ACQUIN
Akkreditierungs-,
Certifizierungs- und
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Institut

Accreditation Report

Program Accreditation of **TUM Asia, Singapore**

"Chemical Engineering" (B.Eng. (Hons))

I Procedure

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Attendance by ACQUIN office: Dr. Jasmine Rudolph /Robert Raback / Dr. Michael Mayer

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The **Assessment Report** of the peer-review experts is **based on** the self-assessment report of the Higher Education Institution (HEI) and extensive discussions with the HEI management, deans and/or heads of the departments, heads of study program, lecturers, staff representatives, students, and alumni.

The basis of the **Assessment Criteria** is part 1 of the "Standards and Guidelines for Quality Assurance in the European Higher Education Area" (ESG) in the current official version. At the same time the national context, particularly the national regulations regarding the establishment of study programs, are taken into account.

Table of Contents

II Introduction

The experts would like to thank the representatives of the HEI as well as students that they have taken part in the discussions and willingly shared information and their views during the site visit. The discussions are valuable not only for the assessment of the institution, but also for a better understanding of the legal and sociocultural context of the local higher education system.

Evaluation basis for the peer-review experts is the self-assessment report of the HEI as well as intensive discussions during the site visit with the HEI management, deans and/or heads of the departments, head(s) of the study program, study program coordinators, teachers, lecturers, administrative staff, students, and graduates.

Main objective of the accreditation procedure is to assess the quality of the study programs and compliance with the "Standards and Guidelines for Quality Assurance in the European Higher Education Area" (ESG). The ESG standards are applied as main assessment criteria in the international accreditation procedure. In addition, the respective country-specific criteria and standards are taken into account.

A group of experts was set up, which ensured that all areas relevant to the accreditation procedure (e.g. legal, structural, social etc. aspects) as well as the ESG and national criteria were considered. The peer-review experts include professors, representatives of the professional practice and the student representative. A certificate with the ACQUIN seal is awarded upon accreditation of the study program.

1 The Higher Education System in Singapore

The higher education system in Singapore is structured to provide a comprehensive range of undergraduate and postgraduate programs, aligning with international standards and fostering a globally competitive academic environment. Due to the close connection to other surrounding Asian countries and its broad history, Singapore is strongly connected within the ASEAN countries as a member state since 1967.

A typical undergraduate program spans three to four years, undergraduate education in Singapore is provided by public universities such as the National University of Singapore (NUS), Nanyang Technological University (NTU), and the Singapore Management University (SMU). These HEI cover a broad spectrum of disciplines, including arts and social sciences, business, engineering, and science, often incorporating practical and industry-related components to enhance employability. Postgraduate education includes Master's programs, which usually require one to two years of study. These programs may be coursework-based, research-based, or a combination of both. They aim to provide advanced knowledge and

specialized skills in various fields, offering to both academic and professional aspirations. PhD programs usually last three to five years, highlighting original research and the contribution of new knowledge to a specific field. These programs involve rigorous coursework, comprehensive examinations, and the submission of a dissertation. They are designed to prepare graduates for careers in academia, research, and high-level professional practice.

Singapore's higher education system is generally characterized by a strong emphasis on research and development, robust industry linkages, and a commitment to innovative development. Institutions in Singapore are known for their high academic standards, international collaborations, and comprehensive support for students, including scholarships and research grants. The system's alignment with global educational frameworks ensures that degrees awarded are recognized internationally, enhancing graduates' mobility and career prospects.

2 Short profile of HEI

Technical University of Munich (TUM)

The TUM is one of Europe’s leading research universities. Since its founding in 1868, TUM has been at the forefront of Science and Innovation, playing a vital role in Europe’s technological advancement. As of 2023, 18 scientists and alumni of TUM have received the Nobel Prize. Some notable inventions from the TUM alumni include the refrigeration technology invented by Carl von Linde; the Dornier airplane by Claude Dornier; and the diesel engine invented by Rudolf Diesel, just to mention a few.

Having earned itself a reputation of being an institute that produces world-changing technologies, TUM strives to create lasting value for society through excellence in education and research, and the active promotion of next-generation talent with strong entrepreneurial spirit. As an entrepreneurial university, TUM has won recognition as a German "Excellence University” the most prestigious funding from the German State since 2006. TUM is regularly placed among the best universities in national and international rankings. In the respected QS World University Rankings 2023, TUM is yet again number one in Germany – for the ninth time in succession. In the European Union it is ranked second and is number 37 worldwide.

In its basic philosophy, the TUM is committed to promoting innovation in scientific fields that promise to improve the quality of life and cohabitation in the long term. The responsibility owed to the future generations forms the basis for the interdisciplinary focal points of health & nutrition, energy & raw materials, environment & climate, information & communication, mobility & infrastructure.

Since 2021, the TUM Department of Chemistry and the TUM Department of Physics were combined in the newly founded TUM School of Natural Sciences to satisfy the society's demand and strengthen the interdisciplinary work in the field of Natural Sciences. The TUM School of Natural Sciences, including its central themes in chemistry: inorganic chemistry, organic chemistry, and physical chemistry, chemical technology, and construction chemistry, plays a leading role and is responsible in covering interdisciplinary research fields and therefore contributes to the appeal and the international reputation of the Technical University of Munich. The Department of Chemistry at TUM has taken great efforts to meet the requirements of a rapidly changing scientific environment. Excellency in fundamental research on a high scientific level and close scientific connections to the chemical industry serve as a basis for a high quality and practically oriented education of the students. By redesigning the course of chemistry as well as implementing bachelor courses as an opportunity for an early career qualification, the TUM School of Natural Sciences accommodates the demands of the job market and the simplification of international exchange.

The close connection to physics in the newly found TUM School of Natural Sciences, facilitates the interdisciplinary work on fundamental questions of the mentioned focus area.

Singapore Institute of Technology (SIT)

In 2024 the SIT is envisioned to be a key university in Singapore that lives and breathes industry, with its students and alumni (collectively called SITizens) being thinking tinkerers, lifelong learners and catalysts for transformation who care for the community and stay connected to SIT and their fellow SITizens. SIT aims to maximise the potential of learners and to innovate with industry, through an integrated applied learning and research approach, so as to contribute to the economy and society.

In addition, the SIT aims to graduate students who possess four distinctive qualities which together are denoted as 'the SIT DNA'. These are (1) Thinking Tinkerers, (2) Able to Learn, (3) Unlearn and Relearn, (4) Catalyst for Transformation and (5) Grounded in the Community.

SIT Food, Chemical and Biotechnology (FCB) Cluster aims to support the continuous development and sustainable success of the food, chemical and pharmaceutical industries, which are key growth areas of Singapore's economies, by educating current and future industry professionals as well as work closely with companies on transformative research. At the core of SIT FCB's capabilities are world-class knowledge and professional experience in food technology, chemical engineering, and biotechnology.

By linking these excellent resources to real-world challenges and opportunities, SIT FCB can provide outstanding learning opportunities for the next generation and improve 'made in

Singapore' products and processes. Among the challenges SIT FCB address through teaching and research are: sustainability, product and process innovation, and opportunities that come from the applications of digitalisation and biotechnology.

The Singapore Institute of Technology (SIT) and Technical University of Munich (TUM) offer this 4 years joint degree programme in Bachelor of Engineering with Honours [B.Eng. (Hons)] in Chemical Engineering (TCE) consisting of two Industry 4.0 specialization tracks – Data Engineering and Additive Manufacturing.

