countries to transpose the regulation to their own legislation is 11 October 2025. (European Commission, 2025a)

The updated energy efficiency directive aims to establish legally binding goal to reduce the final energy consumption by 11.7% by 2030 compared to the 2020 reference scenario. This includes for each member of the European Union the requirement to define indicative national contribution based on objective criteria which reflects national circumstances. If the national contributions do not match to the EU target, an ambition gap mechanism is applied by the Commission. Each country should also increase annual energy savings step by step from 0.8 per cent (at present) to 1.3 per cent (2024-2025), then 1.5 per cent (2026-2027) and 1.9 per cent from 2028 onwards. This means an average of 1.49 per cent of new annual savings during the period from 2024 till 2030. When planning the savings and activities, vulnerable customers and social housing should be prioritised within the scope of their energy savings measures. In addition to this, an annual energy consumption reduction goal of 1.9% for the public sector should be introduced, including the obligatory annual 3% buildings renovation duty extended to all the levels of public administration. Directive also introduces a new approach, based on energy consumption, for business to have an energy management system or to carry out energy audits. Furthermore, a new obligation to monitor the energy performance of data centres, with an EU-level database collecting and publishing data, has been launched. Municipalities are enhanced to promote local heating and cooling plans, particularly in larger municipalities, and to increase the efficient energy use in heat and cold supply, also in district heating and cooling systems. (European Commission, 2023a).

As a part of the *clean energy for all Europeans* package, that aims to help EU to meet the emissions reduction commitments stated in the Paris Agreement, the Renewable Energy Directive (2018/2001/EU) took effect in December 2018 and was revised in 2023. The revised Directive EU/2023/2413 entered into force on 20 November 2023. The directive, that has been legally binding partially since July 2024, and finally from May 2025, sets an overall European renewable energy target of 42,5 per cent by 2030 and aims to 45 per cent (European commission, 2025b). The directive also contains rules to ensure the use of renewable energy in the transport sector, and in heating and cooling. Common principles and rules for renewable energy support schemes, sustainability criteria for biomass and the right to produce and consume renewable energy and to establish renewable energy communities are set in the directive that, in addition to those, includes rules to remove barriers, to increase investments and to achieve cost reductions in renewable energy technologies, and to empower private citizens and organizations to participate in the move towards clean energy. Due to the Ukrainian war and attempts to break away from dependence on Russian energy, and on fossil combustibles, the Commission has on 2022 proposed to raise the target to 45 per cent by 2030. On 30 March 2023, a temporary agreement to raise the target to at least 42.5 per cent by 2030 but aiming for 45 per cent was reached. After having completed this process, the new legislation has become formally adopted and taken effect.

SMEs are needing support

The directives and programmes presented above are not only challenging the people and companies but also giving inspiration for new research and opportunities to new innovations and development projects. However, particularly among the SME-companies the lack of resources, e.g., skilful people, knowledge and funding are restricting their abilities to innovate and conduct successful R&D-projects (see e.g., Ortega-Argilés & Voigt (2009)). To overcome these restrictions, SMEs must build partnerships and co-operate with partners who have resources that SMEs are missing. One natural party for this kind of partnership and collaborating are educational institutions like vocational and higher education institutes, e.g., vocational schools, universities of applied sciences and scientific universities (Paiva;Ribeiro;& Coutinho, 2020). Collaboration between enterprises and schools benefits both parties. Educational institutes and their students gain practical experience, get information on what's going on, and have an opportunity to test new ideas and results of their research in practice. Enterprises, on their part, gets the latest knowledge and results of research on their branch, and – which mostly is the most important – skilful students to solve their problems and innovate new applications and solutions.

In this project, one of the goals was to develop a Development and Coordination Concept for the innovation promotion of SMEs (WP5 A1) to create a working model for supporting and promoting the innovation processes among the SMEs. The models tested will be further presented in the implementation reports written after test phases. The evaluation process presented in this evaluation concept is created to measure the success of the tests, and to find out the possible needs for improvements and changes in the development and coordination concept created.

Evaluation

The aim of the evaluation reported here was to collect data concerning innovation and development projects realized during the project BA&VET- in which the partners of the project have co-operated with an enterprise. The evaluation process followed during this evaluation consists of designing the evaluation concept and questionnaire, collecting the data and feedback from each partner and participant of the collaboration, analysing the data, and reporting the results.

Target of the evaluation

In this evaluation, the target has not been facilitations of course, teaching methods or how teachers and students experienced each other, but the development project, its success, and experiences of each participant group. Thus, information to be collected for the evaluation differs from the data collected during the common course evaluation process, and so does the questionnaire too.

Evaluation process

In best cases, the evaluation survey and the report cover the evaluated development process and collaboration as a whole. This is not always possible, because e.g., the process has taken long time, some of the key persons have been changed, or even some of the partners have been changed or dropped out. In such cases, it is recommendable to conduct the evaluation using the data available and noting the situation in the report.

