Technology transfer process and the handling of manageable R & D tasks in SMEs

1. Introduction

Within the framework of the project "Management and Technologies of Water, Wastewater, Waste and Circular Economy (WWW&CE)",

a) the two existing Bachelor's degree programmes

- Management and Technology Energy Efficiency and Renewable Energy and
- Business Administration for SMEs

transferred and implemented.

b) the four main modules

- Management & water, wastewater technologies,
- Waste management & technologies,
- Management & technologies of Circular Economy and
- Management concepts for sustainable economic activity

with 150 to 175 teaching hours each developed and implemented. These newly developed main modules are integrated into existing study programmes or used for postgraduate studies or further training.

In direct connection with the implementation of Bachelor programmes and of the four main modules, innovation support for companies is to be realised. For this specific support of enterprises, a concept is presented which will be applied and evaluated during the project period in connection with the testing of the four main modules.

2. Promoting innovation and SME needs

Small and medium-sized enterprises are the backbone of the economy. At the same time, they stabilise the development of the society. They are anchored in their region and can use the possibilities of international cooperation and strengthen their position without relocating their workplaces abroad. The economy of the Baltic Sea Region will be shaped mainly by small and medium-sized enterprises, which provide over 99% of all services and about 70% of all workplaces. The Baltic Sea Region, with its efficient SME economy, has excellent opportunities for economic strengthening and mastering international competitiveness. The Baltic Sea Region has the best prospects to develop into an innovative and economically strong region with international recognition.

The Baltic Sea Region has excellent potentials at its disposal in the field of knowledge economy, university education, as well as research and development. Employees are the most important asset especially in small and medium-sized enterprises. However, in this respect significant shortages are looming for the future. Securing the inflow of trainees to excellently qualified enterprises, management and labour force, as well as significant innovations decide about the future of small and medium-sized enterprises, and therefore, they are the most important support task for SMEs and crafts.

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Mastering the future requires intensive cooperation: “links are more important than products “. Information technologies come as problem solvers when needed. Cooperation’s concentrate strengths, however, they preserve independence. Trust and cooperation management is sought after. Successful enterprises and cooperative cultures have to be based on strengths, encompass integration of employees and use the creative potential of all minds. And indeed, SMEs require specific assistance for as the use of opportunities and minimising the risks.

At the time of the Hanseatic League the Baltic Sea Region has been one of the most innovative regions in the world and also today it has distinct innovation potentials at its disposal, which have to be generated and used. The international competition can be won only provided that the Baltic Sea Region will be faster and better than other regions, and again, the most innovative territory in the world.

- ⇨ Effective innovation strategies in the Baltic Sea Region have to extend region-specific strengths, support spatial cooperation of strong points and the division of labour, as well as use cultural differences as a potential for creativity.
- ⇨ Excellent fields for innovation for the SME economy apply to all domains which are currently shaped by shortages. Within the shortage areas of energy, climate and environmental protection, health, information processing and problem-solving capabilities, electronic production and communication systems, as well as personal and organisational development, the Baltic sea Region has distinguished learning and research capabilities, as well as large entrepreneurial potential at its disposal, so that especially promising starting points for targeted innovation policy could emerge here.
- ⇨ Support for research and development by universities and colleges has to turn towards the SME economy in a more intensive and consistent way. Promotion of some clusters of high-tech development is an important part of the present innovation policy. However, a specific innovation promotion for small and medium-sized enterprises must be particularly developed and intensively realised. Customer-oriented definition of innovations and a more concise policy of support is therefore important here and it can allow for example for the development of adjusted techniques and new products, new forms of organisation and the involvement of employees in the process of innovation or the transfer of technology.
- ⇨ Colleges and universities have to assume the transfer of innovation, which is an essential task for small and medium-sized enterprises, as a binding and obligatory task. Study and graduation activities should consistently incorporate the development tasks of small and medium-sized enterprises.
- ⇨ Cooperation between colleges and universities, as well as small and medium-sized enterprises has to be strongly improved and expanded. Therefore, chambers and prominent support institutions of the SME economy can assume the economic communication functions.