German Institute of Science and Technology – TUM Asia (TUM Asia)

TUM Asia is an affiliate of the TUM. As the first German academic venture abroad, TUM Asia is supported by the Singapore Government through the Economic Development Board (EDB), and by the German Government through the Federal Ministry of Education and Research and The German Academic Exchange Service (DAAD). TUM Asia was set up in 2002, with the aim of bringing German academic excellence to Singapore. The academic model employed by TUM Asia places an emphasis on industry readiness and innovation. Blending German academic excellence with industry relevance in Asia, TUM Asia conducts Bachelor and Master programs in Singapore with partner universities such as National University of Singapore (NUS), Nanyang Technological University (NTU) and Singapore Institute of Technology (SIT). Through these joint programs, the international visibility of TUM has increased. Moreover, the teaching portfolio of GIST-TUM Asia also allows teaching staff to gain international teaching experience.

3 General information on the study program

Location	Singapore
Title of Study Program	Chemical Engineering (TCE)
Date of introduction	WS 2020/2021
Faculty/ department	Food, Chemical and Biotechnology Cluster, Singapore Institute of Technology (SIT)
Degree	B.Eng. (Hons) Chemical Engineering
Standard period of study (semesters)	11 Trimesters
Matriculation period	Winter Semester (August)
Number of ECTS credits	240

Frequency of Offered Program	Annually
Number of study places	85
Number of students currently enrolled	266
Average number of graduates per year	
Target group(s)	Diploma holders from any of the five Singaporean polytechnics and A Level / IB Diploma graduates or a formal 12-year education equivalent to A-Levels
Admission requirements	Aptitude assessment (EFV – Bachelor's)
Form of study	Full-time
Tuition fee	SGD 41,280 incl. GST (Subsidised, Singaporean)

Accreditation Procedure

The TCE programme is a 4-year Bachelor of Engineering degree with Honours. This joint degree will follow both TUM's and SIT's degree regulations. The program will be accredited in Germany according to Bavarian regulations. A detailed timeline will be established with the Bavarian Ministry for Science and the Arts' approval. This programme has received provisional accreditation and will later be fully accredited by the Singapore Engineering Accreditation Board (EAB).

III Implementation and assessment of the criteria

1 ESG 1.1: Policy for quality assurance

Institutions should have a policy for quality assurance that is made public and forms part of their strategic management. Internal stakeholders should develop and implement this policy through appropriate structures and processes, while involving external stakeholders.

1.1 Implementation

Quality Management at TUM and TUM Asia

TUM Asia has always laid emphasis on high quality which is aligned with TUM's quality management. Since TUM Asia courses must meet the study regulations of the TUM quality management, the responsible units at TUM are involved from the beginning (TUM Centre for Study and Teaching – Quality Management and Legal Division). This includes the definition of the process, the design of the conceptual draft, preparation of the course documentation, module descriptions and establishing academic and examination regulations. The programs are developed according to the prevailing laws imposed by TUM and the corresponding local partner university.

Further development of the courses also takes place with the involvement of relevant units of TUM (guidelines by TUM Centre for Study and Teaching – Quality Management and Legal Division, review by TUM administrative boards). Existing courses are continuously developed further, performed in close collaboration with the responsible program committee and other units at TUM.

Quality Management at SIT

The SIT Academic Policies apply to undergraduate, postgraduate, and other credit-bearing programs offered by SIT and those jointly offered by SIT with Overseas University (OU) partners. These policies are in accordance to the university's education philosophy to produce work-ready graduates imbued with the "SITizen"-DNA.

Management of the joint TUM-SIT Program

The program has received support from Singapore Economic Development Board Singapore (EDB) and the industrial partners. The faculty is involved in the planning and design of the curriculum structure, and the program was approved by the SIT Board of Trustees and the Ministry of Education in Singapore.

For the joint management of the program, a Collaboration Agreement between TUM and SIT was signed. In this document, all organizational aspects of the joint management of the program are defined (e.g. the responsibilities of each university, financial agreement, academic administration). The Collaboration Agreement includes a section about the quality assurance of the program. It is regulated that SIT and TUM are jointly responsible for ensuring the quality and standards of the program. This includes internal and external requirements for quality assurance, and the maintenance of academic standards.

TUM-SIT Joint Undergraduate Program Administration

TCE is a joint degree programme between SIT and TUM. The joint degree programme is managed by the Joint Board of Examiners (JBOE), Joint Programme Operations Committee (JPOC), as well as Programme Leader (PL) from SIT and Programme Director (PD) from TUM. SIT and TUM have jointly established a JBOE for the joint undergraduate programme by nominating relevant and qualified examiners. The terms of reference, operation, and constitution of the JBOE is set out in the Collaborative Agreement. The JBOE meets every trimester after the examinations, with the Chair and Co-Chair alternating on an annual basis between SIT and TUM. The SIT Chair will be Associate Provost or SIT nominee and TUM Chair will be TUM Dean of School or nominee.

Quality Management for TUM-SIT Joint Programs

The Joint Board of Examiner (JBOE) is responsible for quality management and continuous development. It consists of representatives from each institution, i.e. the TUM School of Natural Sciences and SIT FCB. The JBOE adopts a plan-do-check-act (PDCA) model for carrying out change for continuous improvement. TUM Asia takes into consideration the opinions of teaching staffs involved in the programmes, feedback from graduates, alumni and industry partners to improve the quality of the TCE programme. The performance of the teaching staffs is also evaluated from time to time. TUM Asia’s faculty prepares concept draft, study documentation, module description and articles for each program and the relevant TUM Schools (HRSL and HRSL-Law) assure the quality of the program to maintain TUM quality.

Operations Management

The JPOC is established to jointly review, coordinate, manage, and advise on academic, operational, and administrative matters for the TCE programme. The terms of reference, operation and constitution of the JPOC is set out in the Collaborative Agreement. The JPOC meets every six months to discuss administrative and operational matters arising from the programme operation, with the Chair alternate between TUM/TUM Asia and SIT each

Academic Year. The Chair will be the SIT Associate Provost or nominee, and the Co-Chair will be a faculty professor with the rank equivalent of the Dean of School from TUM.

In TUM, the TCE programme is led by the Academic Programme Director (PD) in consultation with the Managing Director of TUM Asia as well as Dean and Dean of Studies in the TUM School of Natural Sciences. The PD reports to the Senior Vice President, Studies and Teaching in TUM. In SIT, the TCE programme is headed by the PL who is responsible for the day-to-day operations of the programme.

The PL reports to the Provost through the Director of Programmes (DoP) and Associate Provost. The PDs manage and coordinate all issues related to curriculum planning, quality management and examination management.

The SIT PL and TUM PD are supported by the team of TCE faculty members who contribute to the teaching of the programme based on their domain expertise, interests, and time commitment, both from SIT and TUM. In SIT, the programme is administratively supported by the Academic Programme Administration (APA) for faculty and student matters. In TUM, the programme is administratively supported by Academic Service Department (ASD) from TUM Asia.

SIT and TUM have also jointly established one Student Management Committee (SMC) for the TCE Programme. The SMC shall be representative of all students in the TCE Programme. SIT and TUM shall jointly support the SMC by providing representatives of their teaching and support staff to meet with the SMC once a trimester.

In addition, other student activities and campus events such as the Integrated Work Study Programme (IWSP), students' involvement in outreach, and the Overseas Immersion Programme (OIP) are supported by the SI Centre for Career Readiness, Student Life, and Global Experience, etc.

The courses are evaluated by a web-based system evaluation program in the learning management of SIT (Blue, Explorance Inc.), which is suitable for standardized apprenticeship evaluations of different dimensions. The results are shared with the respective teaching staff, who can share their opinions on the feedback. Additionally, the feedback from students, graduates, teaching staff and administration staff is collected and processed by SIT. The compiled information is then discussed with the SMC and in the JBOE and JPOC meetings, wherein steps are taken to work on the feedback and fulfill the shortcomings.

1.2 Assessment

TUM Asia and SIT have a robust quality assurance practice in place, reflecting their commitment to providing high-quality education and ensuring the continuous improvement of their academic programs.

Formal Policy for Quality Assurance

TUM Asia and SIT have well-documented quality assurance policies that serve as guiding frameworks for maintaining and enhancing the quality of their educational offerings. These policies are readily accessible to all stakeholders, including students, faculty members, administrative staff, and external partners, through the institutions' official websites and handbooks.