This evaluation covers different types of supporting, promoting, and development processes. In principle, all of these can be evaluated as a whole, but in the beginning of the project to be evaluated, one cannot be sure of that. However, even if there were changes during the projects, the evaluation method and tools were kept similar in each case to ensure the comparability of results. The evaluation was conducted using the online survey system E-lomake, which enabled and ensured the anonymity of the respondents, and – If needed – enabled following the sent invitations and sending reminders to those who have not responded. However, to guarantee the feeling of anonymity, the invitations were sent as mass mail, thus, no personal reminders could be sent.

The questionnaire has been prepared in English and saved (Appendix A). The aim was to have one common questionnaire will be used, thus all the data will be collected to only one dataset which makes it easier to manage the data, although the analysing phase will require a bit more work. The prepared survey was tested to see if the questionnaire is working, and if the reporting will be possible in a desired way. (Figure 1) The survey was opened in very early phase because some of the partners requested this. However, during the first 12 months (May 2024 - May 2025, no replies were completed. It was also requested to divide the questionnaire into 3 parts, one for companies, one for students and one for teachers, which was done although it made the analysing phase even more complicated.

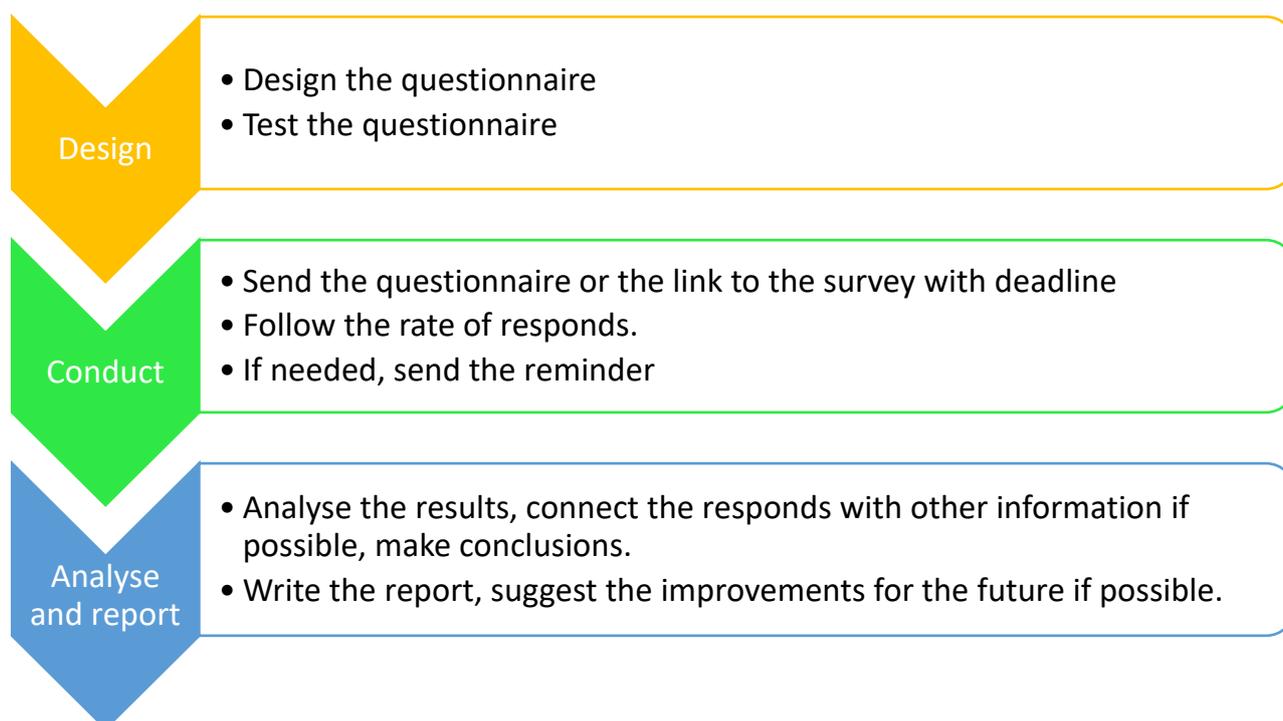


Figure 2: Phases of the evaluation.

An invitation to participate to the survey and a link were sent by e-mail or delivered in other way by facilitator of each test. At the same time, the deadline for responding was announced. The BA&VET project partner participating the support and promotion project was responsible for delivering the link to all potential responders.

Target groups of the evaluation

The main target groups of this evaluation were those participating the support and promotion projects in different roles, i.e., students, teachers, coaches, consultants, supervisors, employees of the company as well as managers, directors, and entrepreneurs. Original plan was, that Each target group would use the same questionnaire in which there were both common questions, and questions for just one group. As mentioned earlier, during the last online meeting before the deadlines a need to have three separate questionnaires had arisen, thus, part of the respondents compiled the common questionnaire and part of the respondents of each target group compiled a questionnaire aimed for teachers, students or companies. In both sets of questionnaires, the questions for each target group were similar.