Promotion of SMEs must be given highest priority. Particularly important for small and medium-sized companies are long-term strategies that are implemented consistently and reliably. SMEs need a reliable framework in which they can orient themselves and conduct safe planning.
Smaller companies cannot have at their disposal corporate staff functions, as large companies’ do that would cover a variety of management tasks. In case of the medium-sized businesses those staff functions and support functions need to be rendered outside within the framework of universities and economic self-government.

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The universities are the key innovation service providers giving small and medium-sized enterprises the necessary tools and guidance, company specific and reliable, and offering them monetary benefits. Relate highest policy priorities for the promotion of SMEs:
a) the area of education, innovation and internationalization, since for many regions of the Baltic Sea the largest growth opportunities and resources for the SME sector are found here.
b) any forms of intra-and inter-company and international co-operation of SMEs, which should be systematically sourced from the chambers.

Specific innovation support for small and medium enterprises must be developed and implemented consistently. There is a need for user-and demand-driven innovation and broader support policies that actively take into account, for example, social and organizational innovations, development of appropriate technologies and new products, new forms of organization and employee involvement in innovation processes and the transfer of technology. Companies do not necessarily have to invent something themselves but could take good ideas and new technologies and modify those for themselves. Funding for the implementation of innovations in enterprises should therefore be increased.
There is an urgent needed for a broad concept of innovation that is geared specifically to the needs of small and medium enterprises. Promotion of innovation should involve development of new technologies, high-tech and appropriate tools, new discoveries and honing, product-, process-, and organizational and social innovations. A very significant added value must be sourced from all innovation subsidies, the one affecting the growth of the "human resources and organizational development" and including education, organization of work, development of partnerships etc.

The promotion of research and development by colleges and universities must turn more intensively and consistently to medium-sized businesses. Colleges and universities need to be given a mandatory task to serve as an important innovation transfer medium for the economy. In course of studies and thesis papers the issue of development small and medium enterprises should be brought up consistently. According to the principle of "region as a living laboratory" research institutions need to achieve a variety of measures to promote innovation with and for the medium-sized businesses, such as tailored research and development projects, effective knowledge sharing, development and transfer of adapted examples of best practice or the implementation of demonstration projects.

In a comprehensive study and survey of SMEs from Germany, Lithuania, Norway, Poland and Russia, the need for innovations in SMEs and their promotion was examined. The results of the study are summarised below.[1]

The role which SMEs play in the economy of the Baltic Sea Region makes creating adequate conditions for their innovation and competitiveness growth a key challenge. For this reason, it is vital to broaden our knowledge of the level of SMEs innovation and to gather data on a demand for innovation support in SMEs.

In the study, the Baltic Sea region entrepreneurs have been asked to specify a kind and a degree of intensity of innovation changes implemented in their companies. It turns out that marketing and product innovations are most frequent. Moreover, an

[1] Development and Demand of Innovation Support in the Baltic Sea Region, Baltic Sea Academy, Hamburg

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innovation climate based on openness in organization culture in these companies has proved to be an important factor in innovation implementation in the majority of the analyzed SMEs. SMEs in general have a bad opinion about the innovation climate in the country in which they operate. A difficult access to financing innovation activities by financial institutions is a common problem with building a friendly innovation climate in all the analyzed countries. Major problems which SMEs struggle within innovation implementation are: lack of financial resources, complicated legal procedures, and a deficiency of adequately qualified staff.

A cooperation with scientific and R&D circles and other institutions designed to increase SMEs innovation level is vital on the account of the specificity of SMEs, which generally have limited human resources and a low financial potential. The results of the analysis indicate that local authorities including chambers of crafts and commerce and entrepreneurs' associations are major partners in innovation cooperation for SMEs.

