Study program documentation Bachelor's degree in Management and Technology at TUM Campus Heilbronn

Part A
School of Management
Technische Universität München

General Information:

- Organisational assignment: School of Management
- Title: Management and Technology on TUM Campus Heilbronn -Technischen Universität München
- Degree: Bachelor of Science (B.Sc.)
- Regular study period and Credits: 6 semester an 180 Credit Points (CP)
- Type of study: Full time, attendance course
- Admission: Aptitude assessment procedure (EFV – Bachelor)
- Start date: Winter semester (WiSe) 2019/2020
- Language: English
- Supplementary information: The program is offered at TUM Campus Heilbronn and the third semester at the TUM Campus München.
- Responsible for the study program: Academic Program Director
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1 Course objectives

1.1 Purpose of the course

The bachelor's degree program in Management and Technology (BMT) at the TUM Heilbronn Campus aims to train students who can solve social and economic problems at the interfaces or interdependencies between business administration and the engineering/scientific field of digital technologies.

The multifaceted interdependencies between the individual organizational areas of companies as well as the progressive dissolution of traditional departmental boundaries are changing the nature of the qualifications required and demand interdisciplinary thinking and action from its participants. Particularly at the interface between the business and the technical or engineering/scientific divisions of a company, communication and know-how barriers repeatedly arise in practice as a result of a lack of knowledge of the respective other specialist discipline and a lack of understanding of the respective other subject culture. In this context, career starters increasingly have to make decisions at the interface between management and the natural sciences/engineering. Managers who have a basic understanding of the natural/engineering sciences can understand the viewpoint from the specialist disciplines much more quickly in interdisciplinary teams with natural scientists and engineers and translate it into management decisions. In this way, they generate competitive advantages for companies and avoid higher costs, lower quality and loss of time. The interface competence of individuals is also an important aspect in small and medium-sized enterprises (SMEs) due to the lower level of differentiation of activities.

Throughout Germany, there are a large number of small and medium-sized enterprises. The Heilbronn-Franken economic region in particular is characterized by a strikingly high density of family businesses that are both highly specialized and global leaders. These so-called "hidden champions" often manufacture only one single product, but have specialized so strongly in this area that their accumulated know-how has made them world market leaders for precisely this product. One example is ebm-papst, a global innovation leader in the manufacture of fans and electric motors. The combination of family-run companies that simultaneously operate globally therefore offers an interesting environment for the research focus areas of the TUM Heilbronn Campus.

Advancing digitalization, the increasing influence of technology on business models and the resulting disruption of the global economy affect global corporations and hidden champions alike. The challenges faced by companies and their employees are similar. Today's world is characterized by volatility, uncertainty, complexity and ambiguity - the so-called VUCA world. Both global corporations and family businesses - companies of all sizes and in all industries are being forced to face this VUCA world and to question all areas of their business.

Digital technologies in particular are gaining importance in this context. Developments in recent years with major implications for companies worldwide represent, for example, the technologies blockchain, cryptocurrencies and Internet of Things. In order to be able to integrate these technologies sensibly into their operations and incorporate them into their strategies, companies need managers who have understood these technologies and their sensible use and who can also confidently assess them in a business administration context. Educational institutions must take this change into account and enable their graduates to think systematically and equip them with technological understanding. As one of the leading technical universities in Europe, TUM and the School of Management have made it their strategic task to educate responsible decision-makers.

For the Heilbronn-Franken region, this means that students at TUM Campus Heilbronn will be equipped with the necessary technological knowledge and awareness of the future challenges in terms of the digital transformation on businesses and companies. The TUM Campus Heilbronn offers the opportunity to pay special attention to SMEs and family-run companies.

1.2 Strategic importance of the study program

With its Bachelor's, Master's and continuing education programs, the School of Management offers a comprehensive program portfolio that takes into account the implementation of the idea of lifelong learning and the mandate of the Bavarian Higher Education Act of a range of studies and continuing education. In line with the strategic orientation of the School of Management, all programs provide international management education at the interface of economics with engineering, natural and/or life sciences, including medicine, with a strong entrepreneurial component. In addition, there is also a focus related to sustainability.

The aim is to enable graduates with a sound, internationally oriented management education and an understanding of engineering, natural or life sciences for a responsible role in business and society. This is promoted, among other things, by active memberships of the professors of the School of Management in numerous academies and advisory boards that deal with important decisions in science, business and society. In addition, a number of professors in the School have secondary memberships in other faculties/schools or members of other faculties have secondary memberships in the School of Management.

The content of the programs varies due to the different admission requirements and the individual educational background of their applicants. The School of Management's programs in economics can be divided into three categories:

(1) (1) Interdisciplinary management programs with a focus on engineering, natural and/or life sciences and sustainability: These include the Bachelor's degree programs in Technology and Management-Oriented Business Administration (TUM-BWL) at the TUM Campus in Munich, the Bachelor's degree program in Management and Technology at the TUM Campus in Heilbronn and the Bachelor's degree program in Sustainable Management and Technology at the TUM Campus in Straubing, as well as the Master's degree programs in Management and Technology (MMT), Finance and Information Management (FIM), Consumer Science (MCS) at the TUM Campus in Munich and the Master's degree program in Sustainable Management and Technology at the TUM Campus in Straubing.

(2) Programs that provide basic management training for students with a first technical or scientific degree (usually a bachelor's degree): The two Master's programs in Management (MiM) at the TUM Campus Munich and at the TUM Campus Heilbronn fall into this category.

(3) Programs in the area of continuing education: In the part-time Executive MBA programs for professionally experienced individuals with management responsibilities, participants are developed into effective and responsible managers by broadening knowledge, expanding their competencies, and developing their personalities. The continuing education master's degree program in Management & Innovation at the TUM Campus Munich and at the TUM Campus Heilbronn and the other planned continuing education programs expand the portfolio of programs to

include the target group of young professionals with initial work experience and no leadership experience (yet). The certificate programs are subject-specific programs both for the further development of managers. They are offered on a part-time basis and, in the area of Customized Programs, are set up specifically for each company.

The bachelor's degree program in Management and Technology at the TUM Heilbronn Campus is in line with the School of Management's vision of playing a prominent international role at the interface between management and technology. The aim is to enable graduates with a sound, internationally oriented management education and an understanding of the natural sciences/engineering to take on a responsible role in business and society.

The bachelor's degree program in Management and Technology at the TUM Heilbronn campus corresponds with the focus of the School of Management's teaching and forms - along with the bachelor's degree TUM-BWL at the Munich location - the supporting pillar in the bachelor's area of the School of Management's program portfolio (Figure 1).