Coverage of Relevant Areas

The quality assurance policies of TUM Asia and SIT comprehensively cover all relevant areas pertinent to academic excellence and program quality. They address aspects such as curriculum design, teaching methodologies, assessment practices, student support services, research integrity, and administrative processes. These policies are designed to ensure alignment with international best practices and accreditation standards, thereby enhancing the overall quality of education delivered by both institutions.

Involvement of Stakeholders

TUM Asia and SIT actively involve a wide range of stakeholders in the development and implementation of their quality assurance policies. This includes input from academic and administrative staff, students, industry partners, accreditation bodies, and relevant government agencies. Both institutions emphasize transparency and inclusivity in their decision-making processes, soliciting feedback and suggestions from stakeholders through various channels such as surveys, focus groups, and advisory committees.

Implementation, Monitoring, and Revision

TUM Asia and SIT have well-defined mechanisms for implementing, monitoring, and revising their quality assurance policies. They appoint dedicated quality assurance teams or committees responsible for overseeing the implementation of quality assurance measures and monitoring compliance with established standards. Regular reviews and evaluations are conducted to assess the effectiveness of existing quality assurance practices and identify areas for improvement. The feedback from students, faculty members, and external stakeholders is actively incorporated into the revision process to ensure that quality assurance policies and internal processes remain relevant and responsive to evolving needs and expectations.

Enhanced Stakeholder engagement

While both institutions involve stakeholders in their quality assurance processes, there is still room for further enhancement in terms of the depth and frequency of engagement. Implementing focus groups, and/or feedback sessions can provide additional opportunities for stakeholders to voice their opinions and contribute to the continuous improvement of quality assurance practices. The general stakeholder engagement should therefore be enhanced. [Recommendation 1]

Streamline the joint monitoring and evaluation processes

Additionally, TUM Asia and SIT can benefit from streamlining their monitoring and evaluation processes to ensure greater efficiency and effectiveness. Implementing automated data collection and analysis tools can help streamline the assessment of key performance indicators and facilitate evidence-based decision-making. The expert group therefore recommends encouraging internal processes to streamline these activities even more. [Recommendation 2]

1.3 Conclusion

The criterion is **fulfilled.** The expert panel suggest the following recommendations:

Recommendation 1: The stakeholder engagement in the quality assurance processes should be enhanced.
Recommendation 2: Joint monitoring and evaluation processes should be streamlined.

2 ESG 1.2: Design and approval of programs

Institutions should have processes for the design and approval of their programs. The programs should be designed so that they meet the objectives set for them, including the intended learning outcomes. The qualification resulting from a program should be clearly specified and communicated and refer to the correct level of the national qualifications framework for higher education and, consequently, to the Framework for Qualifications of the European Higher Education Area.

2.1 Implementation

Design and approval of the study program

The TUM study programs follow the General Academic and Examination Regulations (APSOs) for Bachelor's and Master's degree programs at TUM. Program-specific Academic and Examination Regulations (FPSOs) apply specifically to the degree programs of interest which sets specific regulations and requirements which are unique and different from the APSO.

The TUM Centre for Study and Teaching - Quality Management team (TUM CST) advises TUM schools and colleges on drafting degree program outlines and establishing academic and examination regulations. TUM CST will guide through the entire development process, up to and including the final stages, before submitting the program outline for review by TUM administrative boards. TUM CST outlines the procedure for the design and approval of the study programs along with a list of TUM contact persons and administrative boards.

This procedure, incidentally, represents the core element of quality management at TUM. The manuals include guidelines for each stage of the process as well as a timeline showing the applicable deadlines.

At TUM, the key information concerning a degree program is catalogued in the degree program documentation, which includes a description of the qualification profiles issued to graduates as well as an overview of the structure, thematic focal points, modularization plan, and resources required to run the program.

The degree programs currently in use are not set in stone; rather, they are continually being revised and adapted for reasons such as curriculum updates, improvements to degree program design and studyability, requests from students, and various additional external requirements. The degree program administration at schools or colleges are first notified of the possible changes to the degree programs. The legal division of the TUM Study and Teaching Unit will advise later on updating your Program-Specific Academic and Examination Regulations (FPSOs) and assist in preparing for the administrative board review.

In many cases, program modifications must be recorded in the Program-Specific Academic and Examination Regulations (FPSOs) and documented by means of modification statutes. These statutes, unless exceptionally complicated, are generally reviewed at TUM Senate meetings.

As defined by the Standing Conference of the Ministers of Education in Germany (KMK), modules are “thematically and chronologically related, self-contained units of study assigned with a certain number of credits and subject to assessment. With the aim of promoting transparency, the KMK has now made module descriptions mandatory. These documents serve a dual purpose: By providing an overview of desired learning outcomes, the estimated workload, instructional and self-study methods, and key facts relating to course content and delivery, module descriptions also serve as an important basis for the assessment of academic and study qualifications with respect to their transferability.

In addition to summarizing the desired learning outcomes, module catalogues must contain detailed descriptions of the methods used to achieve these objectives. A module catalogue can comprise the full set of module descriptions for a degree program, a school or college, or

the entire university. Module size and scope will generally depend on the estimated time required by students to work through the instructional materials. Since module content and didactic approach can vary widely, there are no hard and fast reference values available.

For the TCE program, module catalogues are maintained via SIT's Module Profile System (MPS) which maintains and updates the module profile every trimester, reviewed and approved by SIT's programme leader.

Program Initiation

Ideas for new programs can come from top down (Government or SIT Board/Senior Management] or bottom-up (from faculty or industry] approach. For new program ideas from the bottom up, DoPs are to scrutinize the feasibility of the program before it is suggested to the Provost, who may then approve the formation of a Program Development Working Group (PDWG).

The curricula of the proposed programs are tabled for approval at the BOS to ensure that the proposed curricula would satisfy the academic requirements of SIT and that students going through the program would also be imbued with SIT's DNA. The BOS reviewed the curriculum rigour and structure, the pedagogical approach, assessment methodologies and how SIT would infuse the given key elements. Prior to the submission to MOE for program launch, the proposal is submitted to BOT for approval. This program is a joint degree program and therefore it is subject to joint program management.

Joint Program Management

In the management of the joint program, additional joint management committees are set up. These includes the Joint Board of Examiners (JBOE) and Joint Program Operations Committee (JPOC), which SIT, TUM, and TUM Asia jointly established.

The JBOE meets once every trimester after the completion of examinations, with the Chair and Co-Chair alternating between both parties on an annual basis. The composition of the JBOE includes representatives from both SIT and TUM.

History and Purpose of the TCE Program

In the past 150 years, the chemical industry has taken giant leaps in the conversion of raw materials into chemical products, defining the way we all live today. Nowadays, the chemical industry and educational institutes are constantly developing new synthesis paths in order to improve existing or find novel processes to meet the increased demand for commodity and

specialty chemicals, for automotive, construction and pulp industry. Additionally, the environmental impact of the chemical industry and the integration of industry 4.0 have gained more attention, therefore, using new technologies for more atomically efficient processes, sourcing for renewable energy sources with fewer side and waste products, are highly desired.

With the recent economic growth in Asia, e.g. China, India, Indonesia, and even Vietnam and Thailand, the regional and global demand for commodity and specialty chemicals has significantly increased in the past decades. Today almost half of the global chemical sales are owned by chemical companies from Asia. As the global economy expands towards the east, by 2035 at least half of the top 10 chemical companies will be based in Asia or the Middle East. To satisfy the demand in Asia, several European chemical companies have already shifted their activities to Asia and will continue to do so.