As far as an SMEs cooperation with R&D institutions is concerned, a leader-role is generally played by universities. Moreover, the intensity of this cooperation is quite high. The percentage of SMEs cooperating with R&D centers amounts to 50% in the Germany, 64% in Norway, 75% in Lithuania and 90.9% in Russia. Only the Polish SMEs declare a very low intensity of contacts with R&D sphere (only 16.37% of the Polish SMEs can boast of such contacts). The intensity of cooperation with R&D institutions does not translate into R&D projects in the Baltic Sea Region SMEs, however.

In the majority of the Polish, German and Norwegian SMEs, there have not been any R&D activities, when the study was conducted. The Russian and Lithuanian SMEs are exceptions to this rule, because 9 out of 10 analyzed enterprises have been involved in R&D projects. Product and service enhancements are a predominant type of R&D activities presented in the Baltic Sea Region SMEs.

Moreover, the study has shown that about 90% of the analyzed SMEs can see barriers impeding cooperation with scientific institutions. The major barrier SMEs encounter is insufficient proper funds to finance R&D and difficulties with access to external financing. However, according to the SMEs, the reasons for low intensity of cooperation with R&D sphere are scientific institutions themselves - SMEs report difficulties with initiating cooperation with scientific institutions, a lack of interest of these institutions to involve in such a cooperation, and ignorance of the economic subject matter on behalf of these institutions' representatives.

Barriers preventing cooperation between SMEs and R&D institutions (in %)

	Poland	Norway	Lithuania	Germany	Russia
Substantial costs, financial barriers	41	76	50	38	55
difficulties with starting a cooperation	29	32	33	31	36
lack of interest of R&D institutions to start a cooperation	20	28	42	19	19
legal barriers	18	4	8	X	X
R&D representatives do not understand the issue	18	64	46	25	27

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communication problems with R&D representatives	10	36	29	13	X
no barriers	11	8	X	6	18
other (if so, what kind of barri-ers)	2	x	8		x

An attempt has been made to assess the demand for innovation in SMEs when analyzing the Baltic Sea Region SMEs' innovation potential and their cooperation with R&D sphere.

It turns out that SMEs from all the countries indicate a high demand for R&D activities. Polish SMEs are an exception in this respect, because only 1 in 3 of the analyzed enterprises shows interest in R&D activities. Unfortunately, a high demand for R&D is not accompanied by SMEs' intentions to conduct such research in the future. The study shows a high degree of uncertainty among SMEs as to satisfaction of their R&D needs.

The demand for specific types of support from universities has been much lower than the analyzed above demand for periodical R&D. The entrepreneurs have been mostly interested in periodical trainings and workshops for enterprises which were preparing, or which were involved in innovative projects, as well as information meetings on specific types of and kinds of innovations. Such a low level of demand for support from universities is due to the fact that most analyzed SMEs cannot see any potential benefits resulting from cooperation with scientific institutions.

SMEs demand for innovation support from universities (in %)

	Poland	Norway	Lithuania	Germany	Russia
information meetings on types and kinds of innovations	30,7	41,6	37,5	33,3	72,3
periodical trainings and workshops for persons preparing and realizing inno-vative projects	35,5	58,3	50	20	36,6
allowing access to practical training and didactical materials	22,6	16,7	16,7	20	36,4
individual consulting directly in the company	22,6	37,5	62,5	26,7	18,2
individual consulting by phone	7,3	20,8	16,7	x	x
individual consulting via e-mail	11,5	16,7	16,7	x	x
other	2,94	x	4,2	x	x

The only positive effect of such a cooperation, which a majority of the analyzed SMEs from all the countries have agreed upon, is "launching new products and services". However, the analyzed SMEs have declared a very high demand for trainings and consulting services from scientific environment. Services, products and new technologies are desired fields of a possible cooperation

Finally, cluster involvement in innovative projects of the Baltic Sea Region SMEs as well as their intentions to engage in future cluster cooperation have been analyzed. It turns out that the majority of the companies have not been involved in a cluster so

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far. Unfortunately, the majority of the analyzed SMEs do not have any intention to start cooperation with any cluster.

The above results show that it is necessary to start intense activities destined to increase the Baltic Sea Region SMEs' understanding of benefits resulting from cooperation with scientific institutions, and the involvement in a cluster venture. Moreover, abolishment of the barriers identified in this study (mainly financial barriers) limiting both innovation implementation processes and SMEs' cooperation with scientific sphere is recommended.