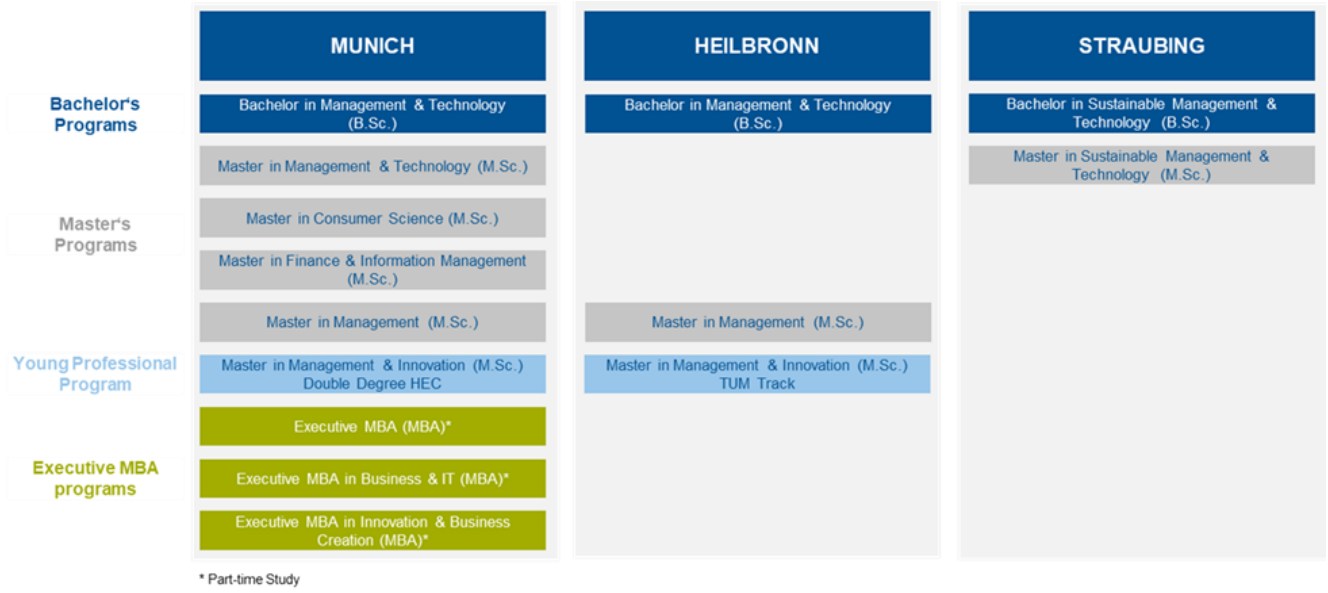

Figure 1: Study programs offered by the School of Management: Bachelor's program (dark blue), Master's programs (gray), Master's program with work experience (light blue), paid Master's programs with work experience (green)

At the new TUM Campus Heilbronn, which started its studies in the winter semester 2018/19 with the master's program in Management and the part-time master's program in Management and Innovation, the School as well as the students have access to an ideal environment for intensive research, teaching and learning. The campus is located at the educational campus of the Dieter Schwarz Foundation (DSS). This project that initially brings together different educational institutions on a local basis and offers a life-phase-oriented learning spectrum: from early childhood education to academic degrees and continuing education in the workplace. A research focus of the School of Management is on the management of digital technologies, entrepreneurship and family businesses.

In addition, the bachelor's degree program in Management and Technology at TUM Campus Heilbronn is also in line with TUM's mission statement of being an entrepreneurial university. Numerous contents of the study program deal with innovations and entrepreneurship. In addition, a central concern of the program is to promote the entrepreneurial spirit of students.

The bachelor's degree program in Management and Technology at the TUM Heilbronn Campus is basically the same program that is also offered at the TUM Munich Campus as TUM-BWL. However, the engineering/scientific subject "Digital Technologies" is only offered at TUM Campus Heilbronn. The focus subject fits perfectly into the thematic focus on Management of Family Businesses and Management of Digital Transformations at TUM Campus Heilbronn and the research focus of the School in general.

As the first university in Heilbronn, the TUM Campus will represent a formative role in education and research as well as in long-term economic development. According to the EU Regional Innovation Scoreboard 2019, the Stuttgart region, which includes the Heilbronn-Franken region according to the NUTS level system, is not only one of the most innovative regions in Germany, but also in Europe. Within Baden-Württemberg, the Heilbronn-Franken region is characterized by a high innovation dynamic in recent years.

The bachelor's degree program in Management and Technology is fundamentally interdisciplinary. The program offers the opportunity to meet the social challenges described above by overcoming disciplinary boundaries, which in many cases have hindered or prevented the development and, above all, the implementation of solutions. The main topics of the TUM Campus Heilbronn in the area of Management of Digital Transformation and Management of Family Businesses particularly reflect the substantive challenges of the companies from the Heilbronn-Franken region. Thus, the medium-sized and often still family-run companies in the region, which are recognized worldwide as highly innovative technology leaders with distinctive production competence, are at the center of the area of Management of Family Businesses. Due to the developments in the context of the fourth industrial revolution ("Industry 4.0"), these companies are challenged to develop new business models and fields of activity in order to continue to be successful in the market. In such a region, the content focus of an educational institution can help to address the particular challenges of small and medium-sized enterprises (SMEs).

The bachelor's degree program in Management and Technology at the TUM Heilbronn Campus prepares students for a career directly after graduation as well as for related master's degree programs, such as the consecutive master's degree program in Management and Technology at the School of Management at the TUM Munich Campus.

2 Qualification profile

The qualification profile complies with the requirements of the Qualifications Framework for German Higher Education Qualifications (Hochschulqualifikationsrahmen - HQR) according to the resolution of 16.02.2017 of the Hochschulrektorenkonferenz und of the Kultusministerkonferenz. According to the HQF, the qualification profile for the Bachelor in Management and Technology can be defined on the basis of the requirements (I) Knowledge and Understanding, (II) Use, Application and Generation of Knowledge, (III) Communication and Cooperation and (IV) Scientific Self-Conception/Professionalism. The formal aspects according to HQR (entry requirements, duration, graduation options) are detailed in chapters 3 and 6 as well as in the corresponding subject examination and study regulations.

The bachelor's degree program in Management and Technology lasts 3 years (180 credits), is a full-fledged first professional degree and thus enables employment qualification in a broad professional environment. The program prepares students both for employment as a generalist, for example in a management consulting firm, and for jobs in the various disciplines of business administration (e.g. marketing activities, auditing), through the possibility of specialization in the field of family businesses, especially in family-owned businesses. In addition to business administration topics, transfer knowledge to other fields, especially in the natural science/engineering subject of Digital Technologies is to be built up. The program is characterized by a high degree of internationality, yet important national fundamentals, such as bookkeeping and accounting, are also covered, which can be intensified by taking appropriate elective modules. The program has a fundamental research orientation. Significant research findings in the area of digitization and the management of family businesses by the professors involved are incorporated into the teaching. However, emphasis is also placed on an application orientation as well as on promoting a sense of responsibility and entrepreneurial spirit.

Furthermore, the Bachelor in Management and Technology prepares students for entry into a more in-depth master's program.

2.1 Knowledge and understanding

Graduates have a broad knowledge and critical understanding of business fundamentals. They are familiar with German and international accounting and various cost accounting systems. They know the basic concepts of entrepreneurship including basic psychological processes and characteristics of entrepreneurs as well as possible development paths of young companies. They know the ethical significance of economic theories, important business strategies as well as the basics of employee motivation, teamwork and communication in an economic environment. They have knowledge of the basic concepts of empirical research, business planning, logistics, financing theory, financial control and project evaluation. Graduates also develop an understanding of the basic concepts of marketing (e.g., customer value, segmentation, marketing mix) and innovation (e.g., market and competitive analysis, research and development processes).