Online questionnaires and duties of each project partner of BA&VET

The online questionnaire was prepared by SAMK who also sent the link to questionnaire to the project partners of BA&VET involved in the development projects (facilitators). Project partner delivered the link to other partners of the development project latest when the project was finished and instructed the target groups to complete the questionnaire immediately after the end of the project. If the link had been delivered earlier, facilitator reminded the target groups to complete the survey, and if needed, sent the link once again.

Needs to translate the questionnaire

It had been agreed with LP, that the survey was conducted only in English. No request for translations was got. However, there obviously were some participants who needed the questionnaire translated to domestic language. In these cases, facilitator in question had

translated the survey in paper, let the participant complete the questionnaire in paper and then completed it into official survey.

When the development project started

In the beginning of project, the facilitator informed, that the project will be evaluated, and that participants will receive a link to the evaluation questionnaire that should be completed in the end of the project. Participants were also informed that the evaluation helps the facilitators to develop and improve the promoting and supporting process in the future.

When the development project ended

In the end of the project, if not earlier delivered, facilitator sent the link to the survey to target groups involved in the project, reminded them that each answer is important, and informed the period when the evaluation survey is active. In common, this period is one week, if there are no needs for longer responding period. In this case, the common evaluation survey was open from May 2024 to deadline of the test and separated questionnaires from June 2025 to the deadline. After the responding period has finished, SAMK collected the results from the system, analysed them and wrote a report.

Report

According to the implementation reports, 32 development projects were run. Four (4) of these were run in Estonia, 6 in Finland, 15 in Germany, and 7 in Poland. The companies in which the project work was done, operated in four branches: Manufacturing, Construction, retailer, ICT-Services and other services (

Figure 3). According to implementation reports, the success of projects was good, and in most cases the goals were achieved.

The evaluation survey was completed 24 times by someone involved in the project in a way or another. In many of projects there were responds from both students, enterprises, and / or teachers, thus the number of evaluated projects is not 24 but smaller. Due to the guaranteed anonymity, it is not possible to specify which of the projects the responds are covering.

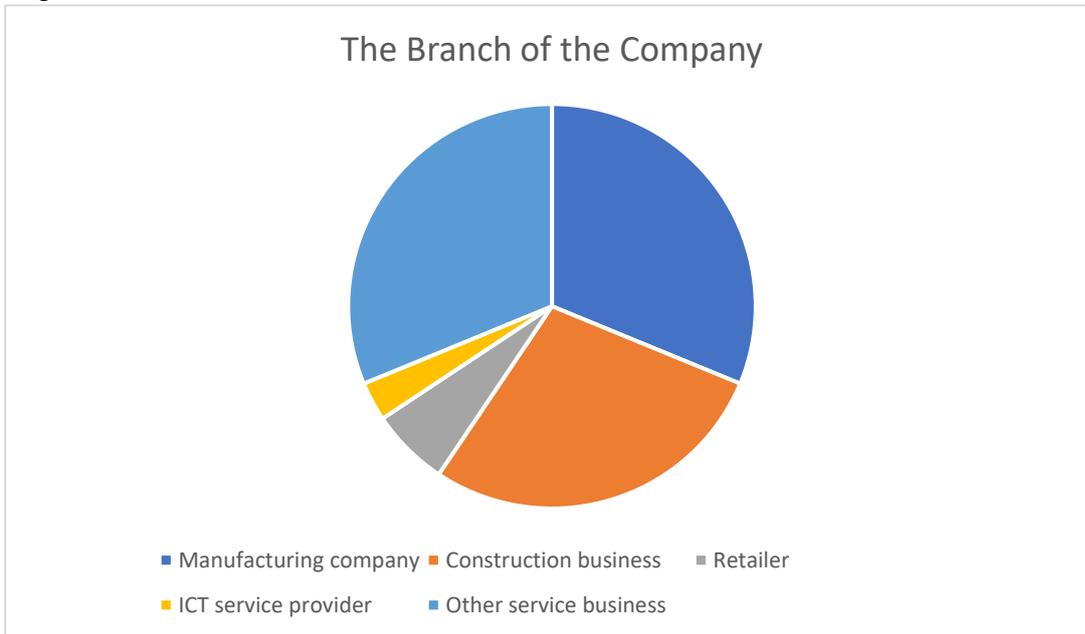


Figure 3: Branches of companies

Description of projects

The size of enterprises where the project was conducted, varied from under 50 000 € to under 250 M€, measured by turnover, but there were also 4 companies whose size was not known (Figure 4).