Expected benefits SMEs can get as a result of their R&D cooperation with universities (in %)

	Poland	**Norway**	**Lithuania**	**Germany**	**Russia**
launching new products/services	38,1	44	62,5	50	81,8
enhancing products/services quality	21,3	60	54,1	50	63,6
optimalization of organization operations	20,1	20	37,5	43,7	45,4
improvement of cooperation with suppliers and customers	30,7	48	25	31,2	27,3
sales increase	33,8	52	58,3	25	27,3
improvement of competitive position	17,7	28	58,3	32,5	45,4
costs lowering	27,1	56	75	31,2	27,3
increase of ecological activity	7,8	24	41,6	18,7	x
increase of company's prestige	27,3	52	45,8	37,5	36,3
access to latest know-how	17,9	44	25	50	27,3
possibilities of new innovations implementations	16,1	16	62,5	31,2	27,3
possibilities of HR development	9,6	16	33,3	25	9,09
gaining new customers/increasing market share	30,2	40	45,8	25	45,4
increase of company's profitability	17,2	52	45,8	25	27,3

In summary, innovation support measures for small and medium-sized enterprises must meet specific conditions of SMEs, in particular:

- SMEs do not have any in-house staff; they require comprehensive services that equal the staff performance of large enterprises, which would offset the size-related disadvantages.
- Services must be provided in closeness to companies and accurately according to specific needs.
- Services must be accessed by the SMEs precisely at the point in time when they are really needed. Services and information on stocks are not really helpful to SMEs.
- SMEs suffer from bureaucracy, they are time- and expense-sensitive. All thenecessary services must be provided without red tape, from a single source and must be cost-effective.

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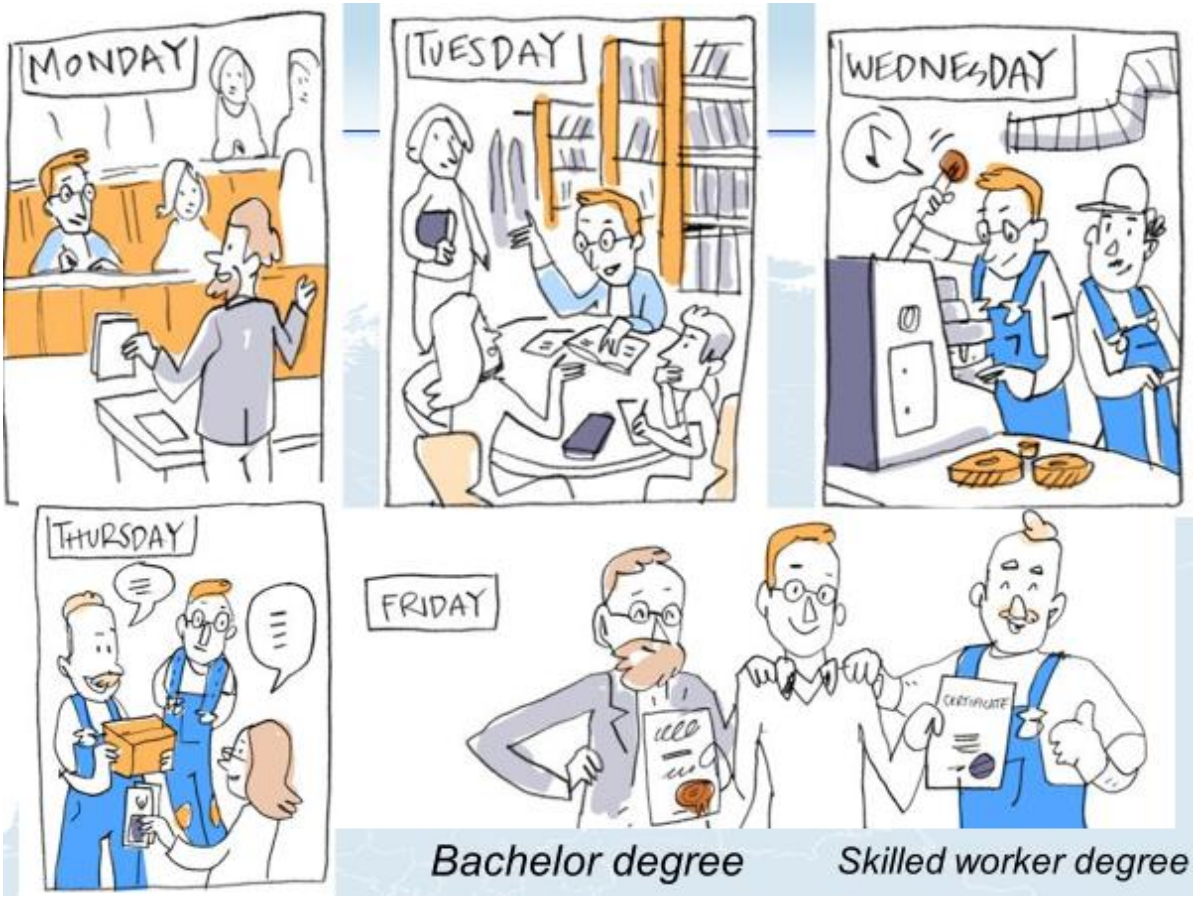
- Continuous exchange of information, stable foundation of trust, high reliability and continuity are important. This requires a permanent contact person.
- Services must be provided in the language of the SMEs and offer financial benefits to enterprises.
- Services must be of outstanding quality, match individual needs and need to be provided exactly at the right time.
- Services must encompass different areas like business administration, engineering, marketing, human resources, sales, etc. Of prime importance are also measures which promote international cooperation, because they create great potential, in particular for SMEs.