Graduates are able to assess the applicability of advanced methods and regulations in business. They are able to apply the most important business management terms and methods in related areas of economics, law and statistics/mathematics that are relevant for business administrators. In particular, they know the basics of micro- and macroeconomics (e.g. market equilibria, price formation, influence of currency and interest rate changes on economic developments), the basics

of German or international business and private law and essential basics of descriptive and inferential statistics as well as business and engineering mathematics. Graduates will be able to identify and evaluate the connections between these fields and business issues.

Through the engineering subject Digital Technologies, graduates have elementary knowledge in electrical and information engineering, mechanical engineering and computer science. These are, for example, basic knowledge of computer and data science, programming skills in Java as well as knowledge in dealing with large amounts of data. This knowledge is necessary for the fundamental understanding of modern digital technologies (e.g. artificial intelligence). In addition, graduates have knowledge of the potential applicability of new digital technologies in a business environment (e.g. logistics, development of digital business models, machine learning) and understand the advantages and disadvantages of these new digital technologies compared to existing, non-digital operational processes and business models. Ultimately, graduates of the program understand whether and in what way the introduction and application of new digital technologies can lead to an economic advantage for companies.

2.2 Use, application and generation of knowledge

Graduates of the bachelor's degree program Management and Technology are able to derive research questions, form hypotheses and test these using predominantly quantitative methods when dealing with business management problems on the basis of central business and economic theories (e.g. company and agency theory, institutional economics, behavioral science theories). They are able to conduct application-oriented studies on scientific and business issues and develop solutions for complex tasks in a team. They can transfer terms, concepts and methods of business research into practice and apply them there. Graduates are able to evaluate new digital technologies and assess them with regard to a possible business application. They can apply machine-learning methods to develop solution approaches. They can use their basic knowledge of digital technologies in the development of new products, business models and corporate strategies.

2.3 Communication und Cooperation

Graduates of the Management and Technology program possess intercultural sensitivity and work successfully and appreciatively with people from other cultural backgrounds. They are able to objectively reflect and take into account different points of view and the interests of others involved in conflicts and in projects - especially at the interface between technology and business administration. In addition, they interact responsibly with others and find fact-based solutions which they can explain convincingly to both specialists and representatives of other disciplines on the basis of their sound theoretical knowledge.

Graduates are able to use new digital technologies to support project teams from different disciplines in finding and developing solutions. They are able to use digital technologies to adapt operational communication channels. Graduates are able to act as mediators, especially at the interface between management and technology, as they have acquired a critical understanding of both worlds and can therefore understand and assess the different perspectives and interests of the respective specialist representatives (engineers, managers, etc.). Graduates of the Bachelor of Management and Technology at the TUM Heilbronn Campus are immediately employable in internationally operating companies and in international teams after graduation due to their studies in English.

2.4 Scientific self-image/professionalism

Graduates take ethical aspects into account when making decisions and can work on projects with determination and perseverance. They can set themselves work and behavioral goals and achieve these goals on the basis of a self-developed schedule. In addition, graduates can recognize their own strengths and weaknesses, building on this and set their own priorities in their work. They are aware of the consequences of entrepreneurial decisions and reflect on their professional activities against the background of social and ethical responsibility.

Graduates are able to develop a diverse, modern and technologically oriented professional self-image. They are familiar with the perspectives of engineers as well as with the thought processes and decision-making behavior of business economists. They use this knowledge for their own decisions and can align their professional actions with the standards and goals of both professional fields.

3 Target Groups

3.1 Target Audience

The target group for the bachelor's program are high school graduates and professionally qualified students from Germany and abroad who have analytical skills, a high affinity for mathematical and quantitative approaches, and can communicate complex chains of reasoning clearly and comprehensibly. In addition, applicants should demonstrate an interest in business administration as well as natural sciences/engineering, in the case of the latter, particularly in the area of new digital technologies. The simultaneous development of these skills is crucial in order to be able to implement the business side of the studies on a quantitative and qualitative level on the one hand, and to enhance the enthusiasm and motivation to deal with a natural science/engineering subject on the other.

3.2 Prior knowledge

An aptitude assessment procedure (EFV) ensures that applicants have mathematical-logical skills, their problem-related application to issues at the interface of technology and economics, and clear and precise reasoning skills. The applicant's suitability for the program is assessed in the first stage of the procedure by the grade point average and grades in the school subjects English and mathematics, and optionally in chemistry, biology, physics or computer science. After evaluation in the first stage, applicants are either admitted immediately or invited to a group selection interview, depending on the score achieved.

The bachelor's program is completed in English throughout. Applicants must therefore demonstrate a sufficiently high level of fluency in the English language.

3.3 Target figures

Basically, the planned annual target size for students in a cohort in the Bachelor Management and Technology at TUM Campus Heilbronn is 30 students in the first year and 60 students in the second year and is to be increased to 150 students per cohort in the final expansion. Approximately 20%

international students were expected at the planning stage. In fact, the proportion of international students is 40% in the 2019 cohort and 52% in the 2020 and 2021 cohorts.

Currently, the entire School of Management educates approximately 40% of its students at the bachelor's level, 52% of its students at the master's level, and 8% of its students in executive education at all of its campuses.