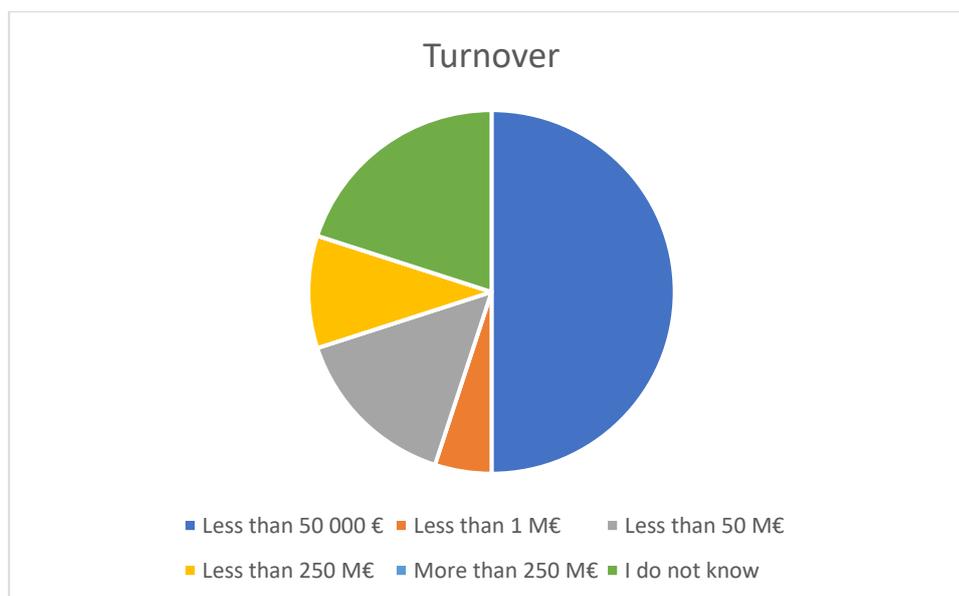


Figure 4. Turnover of companies

Measured by size of personnel the majority of companies had less than 10 persons, but bigger companies were found too (Figure 5).

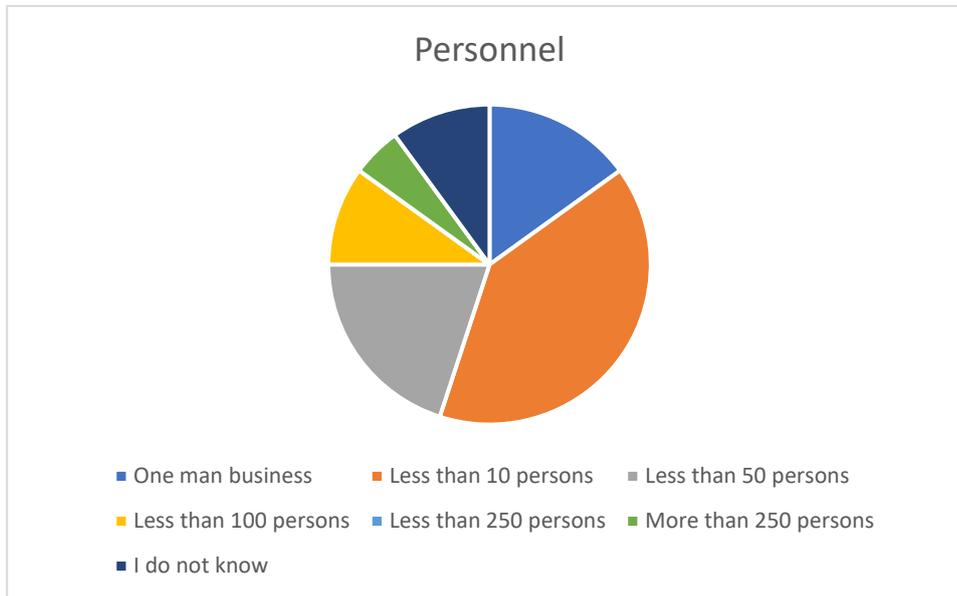


Figure 5: Size measured by turnover

The respondents were students, representatives of companies, and representatives of educational institutes (Universities, Universities of Applied Sciences, or VET-institutes) (Figure 6). The main goals when starting the project were said to be to improve the efficiency of the company, to develop new product or service, to improve existing project or service, and to develop existing or new management processes. Randomized reasons were also renewing existing product or service, developing company's capabilities, improving the profitability of the company, developing technical skills of the company, and developing existing or new manufacturing processes. Approximately 2/3 of projects took less than 1 year, 1/3 took from 1 to 3 years, and the length of one project was not known.