When universities and companies cooperate with SMEs within the framework of dual courses of study, this results in particularly intensive networking, direct technology and knowledge transfer and excellent opportunities for tailor-made research and development work, which is carried out in the company by students supervised by professors and lecturers.



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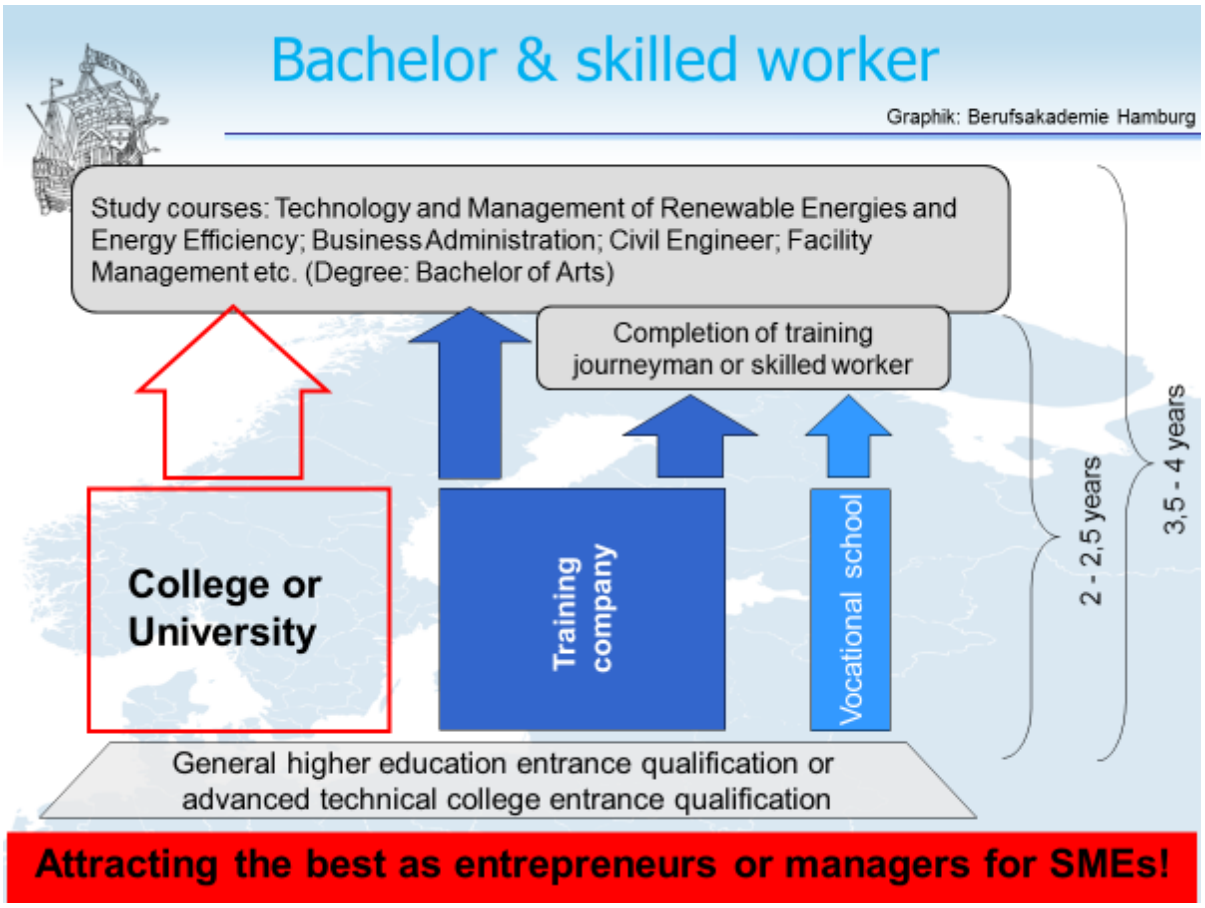
3. Promotion of innovation in conjunction with dual study programmes