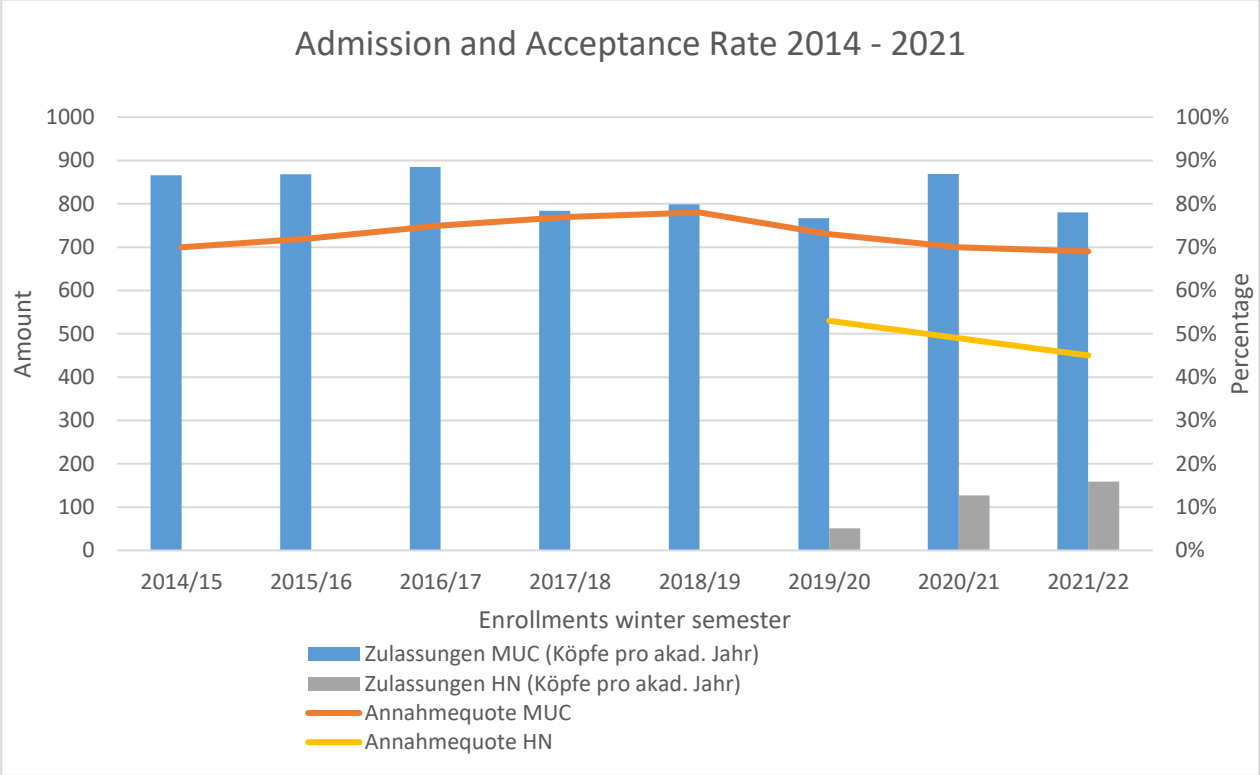

Figure 2: Development of admissions and acceptance rates of the Bachelor TUM BWL over the course of the years at the Munich and Heilbronn campuses 2014-2021

At the TUM Heilbronn Campus, good numbers of applicants (210) can be recorded for the Bachelor in Management and Technology from the start in 2019 with an increase of almost 92% in 2020 to 403 applications and a further increase of 52% (612) in 2021.

The acceptance rate was 53% in 2019 and 45% in 2021. The high acceptance rate demonstrates the attractiveness of the program.

For Heilbronn, the percentage of women in the program for the winter semester 2021/22 is 37%.

34 (48 %) students in the winter semester 2021/22 will come from Germany, 11 (15 %) from the European Union / European Economic Area and 26 (37 %) from third countries.

4 Needs Analysis

The Bachelor in Management and Technology can prepare students for direct entry into a profession as well as for a more advanced master's degree program. The option of studying entirely in English means that international students can also be attracted to the program. At the same time, the degree program contributes to the expansion of TUM as a brand in the international environment, because graduates with an interdisciplinary profile enjoy great popularity among internationally oriented companies and renowned management consultancies. The interdisciplinary education in the natural sciences/engineering as well as in business administration is an ideal prerequisite for business start-ups.

The ability to work at the interface between the two entrepreneurially relevant areas of management and technology, to mediate and to move confidently, represents a major competitive advantage for employees. This is regularly confirmed: The importance of studying at this interface has been emphasized in the past by both the company representatives of the TUM Career Service Center's cooperating companies and the members of the School of Management's Advisory Board. In the meetings of the Advisory Board, the board members emphasize the need to recruit graduates with business fundamentals and technical understanding in the field of digital technologies in order to fill innovation-intensive company areas such as research and development with them and to be able to make the knowledge gained economically usable. In addition to their suitability in terms of content, graduates of the Bachelor in Management and Technology can also be employed in internationally operating companies immediately after graduation thanks to the option of completing their studies in English.

Furthermore, surveys among graduates of the Bachelor TUM-BWL at the TUM Campus Munich indicate the high attractiveness of TUM-BWL graduates on the job market. Not least because of the very good career prospects, around 25% of graduates enter the job market directly after graduation and of these 25%, three quarters have already signed an employment contract with their future employer before graduation. In addition to direct entry into various departments (e.g. accounting, controlling, finance, R&D or marketing departments of companies or other organizations), entry into a trainee program (rotation in various departments) or in the consulting field is also possible. On average, 60% of graduates who go directly into the job market work in an interface position between management and technology.

Ultimately, the bachelor's degree program in Management and Technology offers a specialization option with the promising engineering subject Digital Technologies, which should better prepare graduates for the demands of the modern working world. The engineering subject is designed to build up specialist and methodological knowledge in the fields of computer science, mechanical engineering and electrical engineering and information technology. Care is taken to ensure that this knowledge is relevant for use in both corporate groups and medium-sized companies. The conditions of global competition are changing rapidly in the digitalized world - regardless of the size of the company. This includes not only the innovations in all business areas due to digitalization, but also the influences of trends such as Industry 4.0 and the Internet of Things, as well as the use of digital technologies such as blockchain, artificial intelligence and virtual reality, to name just the most important. To remain competitive, companies therefore need qualified graduates who are familiar with these trends, understand the technical workings and can also respond adequately to the business challenges of the global market. In a survey of the largest family businesses in Germany, around 43% of companies stated that the central obstacle to digitization is a lack of knowledge

among employees in this area. A study on the qualification needs of SMEs in the context of digitization also identified a high qualification need in terms of technical and scientific knowledge as well as management and business organization aspects of digitalization. Within the framework of Horizon 2020, the EU Commission has defined seven societal challenges that Europe is currently facing. These are:

- Health, demographic change and well-being;
- Food security, sustainable agriculture and forestry;
- Safe, clean and efficient energy;
- Smart, green and integrated transportation;
- Climate action, environment, resource efficiency and raw materials;
- Europe in a changing world - inclusive, innovative and reflective societies;
- Secure societies - protecting the freedom and security of Europe and its citizens.

These challenges will also broadly define the respective national and international labor markets and economic sectors. A central factor here is the successful development and use of technology as a whole and digital technologies in particular. For example, in transportation, algorithms are being used to automatically calculate the best transportation and supply routes to handle larger freight and smaller deliveries more efficiently. Modern agriculture relies on drones to better monitor growth in fields and predict weather changes in advance. The finance and insurance industries are adopting technologies such as blockchain, artificial intelligence, and deep learning into existing processes at an increasing rate to track transactions, set up contracts, and estimate investments. Technology-enabled solutions will continue to be developed at the greatest speed in all of the aforementioned areas and industries, increasingly transforming economic sectors. In order to meet this trend and the associated challenges with appropriate expertise in the field of technology and management, appropriately trained specialists are needed. This shows once again that the competencies and skills of the graduates are in high demand and future-oriented on the national but also international markets.

In the Heilbronn-Franken economic region, the demand for graduates who can demonstrate this interface competence is particularly high. The Heilbronn region is home to numerous, mostly technology-oriented companies, in particular many family-run small and medium-sized enterprises (SMEs), which regularly generate more than a third of the total turnover of German companies and are therefore of great economic importance. According to the study "Project Future: Heilbronn-Franken 2020", these companies have a very high innovation potential. This is because they can only maintain their excellent position in international competition through the increased use of new technologies and the expansion of their product range. This is precisely where the need for (highly) qualified employees lies, which according to the study is to be seen as a central weakness of the Heilbronn-Franken region. Compared to well-networked large companies, companies also have a greater demand and need for information, knowledge and technology transfer in the area of digitalization. Since the local economy is facing the challenges of the digital transformation, the real case studies can be discussed directly in the teaching of students with company representatives. Thus, the strong connection between science (at top international level) and practice in the education of entrepreneurial talents is ensured.

In summary: The job marketability of graduates of the Bachelor in Management and Technology can be rated as very high. By providing basic management skills, an opportunity to specialize in the area of Small and Medium sized Enterprises (SMEs), experience in dealing with other cultures and the explicit promotion of English language skills, graduates of the Bachelor in Management and Technology at the TUM Heilbronn Campus are prepared for jobs in companies of different sizes, market orientation and industries.