Singapore's powerful mix of refining, olefins production and chemicals manufacturing, business and innovation capabilities has made it one of the world's leading energy and chemical hubs. Singapore is an APAC outpost for almost 100 European, American, Japanese, Chinese, Korean, Malaysian, as well as local chemical companies with manufacturing, sales, or R&D - a sample of the world's chemical industry and one of the biggest refinery complexes, all in a 728 km^2 island off the Ecuador axis. Singapore is the 8th largest exporter of chemicals in 2019, ranked by the World Trade Statistical Review 2020. Singapore's chemicals and energy industry also ranks among the top 10 globally.

Singapore's position as a global chemical hub has grown with the extensive development of Jurong Island - Singapore's centrepiece for refining, petrochemical, and specialty chemicals activities. Jurong Island's highly integrated infrastructure closely connects both customers and suppliers in an integrated ecosystem, featuring utilities and logistics service providers, creating production synergies that allow companies to save costs. Jurong Island has attracted over S$50 billion worth of investments. In the future, Singapore envisions that a more sustainable Jurong Island would remain one of the most important energy and chemicals export hubs globally. By 2050, it will quadruple the output of sustainable products and achieve more than 6 million tons of carbon abatement per annum.

Given Singapore's strong track record for intellectual property rights protection, the nation is ideal for companies seeking to develop and commercialize proprietary technologies and first-class manufacturing processes. Singapore aims to be a model of sustainable development by taking the lead to address climate change concerns and global resource constraints. Solutions involve energy efficiency, emissions management, and sustainable feedstocks and technologies. Several high impact projects to utilize Singapore's integrated manufacturing location are being implemented. In 2015, the energy and chemicals industry sector contributed S$81 billion of the manufacturing output, which is about a third of Singapore's total

manufacturing output. The industry is constantly evolving and innovating, and Singapore is committed to staying at the forefront of this advancement.

Despite the strong economic fundamentals underpinning the demand for chemical engineers in the future, there is a strong need to evolve the chemical engineering programmes to meet industry needs, evident from industrial scans and the inputs from Singapore Agency for Science, Technology and Research (A*STAR) and Economic Development Board's (EDB) under the Joint Industry Sector Planning (JISP) initiative. The chemical industry scans of 14 companies done by the SIT team indicate that Industry 4.0 skillsets are highly desired in future chemical engineering employees. The Industry 4.0 desired skill sets are in the field of data engineering and additive manufacturing. The desired chemical engineering skills set include competency in topics such as internet of things (IoT), industrial automation, data processing and analytics along with industrial software engineering. For the additive manufacture skills set, topics include basics in polymer engineering, polymers and polymer technology, material and failure analysis and 3D printing with a practical course. TUM currently has industrially relevant academic modules in Industry 4.0 as well as a strong reputation in Chemical Engineering in Germany and globally. The above factors coupled with positioning for a long-term alliance with a top technical university are compelling reasons for SIT to launch this new programme to train a new breed of technically competent chemical engineers who have strong hands-on skill sets and are future ready.

TUM Asia`s close cooperation and partnership with internationally renowned multinational companies ensure that they receive highly skilled and creative professionals and students are assured of leading their competition in the global economy: BMW, BASF, DOW Chemicals Clariant, Budenheim, Bosch, Festo, Linde Gas, DELO, Merck, Wacker, Solvay, Novartis, Evonik, A*Star, and Shell.

Development of the TCE Program

The 4-year joint TUM-SIT Bachelor of Engineering [B.Eng. (Hons)] in Chemical Engineering (TCE) degree programme was first offered in 2020. It is based on an expanded version of the original, 3-year, Bachelor of Science Chemical Engineering degree offered solely by TUM under the auspices of SIT between 2011 and 2019. The TCE programme is offered as a joint degree with SIT, this collaboration increases the mutual exchange and communication between the two institutions in terms of teaching and research, which also ensures continued access to necessary resources (laboratory facilities and classrooms).

3-Year TUM Program (2011 intake – 2019 intakes)

From 2011-2019, the 3-year Bachelor of Science (Chemical Engineering) programme recruited students with relevant polytechnic diplomas and A level certificates. Polytechnic students could be exempted from certain modules and thus complete their studies in 2.5 years. There were two teaching and assessment semesters per academic year, with a long break between academic years. The modules were mostly taught in block teaching mode. At the end of their second year of study, students would travel to TUM for a 3-month Overseas Immersion Programme (OIP) in semester 5.

4-Year TUM-SIT Program (2020 intake –present)

The 3-Year programme evolved into the current 4-year Bachelor of Engineering (Chemical Engineering) degree programme jointly offered by SIT, TUM and TUM Asia. It had its first intake in 2020. The curriculum of the new programme includes all the core chemical engineering elements of the previous programme, while adding more fundamental modules. This enables the recruitment of students without a Chemical Engineering background, thus offering opportunities to those with A-level and IB qualifications and other polytechnic diplomas. The programme is based on a trimester system with a one-week break during each trimester and a three-to-four-week break between trimesters.

Student Learning Outcomes (SLOs)

The assessment and evaluation processes for the SLOs rely on several tools that seek feedback from students, alumni (in future), faculty, and the programme lead. The programme has established a comprehensive assessment process for its SLOs to ensure that it is being monitored and measured adequately and appropriately. Various direct and indirect assessment methods are adopted to evaluate the attainment of the SLOs periodically. The input is evaluated by the Programme lead and proper corrective actions are taken whenever necessary.

The Assessment Methods are split into direct and indirect modes. The direct Assessment Methods include: overall module results, quizzes/tests/midterms, oral presentations, project reports, demonstration of laboratory or design skills, and final examination results. The indirect Assessment Methods consist of module learning outcome survey on selected modules and exit survey of graduating students.

At the programme level, the Programme Leads are responsible for collating and interpreting all the direct and indirect data. They would identify any weaknesses from the directly measured data presented for each module. Where there is significant deviation from its performance target for three consecutive semesters, a closer evaluation of the teaching processes and assessment strategies in the module will be required to determine if expectations have been inappropriately set. Changes can then be made accordingly, after consultation with module

leads/instructors. The Programme Leads provide the final recommendations if any change is required at the programme level.

Below is the list of the 12 Student Learning Outcomes (SLOs) for the TCE program:

a) Engineering Knowledge: Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.

b) Problem Analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c) Design/development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

d) Investigation: Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e) Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f) The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g) Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.

h) Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i) Individual and Teamwork: Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.

j) Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k) Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l) Life-long Learning: Recognise the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

At the program level, the Program Leads are responsible for collating and interpreting all the direct and indirect data. They would identify any weaknesses from the directly measured data presented for each module. Where there is significant deviation from its performance target for three consecutive semesters, a closer evaluation of the teaching processes and assessment strategies in the module will be required to determine if expectations have been inappropriately set. Changes can then be made accordingly, after consultation with module leads/instructors. The Program Leads provide the final recommendations if any change is required at the program level.

2.2 Assessment

The TCE program shows alignment with European requirements and the ESG. The program's design is linked with the strategic objectives of the SIT to equip students with the skills necessary to navigate the evolving demands of Singapore's labour market. The curriculum is structured to develop students' ability to approach complex, multifaceted problems from multiple perspectives, a goal that is consistently pursued through a blend of classroom instruction, lab modules, and the Integrated Work Study Program (IWSP), which also encompasses the bachelor's thesis module.

The approval and oversight mechanisms of the program are robust, involving internal and external stakeholders to ensure that the program meets the demanded standards of quality and relevance. The SIT Board of Trustees and the Singaporean Ministry of Education play a fundamental role in the final approval of the program, ensuring alignment with national educational objectives. The ongoing development and enhancement of the program are systematically managed through collaborative efforts by the Joint Board of Examiners (JBOE), the Joint Program Operations Committee (JPOC), the Program Leader (PL) from SIT, and the Program Director (PD) from TUM. This collaborative governance structure is further supported by the Student Management Committee, which facilitates student involvement in the program's design and continuous improvement processes.