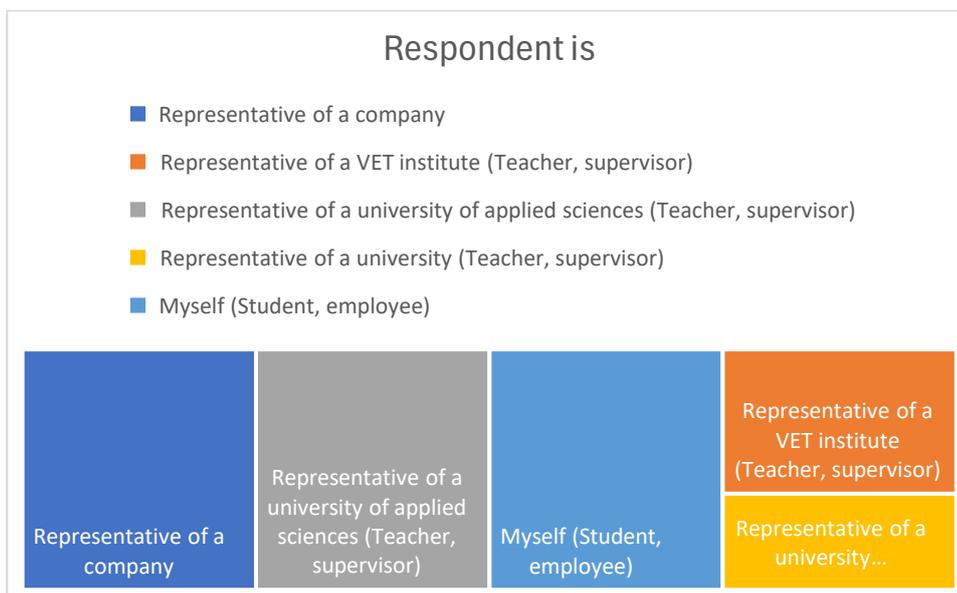


Figure 6: Types of respondents

Experiences gained from projects

The students found project a useful way to improve their skills and to increase their experiences and understanding of practice (Figure 7). They also felt that their skills and knowledge were valued, and that they were able to give their best skills and knowledge to the project (Figure 8). All of the students responded were very satisfied with the projects.

Teachers, on their part, found that they could combine theory and practice, and were able to gain practical experience (Figure 9). Teachers also found that the biggest benefit for their employer, educational institute, was that their students got an opportunity to practical learning (Figure 10). Furthermore, teachers and trainers found, that participating to the project made it easier for an enterprise to hire a student (that they already knew) (Figure 11).

Companies seem to be rather satisfied with the project. The average success in each of four sectors was 8 in scale of one to ten, and the variation was from 7 to 10, with some exceptional values 3, 4 and 5 (Figure 12). The average satisfaction was 4 in scale of 1-to 5. The employers also said that it was very helpful (4 in scale of 1 to 5) to have a student involved into the project. Students were seen to have fresh ideas and latest knowledge (

Figure 13). Having a teacher involved in the project was found to be very helpful too (4 in the scale of 1 -5), and teacher was supposed to have the latest knowledge (Figure 14). Interesting finding was, that some of the enterprises found it easier to hire a student, if there were teacher involved too.

The free speech -part included following comments: I think the whole process as such was done very well and there shouldn't be too many big changes. The root to great project collaboration lies in open communication. The idea behind the project should remain the same, as it helps to connect theoretical knowledge with practical application. It's a valuable way to learn by doing and simulating real work situations. Maybe a better problem and solution description before starting the development. It would be good to have basically documented task that needs to be solved. There must be more time to carry out the project. It would be better if students could communicate directly with the person whose task they are working on. This would allow for more realistic collaboration and clearer expectations. It could be good to bear in mind, that not all the equipment and materials needed are known at the beginning of the project. The complexity of the procurement rules does not allow for multiple procurements during the project; everything has to be purchased at once.