In general, the bachelor's degree program in Management and Technology prepares graduates in terms of content and methodology for further master's studies in business administration. Graduates are also optimally prepared for the master's program in Management and Technology (TUM-BWL) in Munich, since this master's program, which is also offered at the School of Management, continues the same principle as the bachelor's program, i.e. business studies with an engineering and/or natural science subject. Graduates of the Bachelor in Management and Technology at the TUM Heilbronn Campus have the opportunity to attend the basics of a second engineering or natural science subject ("Minor") in the Master in Management and Technology. An in-depth study of economics and law can also take place at the master's level. Graduates of the Bachelor in Management and Technology also have access to the "Master in Consumer Science" (formerly "Master in Consumer Affairs") in Munich and to the master's programs "Bioeconomy" and "Renewable Resources".

5 Competition anlysis

5.1 External competitive analysis

In Germany, a large number of different bachelor's degree programs are offered that focus on training at the interface between business administration and engineering or the natural sciences. Most of these bachelor's degree programs focus on engineering science education. Thus, more than 50% (usually 60-70%) of the associated course offerings comprise modules from an engineering/scientific discipline, while the remaining course offerings come from the business sciences. Examples of this are, above all, courses in industrial engineering and business informatics. One exception is the Digital Management degree program, which also has a management focus.

Table 1 shows the differences between individual major courses of study:

Tabel 1: Selected Bachelor's degree programs at the interface of engineering or natural sciences and business administration

University	Degree	Engineering / natural science focus
Clausthal (TU)	Digital Management	Computer Science, Data Science
Karlsruhe (KIT)	Industrial Engineer	Computer science, mechanical engineering, electrical and information engineering, civil and environmental engineering, chemical engineering, process engineering
Aachen (RWTH)	Industrial Engineer	Mechanical engineering, civil engineering, electrical power engineering, materials and process engineering
Darmstadt (TU)	Industrial Engineer	Mechanical engineering, civil engineering, electrical engineering and information technology
University Hohenheim	Business Informatics	Computer Science
University Mannheim	Business Informatics	Computer Science
University Stuttgart	Technically oriented business administration	Mechanical Engineering
Kaiserslautern (TU)	Business administration with technical qualification	Mechanical engineering, process engineering, electrical engineering, computer science, civil engineering

The difference to the bachelor's program in Digital Management at the Clausthal University of Technology results from the scientific/technical component of the program. Here, the focus is only on computer science and data science, while the Digital Technologies focus of the Management and Technology program is made up of modules from various faculties and schools, thus creating an interdisciplinary perspective on the subject area.

A major difference between the bachelor's program in Management and Technology and the industrial engineering programs is the focus of the program's content. The bachelor's program in Management and Technology consists of approximately 2/3 economics content (and its related

areas such as law) and 1/3 content with a technical orientation. The programs listed in the table, on the other hand, have an inverse distribution or focus on engineering/natural sciences.

In bachelor's degree programs in information systems, exemplified here by the University of Hohenheim and the University of Mannheim, the focus is increasingly on computer science; only a few economics and law subjects are included in the curriculum. In contrast, students in the Management and Technology bachelor's degree program at the TUM Heilbronn campus acquire the broad knowledge of a business economist with an additional qualification in the field of digital technologies during their studies.

In the Technically Oriented Business Administration program at the University of Stuttgart, the business and legal skills are similarly emphasized as in the Management and Technology program at the TUM Heilbronn Campus, but the engineering focus in Stuttgart is on mechanical engineering. The Bachelor TUM-BWL with the engineering subject Digital Technologies offers a broad range of courses in this area: The engineering subject Digital Technologies is the result of cross-faculty and cross-disciplinary cooperation between the faculties of Computer Science, Mechanical Engineering, and Electrical Engineering and Information Technology. This creates an interdisciplinary engineering subject with the Digital Technologies offering.

Due to its special characteristics, the Management and Technology program also attracts great interest from international applicants. On the one hand, this is due to the fact that it corresponds with the core competence of TUM due to its connection between business administration and digital technologies, and thus this strong brand can also contribute to attracting students. In addition, the program offers a wide range of electives and - as outlined in Chapter 4 - is linked to important societal challenges that can be addressed through effective collaboration between management and digital technologies. Students of the Bachelor's degree program in Management and Technology should be enabled to use their acquired knowledge not only to solve specific business problems, but also to solve challenges facing society as a whole. Due to the fact that the program is taught in English, it will certainly attract a much larger number of international applicants in the future and should thus - in line with the School of Management's vision - contribute to being an internationally visible business school at the interface between management and technology. And this not only at the Munich location, but with Heilbronn also outside Bavaria.

5.2 Internal competitive analysis

The Technical University of Munich offers three additional undergraduate Bachelor's programs at the interface of economics and engineering and/or natural and/or life sciences: the Bachelor's program in Management-oriented Business Administration of the School of Management at the TUM Campus Munich, the Business Information Systems program, supervised by the Faculty of Computer Science, and the Mechanical Engineering program with a focus on mechanical engineering and management, supervised by the Faculty of Mechanical Engineering.

In contrast to the Bachelor TUM-BWL at the TUM Campus Munich, the Bachelor in Management and Technology at the TUM Campus Heilbronn offers additional profiling possibilities in the field of business administration with the competence fields Management of Family Businesses and Management of Digital Transformation. Furthermore, the bachelor's program at TUM Campus Heilbronn exclusively offers the natural science/engineering subject Digital Technologies. Whereas the Bachelor TUM-BWL at the Munich campus offers the engineering, natural or life science subjects Chemistry, Computer Science, Electrical Engineering and Information Technology, Mechanical

Engineering, Computer Engineering and Medicine and at the Straubing campus the subject Renewable Resources. Thus, the two bachelor's degree programs are not in direct competition with each other, but offer students the possibility of a targeted study of the above-mentioned subject areas according to their respective interests through their individual profiles. In contrast to the engineering, natural or life sciences concentrations at TUM Campus Munich, the "Digital Technologies" concentration differs in that the various fields from electrical engineering and information technology, mechanical engineering and computer science are combined in such a way that the various components of digital technologies are covered across all faculties.

The other two courses at the interface of economics and engineering or natural sciences have a very low proportion of economics and law modules: the proportions are only 13% (business informatics) and 12% (mechanical engineering and management). Students in these fields thus attend a kind of mirror-image counterpart to the bachelor's degree program in Management and Technology - a fully-fledged education in computer science or mechanical engineering with a few additional qualifications in economics or law. These two programs are thus not in competition with the bachelor's program in Management and Technology, but offer complementary courses to students with different interests, goals and abilities.