The program is clearly structured to achieve its stated objectives, with a curriculum designed to progressively build students' expertise in chemical engineering for the job market not only in Asia. This progression is evident from the foundational courses in the first year, through the core chemical engineering modules in the second year, and into specialized tracks in the third year, which include Data Engineering and Additive Manufacturing. The inclusion of the Introduction to German Chemical Industry (IGCI) module at TUM in Germany underscores the program's international orientation and its commitment to providing students with global industry exposure.

The integration of the IWSP and the bachelor thesis in the latter part of the program is particularly commendable. These components are well-structured, providing students with valuable hands-on experience and opportunities for reflection and feedback, which are critical for the professional development of the students.

The program’s alignment with the Washington Accord’s Graduate Attribute Profile, Knowledge Profile, and definitions of Problem-Solving levels ensures that the learning outcomes are internationally recognized. This alignment, coupled with the program’s systematic feedback loops at various levels—Module Learning Outcomes, Student Learning Outcomes, and Program Educational Objectives—demonstrates a commitment to continuous quality improvement.

The program’s infrastructure, including teaching facilities, laboratories, and the library, is of a high standard, supporting the delivery of internationally related quality education. The workload expectations for students are well-defined and transparent, contributing to a balanced and effective learning experience.

Intercultural and academic mobility opportunities

The program´s nature is to actively integrate intercultural experiences into the curriculum by encouraging student participation in international projects, exchange programs, and collaborations with global partners. These opportunities are designed to enhance students' understanding of different cultural contexts and perspectives, which are crucial for innovation and leadership in a global industry. TUM Asia's strategic location in Singapore, a multicultural hub, already provides a unique environment where students can naturally engage with a diverse community, enriching their educational experience and intercultural awareness. To promote academic mobility, the program offers structured exchange opportunities with TUM in Munich and other partner institutions worldwide. These exchanges allow students to experience different educational systems, research methodologies, and industry practices, broadening their academic and professional horizons. In order to further align the TCE program outside of the ASEAN countries, it is committed to expanding its intercultural and academic

mobility opportunities. This includes the potential development of new partnerships with universities and industry leaders across Asia, Europe, and beyond. Additionally, the program is exploring the integration of virtual mobility initiatives, leveraging digital platforms to connect students with peers and experts globally, thereby enhancing their intercultural competence even when physical mobility is limited. Students do have the option to conduct their IWSP and Bachelors' thesis on top of their Overseas Immersion Programme, subject to availability of such opportunities. The TUM Asia is currently discussing with SIT as a joint degree to increase such opportunities for more students to do at least a Bachelor's Thesis in TUM. They are also in deep talks to include an elective for German language and culture for the future. [Recommendation 4]

More academic freedom in the block modules

By allowing students to choose from overlapping block modules, the program enables them to tailor their studies to their specific interests and strengths. This flexibility not only raises deeper engagement with the material but could also encourage interdisciplinary learning, as students can explore connections between different areas of the TCE program. This modular approach could be particularly beneficial in accommodating diverse learning paces and styles, as students have the option to balance their workload according to their preferences and schedules. Additionally, it supports the integration of practical and theoretical knowledge, as students can select modules that align with ongoing research projects or industry collaborations. Ultimately, by providing better freedom in module selection, the program empowers students to take control of their education, nurturing a more dynamic and student-centred learning environment that prepares them for the complexities of the engineering field. [Recommendation 5]

In conclusion, the TCE program is well designed and continuously refined in line with international ESG frameworks and its requirements. The program benefits from its independently aligned quality assurance processes, ensuring that it meets the academic standards expected by TUM and the needs of its students and stakeholders.

2.3 Conclusion

The criterion is **fulfilled.**

The expert panel suggest the following recommendations:

Recommendation 4: More intercultural and academic mobility opportunities should be considered.
Recommendation 5: More academic freedom in the block modules should be ensured.

3 ESG 1.3: Student-centred learning, teaching, and assessment

Institutions should ensure that the programs are delivered in a way that encourages students to take an active role in creating the learning process, and that the assessment of students reflects this approach.

3.1 Implementation

TUM Asia uses a variety of approaches to learning and teaching are used, the most widespread being lectures, tutorials, computer classes, laboratory work and individual or group projects. The lectures are conducted via Microsoft PowerPoint and video presentations, which are supplemented by smart board, white board or digital visualizer. Academic staff are encouraged to adopt and utilize the full range of pedagogic techniques to enhance the quality of the student's learning experience and, in some cases, improve the overall efficiency of delivery. Furthermore, all lectures are recorded and published on the xSiTe (SIT's learning management system) to provide students a convenient way to review the lectures after they were held. Many of the modules taught by TUM faculty are conducted in "block-teaching" mode. In such cases, the lessons are run daily for 2 weeks.

Tutorials

During class, tutorial sessions are offered as part of the student´s self-assessment. The instructor discusses application examples and case studies that reinforce principles, concepts, and analytical techniques covered during lectures. In some sessions, students have the opportunity to present their or their groups' views or solutions, which allows them to learn, unlearn, and relearn from their peers and instructors. Tutorial rooms with movable tables and chairs which facilitate active learning, interactions and discussions between instructors and students, and among students are available.

Design and Project Work

There are various modules that focus on design and project-based learning; the two main ones being the Plant Design 2 module, and Integrated Work Study Programme (IWSP). These modules train students to be thinking tinkerers and catalysts for transformation, who are practical, relevant and have the ability and skills to find ways to improve and implement greater efficiency in engineering systems by applying sound fundamentals and principles of engineering. The hands-on, projects-based nature of these modules also encourages applied-learning, a cornerstone of the pedagogies at SIT. Through these modules, students are also given exposure to current industry practice and real-life problems such that they can link what they are taught in class to what will be expected of them as future engineers. In addition to technical grounding, learning activities within these modules typically include ample opportunity for teamwork, discussions, critique and pitching of ideas and design and

engineering concepts to facilitate the production of graduates who are confident, articulate and presentable for industry upon graduation. Students will typically work independently or as part of a team. They will be guided by academic or industrial supervisors and are provided with the necessary support and resources to execute their projects.

Seminars and Site Visits

Seminars and site visits are arranged to increase students' exposures to the latest industrial practices and to strengthen their interactions with their future potential employers, thereby grounding students in the community. Seminars are conducted by industrial experts.

Study environment and support

TUM and TUM Asia value the diversity of talents. TUM and TUM Asia support equal opportunities for men and women, acknowledge and promote the diversity and differences among the students, regardless of gender, nationality, religion and worldview, disability, age, or sexual orientation. Openness and mutual respect are the basis of intellectual advancement. Diversity among scholars and scientists, students and employees make TUM an innovative and dynamic university. With the motto "Talents in Diversity", TUM Asia creates a study and work environment in which individual abilities can develop and flourish. The result is a study and workplace characterized by vibrant teams, fruitful debate and outstanding research. The Academic Service Department (ASD) offers a broad range of advising and services to support students in all life circumstance. The academic staff and the Academic Service Department work closely to create a conducive study environment for students. Furthermore, teaching staff offers support via email or even Teams/Zoom/Skype in case students have further inquiries.

TCE Module Assessment

Except for the OIP, which will be graded as non-letter pass/fail grade, the modules will be graded according to SIT's 5-point Grade Point Average (GPA) system. The total mark obtained by a student for each module is translated into a letter grade with an assigned grade point and descriptor in accordance with the grading scheme. An F grade is deemed as "Failure to attain most learning outcomes".

Students will be able to submit an appeal for review of results for all modules upon results release after the concurrence from examiners in the JBOE. Module leads ensures that results have been accurately reflected and tabulated upon receipt of an appeal request by students in the learning management system before either agreeing/rejecting the appeal based on the investigation outcome. Students will then be informed of the outcome of the appeal via SIT's Registrar's Office (RO).