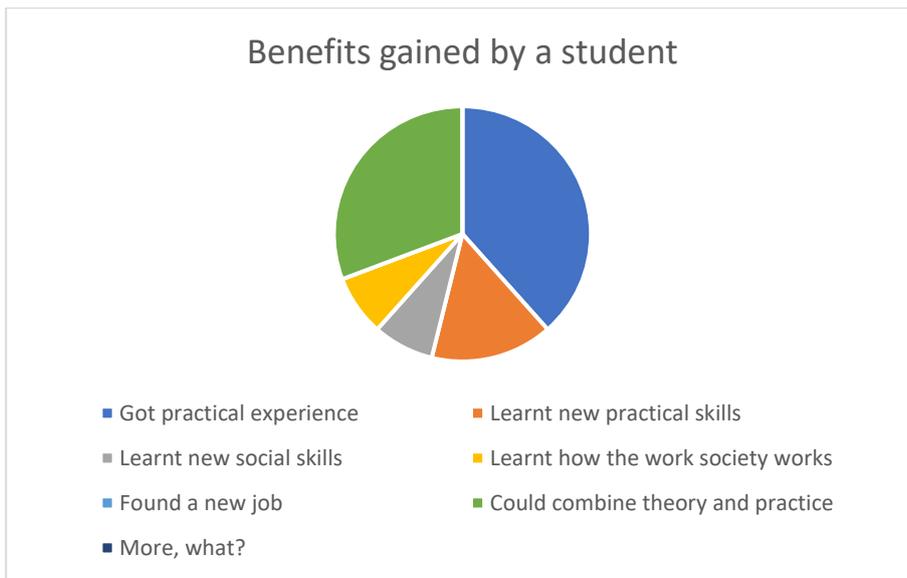


Figure 7: Benefits for students

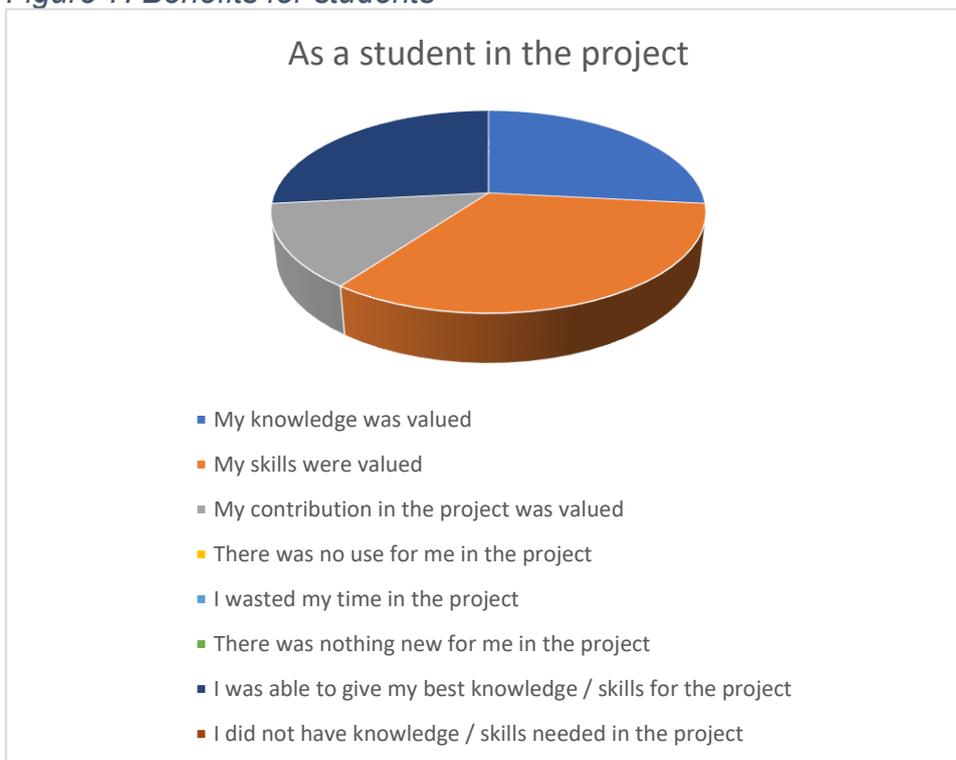


Figure 8: Benefits for students 2

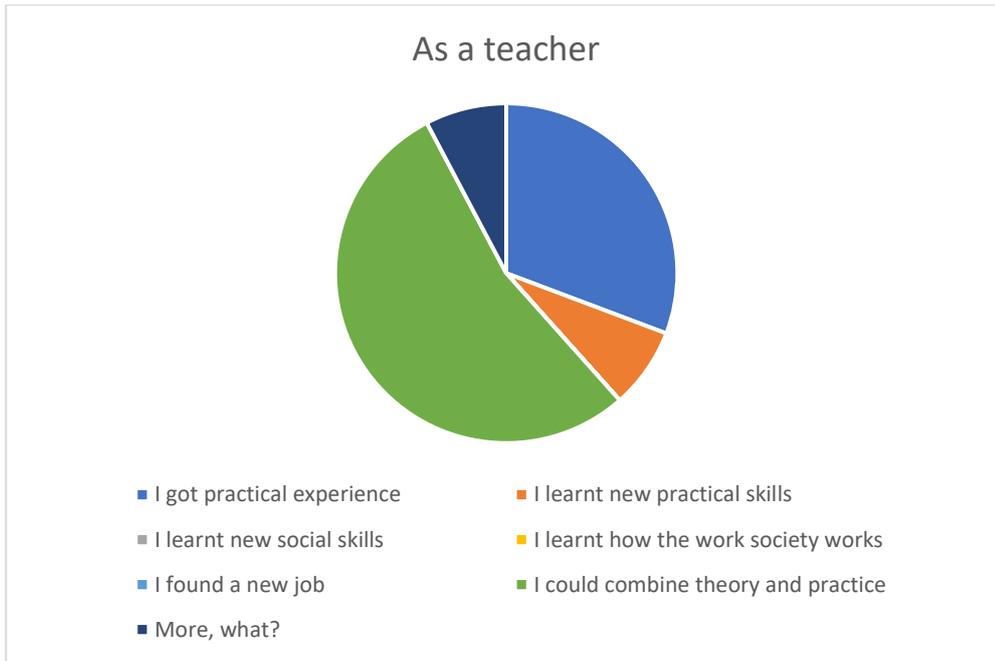


Figure 9: Teachers' experiences

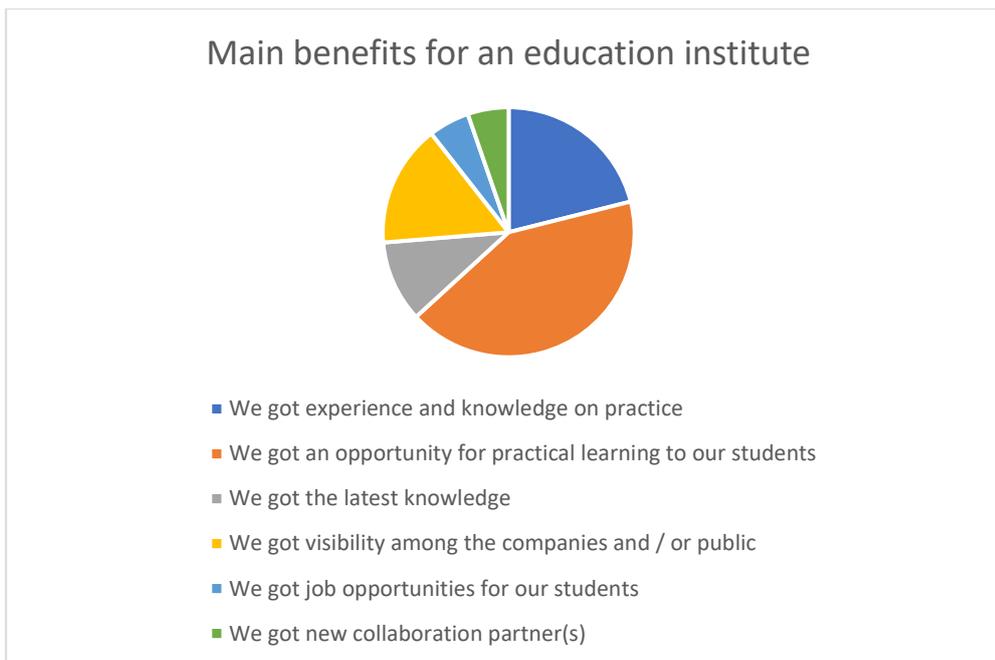


Figure 10: Benefits for educational institutes

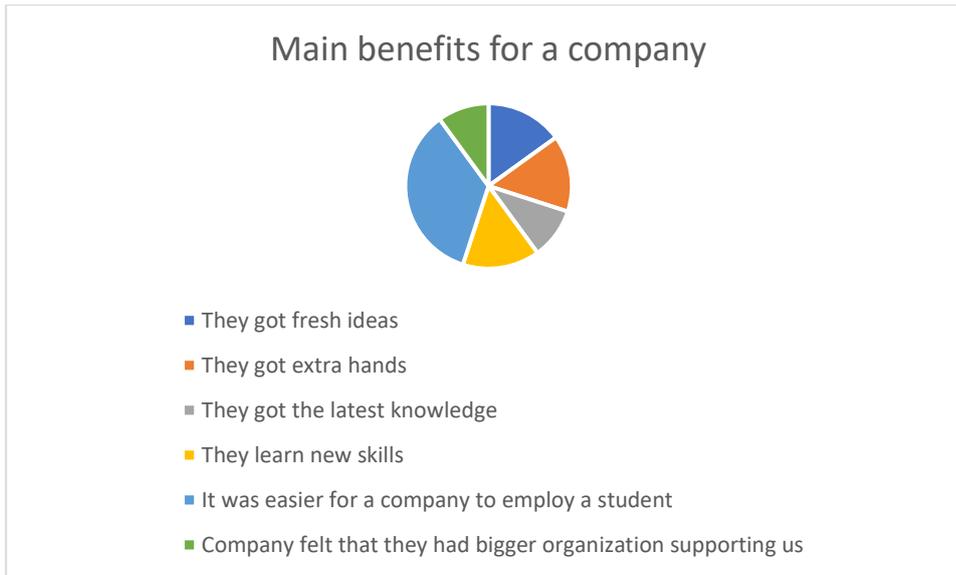


Figure 11: Benefits for a company