6 Program Structure

The undergraduate bachelor's program comprises six semesters and consists of the following two sections: In the first four semesters, students are taught the fundamentals of business administration, economics, law, mathematics and statistics, as well as the fundamentals in the engineering subject Digital Technologies. A special feature of this program is that the third semester takes place entirely at the TUM Campus Munich and Garching instead of at the TUM Campus Heilbronn and exclusively teaches knowledge, skills and methods from the natural science/engineering subject Digital Technologies. In the fifth semester, the economics/engineering elective is scheduled. In addition, this semester can also be used for the so-called "mobility window", e.g. a semester abroad can be completed. In semester six, the content and methods of the natural science/engineering subject are taught in more detail by means of a project work carried out in cooperation with a chair at the Heilbronn site. In addition, in the course of the fifth and sixth semester, methodological, social and personal skills are taught more intensively in the course of a project study (not the same as the aforementioned project work), in the course of the "Communication Skills" module and in the course of the bachelor thesis.

The following figure 3 shows the basic structure of the study program:

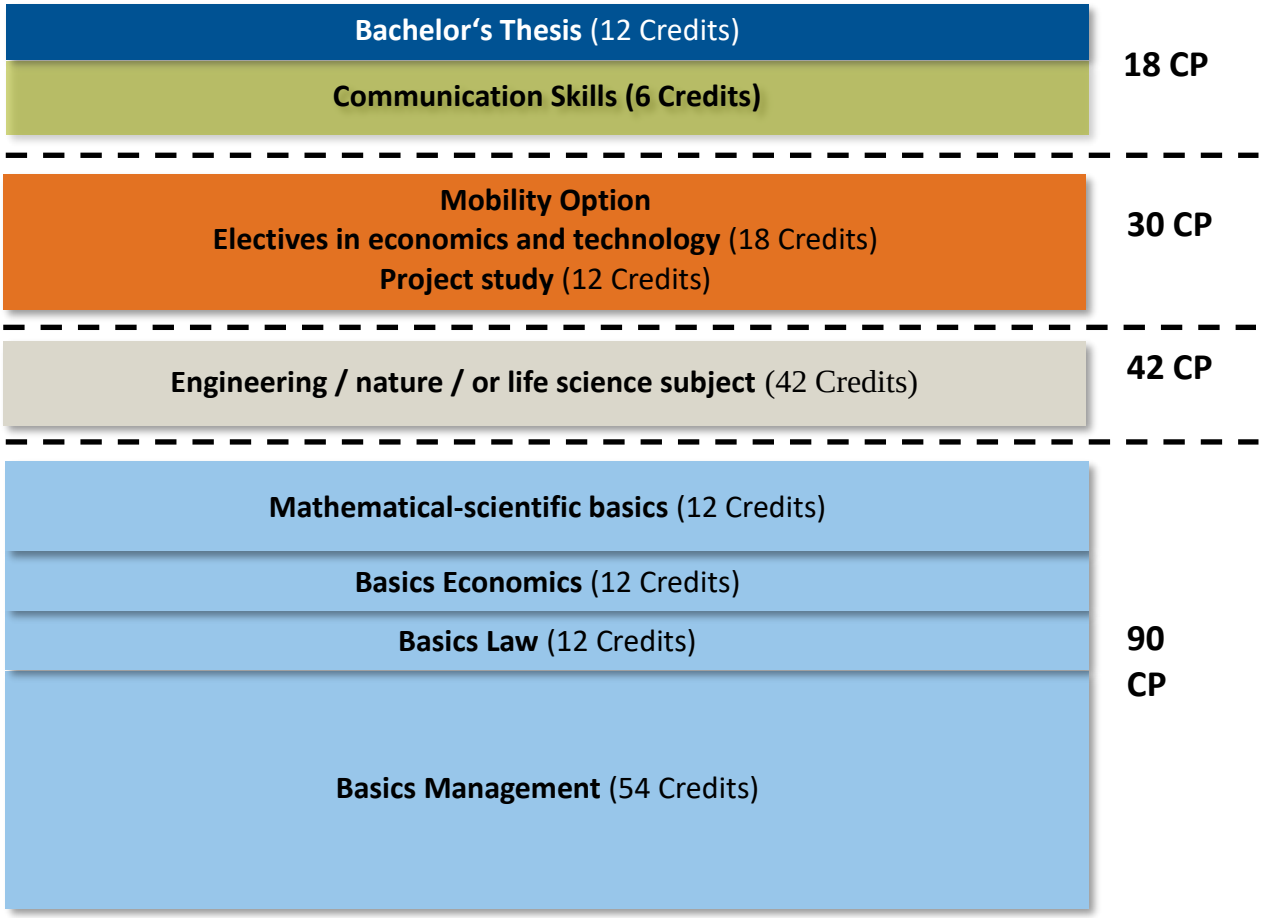

Figure 3: Structure of the Bachelor's degree program in Management and Technology at TUM Campus Heilbronn

The following figure 4 shows the study plan:

Semester	Module						Credits
1.	Mathematics in Natural and Economic Science 1 (mandatory) Exam 6 CP	Management Science (mandatory) Exam 6 CP	Financial Accounting (mandatory) Exam 6 CP	Economics I – Microeconomics (mandatory) Exam 6 CP	Business Law I (Pflicht) (mandatory) Exam		30
2.	Statistics for Business Administration (mandatory) Exam 6 CP	Cost Accounting (mandatory) Exam 6 CP	Foundations of Entrepreneurial and Ethical Business (mandatory) Exam 6 CP	Economics II - Macroeconomics (mandatory) Exam 6 CP	Business Law II (mandatory) Exam 6 CP		30
3.	Principles of Information Engineering (mandatory) Exam 5 CP	Machine Learning and Data Science (mandatory) Exam 5 CP	Introduction to Computer Science (for non-Informatics students) (mandatory) Exam 5 CP	Introduction to Informatics for Students of Management & Technology - Programming Lab Course (mandatory) Excercise 5 CP	Design and Analysis of Digital Control Systems (mandatory) Exercise 5 CP	Logistics Engineering in Production Systems and Supply Chain Management (mandatory) Exam 5 CP	30
4.	Production and Logistics (mandatory) Exam 6 CP	Strategic and International Management & Organizational Behavior (mandatory) Exam 6 CP	Investment and Financial Management (mandatory) Exam 6 CP	Marketing and Innovation Management (mandatory) Exam 6 CP	Empirical Research Methods (mandatory) Exam 6 CP		30
5. mobility window	Topics in Operations & Supply Chain Management I (elective) exam 6 CP	Advanced Technology and Innovation Management (elective) exam 6 CP	Project Management (elective) exam 6 CP	Project Studies (mandatory) Project Work 12 CP			30
6.	Bachelor's thesis (mandatory) Research paper 12 CP		Project Work in Informatics (mandatory) Research paper 12 CP		Communication Skills (mandatory) Study performance 6 CP		30

Legende:
dark blue = Bachelor's thesis / Project Studies
light blue = engineering science subject
grey = mandatory modules
green = Business and Technical Electives (WTW) /Communication Skills (CS)

Figure 4: Exemplary representation of the curriculum of the bachelor's degree program Management and Technology.

In order to achieve the competencies outlined in the qualification profile, various forms of teaching/learning are offered in the degree program. Basic knowledge in the individual business disciplines as well as in related areas is taught through lectures. In addition, skills for applying the knowledge gained to standard problems are practiced in accompanying exercises and tutorials. The technical and methodological skills in the business administration subjects are taught through seminars as well as through the project study and the Bachelor's thesis. The latter two forms of teaching/learning also serve to develop the above-mentioned social and personal skills. The knowledge and skills in the engineering subject Digital Technologies are first taught through lectures and exercises and then deepened through a project work, so that the students can develop related technical and methodological competencies. There are no mandatory internships. The mobility window in the fifth semester, allows students to acquire language and intercultural skills in particular.