3.2 Assessment

A diverse range of teaching and learning methods is used to enhance and consolidate the learning outcomes of students. Various pedagogical approaches are designed to complement each other, ensuring a comprehensive educational experience. The primary focus of most teaching strategies is to engage students actively in their own learning process, enabling them to gain new knowledge and deepen their understanding of theoretical concepts effectively. This student-centred approach places learners at the heart of the educational process, encouraging them to take an active role in their academic development. The regulations for assessment and grading are clearly defined in the MPS. Even though the number of individual assessments is high, the students evaluate this as a good reinforcement of the learning outcomes.

The study environment is considerately designed to support student learning, providing access to resources such as libraries, online databases, and study spaces conducive to both individual and group work. Support services are readily available to assist students in navigating academic challenges, offering guidance and advice tailored to individual needs. In addition, project work plays a crucial role in the curriculum, allowing students to apply theoretical knowledge to practical problems, developing critical thinking, collaboration, and problem-solving skills.

Laboratory work is another integral component of the educational program, offering hands-on experience that is vital for understanding complex scientific and technical concepts. Through laboratory exercises, the students at TUM Asia can experiment, observe, and analyse results in a controlled environment, bridging the gap between theory and practice.

Tutorials provide an additional layer of support, enabling students to engage in small-group discussions facilitated by instructors or teaching assistants. These sessions offer opportunities for personalized feedback, clarification of difficult concepts, and deeper exploration of subject matter.

3.3 Conclusion

The criterion is **fulfilled.**

4 ESG 1.4: Student admission, progression, recognition, and certification

Institutions should consistently apply pre-defined and published regulations covering all phases of the student "life cycle", e.g. student admission, progression, recognition and certification.

4.1 Implementation

In general, admission for the TCE program is handled by SIT (this is regulated in the TUM-SIT Collaboration Agreement).

General Admission Requirements

Applicants presenting the following qualifications may apply to the Chemical Engineering BEng (Hons) program:

1. Local Polytechnic Diploma: Applicants presenting the polytechnic diploma from one of the five local polytechnics, namely, Nanyang Polytechnic, Ngee Ann Polytechnic, Singapore Polytechnic, Temasek Polytechnic, and Republic Polytechnic may apply. Final semester polytechnic students may apply for admission with their first five semesters' results within the stipulated application period. They are required to furnish the results of their sixth semester and diploma certificate as proof of graduation upon receiving them.
2. Singapore-Cambridge GCE A-Level: Applicants presenting the Singapore-Cambridge GCE A-Level certificate may apply.
3. International Baccalaureate Diploma: Applicants presenting the International Baccalaureate (IB) Diploma awarded by the International Baccalaureate Organisation (IBO) may apply.
4. NUS High School Diploma: Applicants presenting the National University of Singapore (NUS) High School Diploma awarded by the NUS High School of Mathematics & Science may apply and will be evaluated on a case- by-case basis.
5. International & Other Qualifications: Applicants presenting a Year-Twelve International qualification (e.g., Malaysia Higher School Certificate (STPM), Unified Examination Certificate (UEC), India Standard Twelve, Peoples' Republic of China GaoKao (University Entrance Examination), etc.), or other equivalent Year-Twelve qualifications not specified in the preceding groups above may apply and will be evaluated on a case-by-case basis.

Local polytechnic graduates are invited to apply, regardless of the diploma they hold. Applicants with Chemical Engineering or closely related Science and Technology diplomas are strongly encouraged to apply. Subject to approval by the module leads and programme leader, diploma holders may be granted exemptions based on the modules taken during their diploma course. Exemptions may also be considered for relevant professional or industrial certifications.

Holistic and Aptitude-based Assessment for TCE Admission

SIT adopts a holistic and aptitude-based approach in assessing applicants for admission, with broad merit-based admissions criteria. Apart from academic achievements, non-academic

merits such as relevant work experience, passion, co-curricular interests and personal qualities will be duly considered in the admission process.

For the consideration of the applicants' personal qualities, a brief personal statement would be submitted. The applicant elaborates on his/her motivation to apply to the program, further describing any achievements and personal growth & development from past education or work experience. Applicants also share their aspirations after graduating from the program.

All shortlisted applicants are required to go through an admissions interview assessment. In general, SIT will review applicants on their suitability for a degree program based on their aptitude to complete the program, likelihood of pursuing a career in the area after graduation, and their personal attributes/character (passion, determination, team-spirit, and interpersonal skills), as well as their professional experience in the area.

Specifically, applicants shortlisted (based on both academic and non-academic merit) for consideration to the BEng (Hons) Chemical Engineering program are assessed during the interview on their passion/interest in the program, domain knowledge including relevant work experience or prior learning, problem-solving and adaptability skills, positive attitude towards learning, and communication (articulation) skills.

Shortlisted applicants will be assessed through an interview (either via a video platform or a face-to-face assessment) to determine their suitability for the program by the academic staff from SIT as well as TUM Asia or TUM.

Discretionary Admission for Applicants with Relevant Work Experience

Discretionary admission will be considered for TCE applicants who have not met the cut-off point for the programme within an accepted margin but are outstanding on other aspects, including relevant work experience, demonstrated ability and interest, and other areas such as participation in prestigious competitions which are of relevance to the programme etc.

Application Processes

Application for admission is usually open from mid-January to March every year. The application procedure is as follows:

1. Apply via the SIT online application portal, which requires payment of application fee, and uploading of required supporting documents to the portal;
2. Shortlisted applicants are invited for interviews;

3. Check final application outcome via email notification from SIT or via the SIT online application portal;
4. Successful applicants are required to accept their offer via the Joint Acceptance Exercise (JAE) Platform, or by completing an acceptance form (instructions are detailed in the e-offer letter);
5. Successful applicants who have accepted their offer will receive a pre-matriculation package via email and are required to complete the stipulated matriculation procedures by the deadline. Details of the admission process are available on SIT's website.

If the applicant is not offered his/her choice of program, the applicant may make an appeal during the Joint Admissions Exercise (JAE) appeal exercise that is usually conducted in late May-early June after the JAE acceptance closing date. If successful, the applicant can decide to accept the new offer as specified in the offer letter via the JAE Platform as well. He/she will then receive a pre-matriculation package via email and will be required to complete the stipulated matriculation procedures by the deadline.

4.2 Assessment

The recognition of prior learning and qualifications within the program follows the General Academic and Examination Regulations (APSOs) and is fully compliant with the Lisbon Recognition Convention. This guarantees that students' previous academic achievements are fairly and consistently recognized, facilitating smooth transitions for those entering the program with prior qualifications or transferring from other institutions. The recognition procedure is clearly outlined, ensuring that students are fully aware of how their prior learning is evaluated and credited.

Graduation documentation provided to students is comprehensive and includes all necessary information, such as qualification profiles, learning outcomes, and the specifics of the completed modules. This documentation is not only essential for academic recognition but also serves as a valuable resource for graduates as they enter the workforce or pursue further studies.

Regarding student progression, the program employs a proactive approach to monitoring academic performance. SIT in collaboration with TUM Asia, has developed a thorough system to detect underperforming students early in their studies. This early detection is critical in addressing academic difficulties before they become challenging for the further progress. Students identified as struggling receive personalized attention, with the institution working closely with them to diagnose issues and develop tailored support strategies. This may include academic counselling, tutoring, or adjustments to their study plans, ensuring that each student has access to the resources necessary to succeed.

4.3 Conclusion

The criterion is **fulfilled.**

5 ESG 1.5: Teaching staff

Institutions should assure themselves of the competence of their teachers. They should apply fair and transparent processes for the recruitment and development of the staff.

5.1 Implementation

In its basic philosophy, the TUM is committed to promoting innovation in scientific fields that promise to improve the quality of life and cohabitation in the long term. With scientific and technical skills being promoted as the cornerstone for securing the future development of a nation, TUM is responsible for a high quality of teaching with active participation from all faculties involved. Excellence in fundamental research on a high scientific level and close scientific connections to the industry by TUM faculty serve as a basis for a high quality and practically oriented education of the students. TUM's education emphasizes fundamentals, which will serve graduates for decades in their careers. The university-wide principles for teaching are set out in the TUM Teaching Constitution.