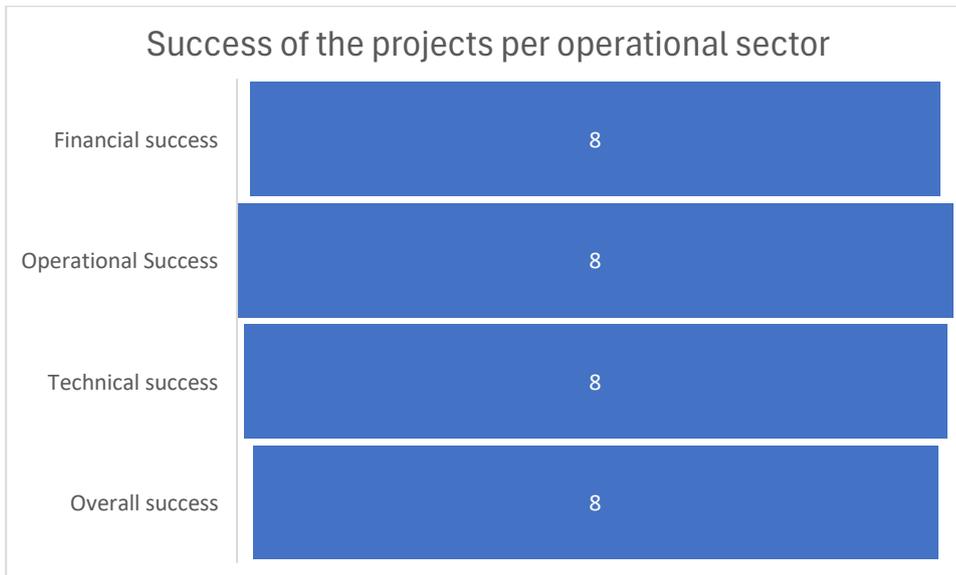


Figure 12: Success of the projects

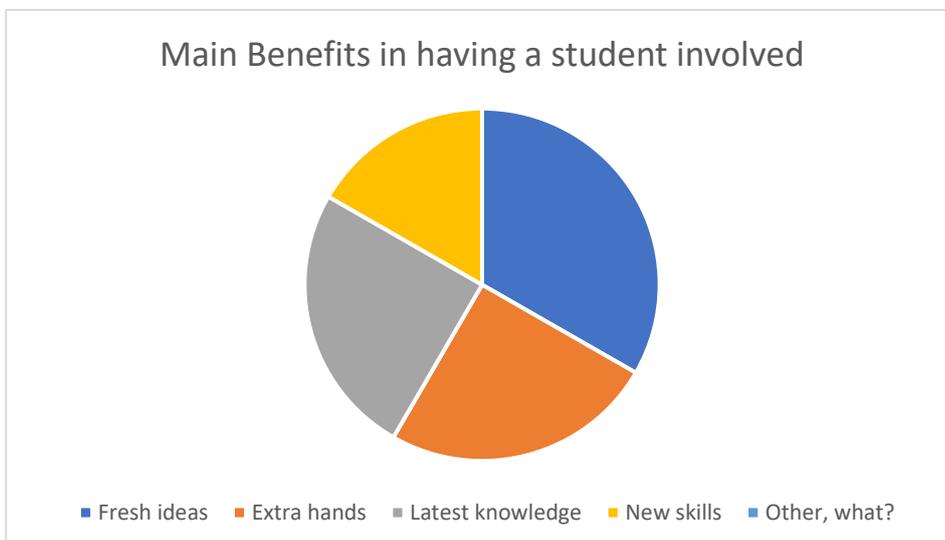


Figure 13: Benefits of having a student involved

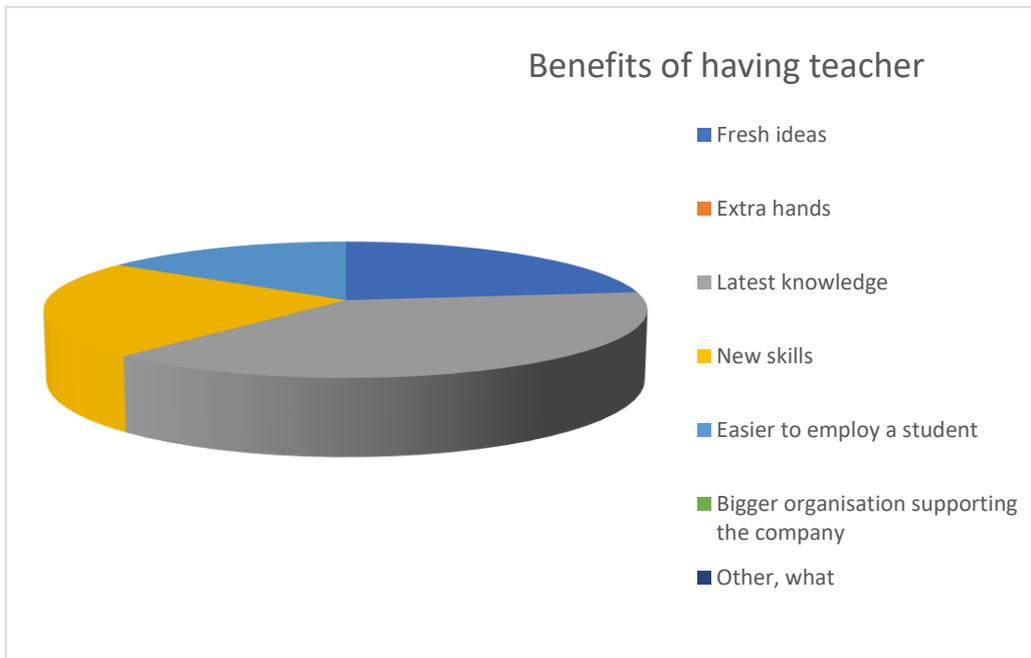


Figure 14: Benefits of having a teacher involved in the project.

Conclusion

The support model developed seems to produce successful projects in each country where it was tested. Some minor targets for development were mentioned in free speech parts, but these topics (communication, tight schedule, rules of procurement, and varying goals of the project) may be connected with country- or even organization-specific cultural properties. Thus, it is recommended, that when implementing and applying the developed support model, also these aspects will be considered case by case.

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