In detail, the different teaching/learning forms, which are sufficiently described in the module descriptions, are used in the study program in the following way: The specialized knowledge and skills in business administration are taught through a broad basic education in the disciplines of financing, accounting and bookkeeping, cost accounting, marketing, management science, innovation management, production and logistics, entrepreneurship and organizational behavior. In addition to the first four classical disciplines, additional disciplines are included here that have an explicit connection to the profile of the School of Management (Management Science, Innovation Management, Logistics, Entrepreneurship, and Organizational Behavior) and also have an interface with the natural science/engineering subject Digital Technologies.

Mandatory modules in important related fields of business administration are integrated into the program. These include economics, law, statistics, and mathematics. These fields are essential for a comprehensive business education. For example, business administrators must also be able to deal with legal issues (e.g. contract law, company law) in numerous later professional fields and must be able to assess business developments in a macroeconomic context. As part of the Communication Skills module, students can enhance their communication skills in language courses, soft skills and business plan seminars. In addition, quantitative knowledge and quantitative methods are of great importance, especially in view of the increasing evidence-based nature of management decisions as well as the growing importance of data analysis, and are emphasized accordingly due to the quantitative orientation of the education at the School of Management. Furthermore, the knowledge, skills and competencies in mathematics and statistics are also prerequisites for other business subjects (Investment and Financial Management, Empirical Research Methods) as well as for the natural science/engineering subject Digital Technologies. In the aforementioned compulsory modules, the central contents are taught in lectures and then practiced in exercises in smaller groups through intensive supervision and using many application examples.

The third semester is entirely dedicated to the study of the scientific/engineering subject Digital Technologies. For this purpose, the students move to the Munich region for one semester, where the teaching of the natural/engineering subject Digital Technologies takes place at the central campus and at the Garching campus. Through a project work in the sixth semester at the TUM Campus Heilbronn, the scientific/engineering knowledge, skills and abilities are further deepened. The subject Digital Technologies consists of seven modules, which are the result of a cross-faculty and cross-disciplinary cooperation between the faculties of Computer Science, Mechanical Engineering and Electrical Engineering and Information Technology.

In the computer science modules "Introduction into Computer Science (for non-Informatics students)" and "Introduction to Informatics for Students of Management & Technology - Programming Lab Course" students learn to understand and overview important basic terms, concepts and ways of thinking in computer science, especially object-oriented programming, the programming language Java, databases & SQL and basic algorithms and data structures. They will be fundamentally enabled to develop their own programs with database connectivity. Students will be able to apply the content taught in the module to solve programming problems in their professional field or for later scientific work.

In the module "Design and Analysis of Digital Control Systems" from the engineering field of mechanical engineering, students learn important concepts and methods to model and analyze modern digital control systems. Students learn to describe reasons for costs and complexity associated with developing reliable software. This prepares students for a future job at the interface with the development area of companies. In the module "Logistics Engineering in Production Systems and Supply Chain Management", students learn the essential tasks and objectives of logistics and how to apply methods for planning logistical structures. In addition, students understand the essential functions of physical logistics and can apply methods for mapping the flow of materials and for dimensioning and evaluating logistics systems.

In the modules of the Faculty of Electrical Engineering and Information Technology, students acquire a basic understanding of the technical nature and limitations of information networks. For example, the module "Machine Learning and Data Science" teaches content that enables students to organize and evaluate large amounts of data into meaningful dimensions, to understand algorithms and how they work, and to know and apply the basic principles of machine learning. The module "Principles of Information Engineering" teaches the basic principles of operation of information transmission systems and networks, as well as data processing equipment and-methods. -methods. Participants learn basic design principles of such systems; gain an overview of the underlying physical and mathematical principles and the differences between technological limitations of such systems.

Completion of these basic modules is followed by a final engineering module, project work, in the sixth semester. For this module, students can choose at which of the three participating faculties (computer science, mechanical engineering, electrical engineering and information technology) they would like to complete the module in question. In interdisciplinary teams with engineering students from Munich, the students work out a solution to a given research problem under given technical, economic and social conditions and thus learn to apply the acquired theoretical basic and methodological knowledge in the chosen field. In doing so, they can also clarify important questions regarding the research problem posed in close coordination with the scientific working group and prepare developed solutions in such a way that these can be presented to the scientific work group both in writing and orally.

The project work project runs over the entire sixth semester in partial blocks with blocks for teaching the specialized knowledge required for the respective project, team work phases, overall team workshops and a final presentation as well as submission of the scientific paper.

In principle, the project can be completed completely online, but the School of Management and the participating technology faculty recommend at least one mutual meeting (kick-off meeting) at one of the locations, especially for interdisciplinary project teams. These meetings should be made possible without travel expenses to be borne by the team members themselves.

In the course of their studies, students can selectively deepen their knowledge of both business administration and engineering. This should give them a high degree of flexibility to prepare for their individually preferred career or a subsequent master's degree.

In the field of business administration, students in the Management and Technology bachelor's program at TUM Campus Heilbronn can choose modules from the focus areas of TUM Campus Heilbronn in Management of Family Businesses and Management in Digital Transformation in particular.

In addition, modules from the following disciplines are offered:

- Entrepreneurship
- Innovation Management
- Business and Corporate Management
- Investment and Financing
- Supply Chain Management
- Business Analytics
- Accounting
- Organizational Behavior
- Production and Logistics
- Business Law
- Negotiation
- Marketing and
- Strategy Management

After the basic training, students can take elective modules from their specific areas of interest. The exercises that usually accompany the lectures, the advanced seminars and the case study seminars (a small group of students work on relevant problem cases from corporate practice with intensive academic supervision by the respective chair) also enable students here to apply the specialist knowledge they have acquired in the lectures using practical examples.

An essential component for conveying specialized competencies in business administration areas is the preparation of seminar papers and the execution of case studies. In practical scenarios, students develop meaningful solution strategies in order to discuss content-related and methodological approaches of economics in a differentiated manner. Empirical methods are also applied throughout these modules.

The fifth semester can also be used as a mobility window for study abroad. Within this framework, students can take special modules that are not offered at the School of Management in order to further specialize or obtain a broader qualification profile in terms of content. In addition, studying abroad is ideal for developing intercultural competencies and expanding language skills. It is a good idea to take all or part of the examinations for the elective in economics and technology abroad. The students have the possibility to choose from the economics and/or engineering or natural science courses offered at a foreign university. A stay abroad can thus be integrated into the course of study

without extending the standard period of study. Here, too, close support from the student advisor ensures that students make the right choice of modules for their professional or academic future.