The innovation capacity of SMEs is most limited by the availability and skills of entrepreneurs, managers and professionals. Due to a lack of skills and entrepreneurs and employees, innovation in SMEs is already much lower than it could and should be. With the exception of Sweden, the number of younger people of working age in all Baltic Sea countries will fall by up to 25% over the next 15 years. At the same time, qualification requirements are increasing; human resource and social skills are becoming equally important alongside specialist knowledge. Improving qualifications and eliminating the shortage of skilled workers are the most important promotional task and the key to sustainably strengthening innovation, competitiveness and growth in SMEs. The realisation of dual Bachelor's degree programmes, in which the studies are combined with relevant vocational training, makes a decisive contribution to mastering this challenge in order to attract the high demand for junior staff in innovative entrepreneurs and managers for SMEs and at the same time to emphatically strengthen innovations in SMEs.

Under dual study programs, close collaboration between academia and small medium-sized enterprises is achieved. In that regard, further welcome features are active exchanges of knowledge and experience as well as implementation of manageable research and development tasks for and by SMEs. Students will implement their semester or bachelor`s theses at companies where they complete their practical training. They will select topics that are particularly business-relevant, thus ensuring notable benefits to SMEs.



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A dual bachelor study program is composed of the following basic elements:

- Admission requirement: higher education entrance qualifications (i.e. A-levels) or advanced technical college certificate.
- Duration: 3 to 4 years maximum (depending on subject).
- About 50% of the educational period as practical training or professional activity in a company. Vocational education takes place in dual form in companies and vocational schools.
- About 50% of the educational period takes place at the university.
- Both parts of the training are coordinated with each other and are carried out in parallel. Theory can be taught in longer blocks (e.g. 3 months) or 3 days a week with shorter additional blocks.
- About 60% of the courses offered at the university are taught by full-time professors and lecturers and about 40% by practitioners from companies.
- The participants sign a contract for vocational education/activity with the company and a contract for study with the university.
- Degree: Journeyman/skilled worker and Bachelor.

The bachelor's degree also entitles the holder to follow a master's program at a university at a later date. However, the aim is that at least 80 % of the bachelor's degree holders should remain in the small and medium-sized business sector as entrepreneurs and managers and, building on their initial bachelor's degree, improve their skills within the context of ongoing continuing education.