SIT recognises that the quality of the educators defines the quality of the programs and the graduates. The University is committed to establishing a culture of educational excellence by recruiting academic staff with strong industry experience, a heart for students and the passion to bring the best out of them. This will train graduates with distinctive qualities highly valued by the industry. Over time, SIT aims to achieve distinction in education based on its unique applied learning pedagogy, thereby enabling the University to attract and retain more like-minded educators with a strong standing in their community.
For TUM staff, teaching in the TCE program is not obligatory. It is a voluntary assignment with the TCE program and TUM Asia in Singapore.

Academic Staff Structure
The TUM is gearing its recruitment policy toward highly distinguished scientists of international calibre. In addition to recruiting from academia, TUM continues the German tradition of recruiting top candidates with an outstanding industrial career, especially in engineering disciplines. A systematic, ongoing screening process proactively identifies top-flight talents who are then recruited into TUM by means of headhunting principles: TUM Faculty Executive Search. Moreover, TUM's recruitment strategy is increasingly oriented toward outstanding young scientists: Attractive employment conditions and career prospects will help them to further develop their scientific potential and to actively shape the academic landscape at TUM.

To stay nimble, cost effective as well as responsive to industry and community needs, SIT adopts a nontraditional matrix academic structure that promotes inter-disciplinary collaborations and allows academic staff to teach across numerous degree programs that require their expertise.

Academic Staff Profile

TUM/TUM Asia academic staff can be broadly classified into the following two categories: Faculty and Associate Faculty (e.g. Adjunct Professors, Honorary Professors, Lecturers). SIT academic staff can be broadly classified into the following three categories: Faculty, Professional Officers (POs) and Associate Faculty.

Faculty (TUM)

The faculty of the TUM includes more than 600 professors, who represent the core subjects of the 8 TUM Schools and Departments (as of Aug 2023). Honorary professors and adjunct professors lecture on specific aspects of professional practice. Lecturers (pre or post PhD) often offer tutorials and supervise lab sessions in addition to the fundamentals taught by professors. The teaching staff currently consists of the following categories: Professors including joint appointments with non-university research institutes (e.g. MaxPlanck, Fraunhofer, Helmholtz), Adjunct and Honorary Professors and Lecturers. The criteria upon which each decision is based are academic qualifications, experience, reputation and future potential. In all cases, the candidates must have gained experience outside Germany and possess intercultural skills. Endowed chairs are assigned to one of the categories A–D depending on the purpose of the endowment and the qualification and maturity of the applicant.

Faculty (SIT)

Faculty is the core group of educators responsible for the development, design, delivery and review of the academic programs. They are expected to contribute to the three pillars of Education, Applied Research & Innovation and Service to the university, industry and/or community. With the focus on applied learning and applied research, the qualities that SIT looks for in faculty are distinct from other traditional universities. Having the required academic qualifications, faculty are expected to be well aware of the industry needs in the area(s) that they will be teaching. They are also expected to create and maintain industry linkages that allow them to keep abreast with and anticipate the new technologies and skills required by industry.

In addition, the faculty are expected to adopt the practice-oriented applied learning approach in teaching. Assessment methods should closely resemble real work to ensure students' acquisition of knowledge and skills that are highly relevant to industry. In summary, the qualities SIT looks for in faculty are:

1. Innovative, practical and exploratory
2. Able to develop new pedagogies to equip students with capabilities to adapt to the fast changing knowledge economy
3. Able to build strong connection with industry through successful and impactful applied research that brings value to the industrial partners, students, and the university
4. Able to nurture and inspire the students with innovative ideas and hands-on experience through close collaboration with industry.

SIT faculty are organised in technical domain clusters, which form the vertical components of the matrix structure. In the area of teaching, they are expected to contribute to a primary program while supporting another one or two secondary programs requiring their expertise.

SIT Professional Officers

The SIT Professional Officers Division (POD) houses a centralized pool of academic staff under the professional officer scheme. Professional Officers come with specialised and deep technical skills acquired through extensive industry experience. They form the talent pool which brings a much-needed industry perspective to student learning. They facilitate applied learning and applied research in SIT, complementing the academic expertise of the faculty to bring industry practices and applications into the curriculum.

Professional Officers (POs) are respected as equals to the faculty in SIT. They leverage on their industry experiences to create authentic learning environments, where discovery and innovation take place. They act as coaches and mentors to students during practical learning activities such as laboratory sessions, Capstone Projects and the Integrated Work Study Program (IWSP). Professional Officers could also lead or work with faculty on industry innovation projects to provide solutions to the industry.

In addition to their role in applied learning and applied research, POs manage the centralised laboratory facilities and resources in SIT. With Technical Officers (TOs), laboratory safety professionals, and administrators in POD, they jointly develop central policies and processes for the safe and seamless operation of laboratories in SIT.

TUM Faculty Professional Development in Research

First and foremost, TUM professors are expected to be at the forefront of research in their area of expertise. They will regularly present their research at the leading conferences in their field which they attend on a regular basis and publish their research in the most prestigious journals of their field. TUM professors will often contribute to the program, executive or steering committees of the leading conferences. They will hold relevant editorships at the key journals. This way they not just stay abreast of key developments in their fields, they actively influence and shape them. Their research acumen and achievement will find its way into their lectures (of course, current research results will primarily enter graduate courses; foundation undergraduate courses are affected by new developments in research typically with some time lag and primarily in case of fundamental paradigm shifts).

Financial support and time-off are also provided for faculty and professional officer to attend international academic and trade conferences, workshops and masterclasses. This allows them to keep abreast of the latest development in their respective areas of expertise. These new ideas and development will be infused into lesson content and/or module design, where appropriate. It is also at these conferences that academic staff share with the academia and industry communities about SIT, which potentially creates opportunity for collaboration. Faculty without a PhD may be sponsored for qualifications upgrading. Their PhD topics are expected to be applied in nature, with direct relevance to Singapore and the region.

5.2 Assessment

The TCE program at TUM Asia and SIT aims to recruit top-tier educators from academia and the industry. This commitment to excellence aligns with the ESG requirements, which emphasizes the importance of qualified and diverse teaching staff in enhancing the educational experience.

In partnership, TUM Asia and SIT run an active search strategy to attract leading experts through comprehensive recruitment processes, ensuring transparency and inclusivity by involving various stakeholders, including students. These procedures are guided by established legal frameworks that guarantee a fair and equitable hiring process. Beyond academic qualifications, significant emphasis is placed on candidates' educational experience and their intercultural competencies, particularly those gained outside of Singapore and Germany. This approach ensures a multicultural and dynamic learning environment.

The TCE program actively supports the career development of young academics by providing clear career pathways, such as the TUM Faculty Tenure Track. This system is supported by

initiatives like the TUM Tenure Track Academy and dedicated mentoring teams, which systematically nurture young scientists' growth, guiding them towards full professorships through regular evaluations and performance assessments.

In Singapore, teaching at TUM Asia is a voluntary endeavour for TUM faculty, yet it benefits significantly from the enthusiasm of newly recruited professors eager to contribute to the program. This has resulted in a strong pool of highly qualified TUM professors actively engaged in teaching, ensuring technical diversity and continuity in the curriculum. The faculty is further strengthened by teaching assistants who manage tutorials and laboratory courses, enhancing the hands-on learning experience for students.

SIT adopts an industry-focused teaching approach, requiring educators to remain attuned to current industry needs. This approach is supported by professional officers who bring extensive industry experience, facilitating applied learning and the use of centralized lab facilities. This industry-oriented methodology complements TUM’s research-focused approach, creating a well-rounded educational experience for students.