The project study serves to combine acquired theoretical knowledge and practice (unlike project studies, which takes place as part of the engineering subject in the 6th semester and represents a purely scientific paper). It can be completed flexibly in the fifth or sixth semester or after a study abroad, which is usually completed earlier than the semester at TUM. Representatives from corporate practice or research-related institutions accompany this project study as advisors. The supervising professors and their academic staff form the bridge to the academic training and ensure intensive support throughout the entire duration of the project. The study projects should not only produce solutions for research or for companies, but also networks of relationships for later entry into the professional world or for internships in an advanced master's degree. The project studies can also be performed abroad as part of the mobility window. Overall, it enables graduates to develop solutions to both academic and practical problems. Feedback from the TUM Campus Munich so far shows that the project study is very well received by the project partners. The students also see the project study as important. On the one hand, for the development of their technical and methodological skills and, on the other hand, because of the processing of a real complex problem in the group, which also promotes the development of their social and personal skills.

The mandatory module "Communication Skills" is to be completed between the fourth and sixth semester. This course is designed to teach communicative skills in an interdisciplinary and international environment. Examples are presentation techniques, conflict management, and intercultural communication or language courses.

The Bachelors Thesis marks the completion of the program. This is a central component of the scientific training and should show whether the students have mastered the most important fundamentals of the subject area and are able to work on a project independently, systematically and scientifically, and are thus prepared for an early transition to a more advanced master's program or to professional practice.

In order to ensure the best possible study ability for students, the School of Management has developed a corresponding study (shown it in the appendix to the subject examination and study regulations for the bachelor's degree program in Management and Technology at the TUM Heilbronn Campus). If this ideal-typical schedule - as shown in the appendix - is not feasible for every student, it is made possible for him or her to make appropriate changes in the elective module area by individually adapting their study plan in order to be able to acquire the specified 30 credits per semester in this way. This can be done without compromising the logical structure of the program.

7 Organizational connection and responsibilities

The School of Management is responsible for the content of the Bachelor's program in Management and Technology. The School of Management at the Heilbronn Campus is responsible for the curricular components of business administration fundamentals, economics fundamentals, law fundamentals, communication skills, business administration in-depth studies, project studies and the bachelor's thesis. In addition, the Faculties of Computer Science, Mechanical Engineering, and Electrical Engineering and Information Technology at the Munich and Garching campuses - together with the School of Management at the Munich Campus - are responsible for the implementation of the natural science/engineering subject.

The overall responsibility for the bachelor's degree program in Management and Technology lies with the current Dean of Studies, who is supported by the Office of the Dean of Studies. The Academic Program Director is also responsible.

The centralized and decentralized administrative responsibilities are shown in Table 3.

At the level of the study program, the Bachelor Examination Committee and the Suitability Assessment Committee of the School of Management should also be mentioned. The Bachelor Examination Committee of the School of Management is responsible for the clarification of examination-related matters, whereby the recognition of examination achievements can be delegated to module supervisors at the locations. The Suitability Assessment Committee is responsible for the proper implementation of the suitability assessment procedure.

Information about the program is posted on the School of Management website (School of Management website) under the "Programs" section.

The following administrative activities are performed by:

- General study counseling:
  TUM Center for Study and Teaching (TUM CST),
  Student Advising and Information Services
  e-mail: studium@tum.de
  phone number: +49 (0)89 289 22245
  offers information and counselling for:
  prospective students and students
  (via hotline / service desk)
- Academic study counseling:
  TUM School of Management
  Program Management, Carina Strohmeier,
  e-Mail: studentcounseling_heilbronn@mgt.tum.de
  phone number: +49 (0)7131 26418607
- Advisor study abroad/internationalisation:
  central: TUM Global & Alumni Office,
  globaloffice@tum.de
  decentral: TUM School of Management,
  International Office
  E-Mail: internationaloffice_hn@mgt.tum.de
  phone number: +49 (0) 7131 26418606

- Women's representative: Prof. Dr. Breugst
  office.ent@mgt.tum.de
- Consultation barrier-free study: central: CST, Studying with special needs,
  e-Mail: Handicap@zv.tum.de
  phone number: +49 (0)89 289 22737
  decentral: TUM School of Management, Sandra Lütkemeyer E-Mail: sandra.luetkemeyer@tum.de
  phone number: +49 (0)89 289 – 25086
- Admission and enrollment: CST, department admission and enrolment
  e-Mail: studium@tum.de
  phone number: +49 (0)89 289 22245
  Admission, enrollment,
  student card, leave of absence,
  re-registration, disenrollment
- Admission process: central: CST, department admission and enrolment
  decentral: TUM School of Management
  admission management, Tanya Göttinger,
  e-mail: admission_heilbronn@mgt.tum.de
  phone number: +49 (0)7131 26418703
- Beiträge und Stipendien: CST, semester fees management,
  e-mail: beitragsmanagement@zv.tum.de
  scholarships and semester fees
- Central examination matters: CST, Graduation Office and Academic Records,
  graduation documents, examination certificates,
  degree certificates
- decentral exam administration: TUM School of Management
  Grade Management, Annette Rank von Bronk und Ulrike Zerrahn
  e-Mail: studentcounseling_heilbronn@mgt.tum.de
  phone number: +49 (0)7131 26418 -604, -704
- Examination committee: name (chair): Prof. Dr. Maume
  name (secretary): Dr. Feilcke
- Quality management study and teaching:
  central: department of study and teaching,
  www.lehren.tum.de/startseite/team-hrsl/
  decentral: TUM School of Management
  dean of students: Prof. Dr. Jürgen Ernstberger
  quality management: Tanya Göttinger,
  tanya.göttinger@tum.de, +49 (0)7131 26418703
  organization quality circle: Carina Strohmeier,
  carina.strohmeier@tum.de, +49 (0)7131 26418607
  evaluation officer: Edo Octavianus
  edo.octavianus@tum.de, +49 (0)89 289 – 25849

coordination module management: Sonja Kopf,
sonja.kopf@tum.de, +49 (0)89 289 - 25075

8 Developments in the study program

The TUM-BWL program has been offered at the Munich campus since the winter semester 2001/2002. It was initially offered as a diploma program with 240 ECTS (Program specific academic and examination regulations for the Diploma and Bachelor's Degree Program in Technology and Management-Oriented Business Administration at the Technical University of Munich dated August 23, 2001). Since WS 2008/2009, the bachelor's degree program has existed with 180 ECTS (Program specific academic and examination regulations for the Bachelor's Degree Program in Technology and Management-Oriented Business Administration at the Technical University of Munich dated June 12, 2008/September 13, 2013 with various amendment statutes).

The selection options for students in the business and technical elective area have been expanded. First, the requirement to choose electives from only one area of competence of the School was abandoned in WS 2016/17 in order to offer a broader selection that can be used equally for specialized profile formation or a generalist education. In addition, the recognition of achievements from abroad was made much easier in order to promote international experiences of students.

With the opening of the TUM Campus Heilbronn in the winter semester 2018/19, the Bachelor TUM-BWL was offered at this location one year later with the start of the winter semester 2019/20 with the technology subject Digital Technologies and renamed Bachelor in Management and Technology in 2020. Due to further developments on campus as well as the completed appointment procedures, the elective module catalog was revised.

Internationalization as a declared goal of the TU Munich has a very concrete effect on the curriculum of the Bachelor Management and Technology in Heilbronn. For example, the mobility window allows students to easily integrate a study abroad program. Due to a curriculum that is purely in English, the program is also excellently suited for first-year students with no knowledge of German. While the percentage of international students was 40% at the beginning (2019), it has now risen to 52% (2020, 2021) and is thus far above the initial planning of 20%.