The excellent qualifications acquired in the dual study programs are also decisive prerequisites for high innovations. In addition, the participating universities/colleges should also take part in practice-oriented research and development projects for medium-sized companies and thus promote innovations in the long-term. The study programs and innovation promotion are aimed at the identical target group, namely high-performing, medium-sized companies and their management personnel. As companies are always included in the dual study programs, there is direct cooperation between companies and universities, which can be used for knowledge and know-how transfer as well as for research and development work by companies. Research and development tasks can be carried out in various ways, for example

- Work as part of semester or bachelor theses of the participants/students
- Targeted individual assignments of the companies or consulting/know-how transfer by professors and teachers
- More complex projects with public funding (especially from the EU)
- Joint work on projects with several companies in one industry (industry association projects)

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Universities and companies are training partners in dual study programmes. About half of the entire training period takes place at the university and half at companies. Credit points required for the Bachelor's examination are earned both during studies at the university and to a certain extent during training and work in the company. The change of qualification in the university as well as in the company can take place in block form (e.g. three-month blocks) or in daily form. The dual study programmes are Bologna-compliant and lead to a recognised Bachelor's degree. The qualification in the company can be combined with a vocational training with the degree "journeyman" or "skilled worker".

The close cooperation between universities and companies in teaching offers optimal conditions for the promotion of innovation by SMEs through universities. The following starting points and funding measures are particularly relevant.

a) The professors and lecturers of the universities must see themselves as equal partners of the companies. They must regularly visit the companies, check their innovation needs, provide advice, transfer new technologies, best practices, etc. and accompany implementation in the companies. The more effectively companies experience such innovation support, the greater their willingness to participate as training partners.
b) In addition to personal exchange and transfer, universities shall maintain a comprehensive written and electronic transfer. For example, regular publication of newsletters, innovation platforms, publications of prepared research results, dialogue forums, etc.
c) Approximately 60% of the teaching at the university is carried out by the academic staff of the university and about 40% by practitioners from the

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companies. In connection with this, the practitioners should continuously bring the needs, topics and tasks of the companies for innovation development into the research and development work of the universities, so that an SME-specific orientation can be achieved. At the same time, through the participation of practitioners in teaching, entrepreneurial thinking, modern management methods, etc. can be transferred to the universities and thus future-oriented organization, administration, work processes, etc. in the universities.

d) Since the students spend half of their time in the university and half in the company, a personal transfer of knowledge, new technologies, best practices etc. from the universities to the companies can be optimal. Equally intensively, questions, concerns, tasks, etc. can be transferred from the companies to the universities via the students and the work of the universities in research and teaching can be stimulated and shaped in a way that is close to the company.

e) Topics and tasks for semester or bachelor theses should be formulated by the participating companies according to their innovation needs, which are processed by the students in the companies after review and approval by the university. This work process is accompanied by professors and lecturers in the companies who advise both the students and the companies on the development work and subsequent implementations. In this way, innovative tasks and manageable research and development tasks in the companies are realized in a targeted manner and without additional costs.

f) For the realisation of complex research and development tasks of SMEs, additional financial resources must be obtained. National, but also especially the EU innovation support programs are too bureaucratic for small businesses; the cost of application and project management is in disproportion to the potential

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outcome of the project and is too much for many companies. Another obstacle to innovation is that SMEs cooperate too little in research and development, in contrast to large companies. Universities must therefore develop their role as an innovative service provider for the SMEs. They can advise companies on formulating project proposals, or even serve as an applicant's representative and project manager. Industry association projects with several SMEs should also be developed by the universities, applied for funding and carried out by the universities as lead partners.

During the project four main modules will be developed for Bachelor's programmes:

- Management & water, wastewater technologies
- Waste management & technologies,
- Management & technologies of Circular Economy
- Management concepts for sustainable economic activity

During the testing of these modules, the above-mentioned innovation subsidies are to be implemented and tested at the same time. The focus is on the implementation of manageable research and development tasks (see e). During the course of the project, the trials of the four main modules as well as the trials of the innovation support measures will be evaluated.

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