Both institutions provide substantial support for teaching staff development. TUM's "ProLehre" program offers comprehensive support in teaching and didactics, including course planning, revision, coaching, e-learning, and innovative teaching methods. Similarly, SIT has established the Centre for Learning Environment and Assessment Development (CoLEAD), which promotes an application-oriented teaching approach and offers dedicated programs for staff development across various career stages, focusing on learning design, classroom practices, and media production. Additionally, grants for teaching projects are available to encourage pedagogical innovation.

Succession of the study program director at TUM Asia

The collaboration between TUM and SIT ensures that high standards of teaching are maintained at TUM Asia, leveraging the strengths of both institutions. TUM's focus on research excellence and SIT's emphasis on industry applications provide students with a comprehensive education that prepares them for diverse career paths. This synergy reflects the institutions' commitment to high-quality teaching and the continuous professional development of their teaching staff. It can be seen that there is a lot of effort to undergo this very challenging project between TUM in Germany and SIT in Singapore. Due to the individual performance of unique active lecturers at TUM and TUM Asia, it is recommended to clarify future appointment procedures with the succession of the study program director at TUM Asia and the managing director at an early stage and with suitable candidates. This leads to improved planning for all involved lecturers and eliminates overlaps in personnel planning. [Recommendation 7]

5.3 Conclusion

The criterion is **fulfilled.**

The expert panel suggest the following recommendation:

Recommendation 7: The appointment of a successor to the head of the degree program and the managing director at TUM Asia should be tackled at an early stage.

6 ESG 1.6: Learning resources and student support

Institutions should have appropriate funding for learning and teaching activities and ensure that adequate and readily accessible learning resources and student support are provided.

6.1 Implementation

SIT's main campus is located at Dover Drive, where classes for SIT and joint degree programs are held. SIT have five satellite campuses located across Singapore, within the grounds of a polytechnic, offering SIT, joint and overseas university degree programs.

SIT will move to a brand-new campus SIT Punggol and is set to transform Punggol North in Singapore into a vibrant learning and economic hub. SIT's new campus has been designed to seamlessly integrate with the industry and community as part of the Punggol Digital District. This will enable SIT to deliver a practical, industry-focused education that will prepare SIT's students for the future.

SIT is leading the way in creating an intelligent and sustainable university experience by harnessing the power of the Internet of Things. SIT students have the opportunity to work closely with industry partners in SIT's smart laboratory. These partners can take advantage of SIT's living lab, which provides an open innovation ecosystem for testing and piloting their prototypes in a real-life environment.

TCE students can use all of SIT's physical resources available for students.

Funding for Learning & Teaching Activities

SIT is a publicly funded university. Ministry of Education (MOE) is the primary source of operating and capital development funding for the University. The allocation mechanisms for the various pools of funds are performance-driven, i.e. MOE's funding is provided in return for delivery of a set of predetermined outcomes.

The program is heavily subsidized through MOE grants. Together with the tuition fees received from students, it is sufficiently resourced to support its operations. MOE grants comprise operating grants and capital funding for the acquisition of Information Technology, Furniture, and Equipment (ITFE).

Academic Service Teams at TUM Asia and SIT

A dedicated Academic Services Department (ASD) at TUM Asia ensures the smooth running of the TCE program, as well as other programs administered by TUM Asia. This team consists of one academic service manager (ASM, TUM-Asia) and one academic service executive (ASE, TUM-Asia).

The Academic Programs Administration (APA) division at SIT provides administrative support for all degree programs and to faculty at SIT. Within APA, the functional sections comprise of support teams for the five clusters and two horizontal pillars - Academic Services and Faculty Support teams as APA adopts a centralised approach in efficient allocation of its resources to support the wide spectrum of activities within the Academic Group.

Student Support Services

There are many services available for students seeking support during their study life cycle. The SIT Counselling Service, conducted by in-house, professional counsellors, is available for all students, either in person on campus or via online counselling sessions. Student counsellors provide assistance and support to students facing personal challenges in their lives. For regular academic counselling, this is usually handled by the assigned academic mentors and/or the program academic advisor to the SMC. A counselling advisory committee was set up in July 2018 for optimal systems and processes to meet best practices.

Centre of Career Readiness (CCR) conducts various information sessions and workshops to prepare the students for their IWSP. These activities include networking workshops, resume review clinics and mock interview sessions, self-discovery through Myers-Briggs Type Indicator (MBTI), IWSP reflection learning, pre-departure briefing etc. CCR also organizes annual Career Nexus which is a networking event for students and graduates seeking IWSP and full-time employment opportunities, respectively. Through the interactions with the representatives from participating companies, students get a chance to better understand the company’s culture and various career opportunities, thus allowing them to make more informed choices of their employment application.

The Global Experience Division (GED) provides potential overseas internship opportunities and coordinates the 3-week Overseas Immersion Program (OIP) at TUM.

Material Resources and Student/Teacher Ratio

The average student/ teacher ratio since the start of the program is 18/1. Students are enrolled in these joint degrees have free access to the facilities and benefits from both universities: TUM Library Membership and Study Resources; SIT Library Membership and Study Resources; SIT Lab facilities; SIT Sports facilities; SIT Intranet, Email, and Wi-Fi; and SIT Computer Labs; SIT Study and Collaboration Areas; and SIT Health and Wellness.

Library and Information Resources

The library's mission is to provide timely access to relevant information resources and services to support SIT's teaching and learning needs. It serves as a virtual library, as an instructional unit for information literacy and as a learning space.

Students pursuing Chemical Engineering can tap on both SIT Library's resources and Technical University of Munich (TUM) Library's e-resources for their study and learning.

TUM Library Resources

With over 2 million printed and electronic items, 260,000 loans, over 4.8 million full-text downloads and 1.5 million library visitors each year, the university library is the academic information centre of TUM (TUM University Library). These services support students, scientists and university staff in their studies, research, teaching, further education and advanced training.

At TUM's nine branch libraries, situated at the university's campuses in Munich, Garching, Freising and Straubing. TUM carries out tasks in the area of literature and information provision for research facilities, companies and private individuals both in Bavaria and nationwide. As a library for legal deposits, TUM archives an essential part of the technical literature published in Bavaria.

By using modern information and communication technologies and professional knowledge management, librarians have adopted an important role as information professionals, who make literature and information available - wherever and whenever required. Working at the interface between knowledge production, knowledge archiving and knowledge transfer, TUM offers immediate and efficient access to scientific information and support academics and students in carrying out their research projects, learning and teaching processes efficiently.

TUM Learning Commons and Meeting Point

In TUM's nine branch libraries, patrons find a modern environment for learning and studying with computer workstations, internet access, scanning facilities. This, along with long opening hours until midnight and on weekends, makes the library a preferred location for learning and communicating at university for many students.

Loan Services and Textbook Collections

An extensive range of literature and five textbook collections are available to all library patrons. TUM's courier service enables library items to be borrowed and returned free of charge at any branch library.

E-Book and E-Journal Collections

TUM ensures that the latest academic books and printed journals reach the library shelves quickly. Furthermore, TUM purchases and licenses numerous e-books, e-journals and specialized databases and make them accessible for TUM students and university staff, on campus and off-campus.

Document Delivery Services

TUM provide library patrons with articles and books delivered directly to their desks and literature that is not available at the university library. TUM's document delivery portfolio comprises the following online services: interlibrary loan, digitisation-on-demand and the in-house delivery service dokumenTUM.

Information Literacy Training

In today's information-based society, skilled handling of information and media is a key competence for success at university and work. As information professionals, TUM Library provides a wide range of information literacy training options to support studies, further education and lifelong learning. TUM Library offers library tours, lectures and courses as part of bachelor and master programs and information literacy workshops for students, doctoral candidates, high-school students and teachers.

Electronic Publishing and MediaTUM

TUM Library offer academics at the university the opportunity to publish their dissertation or habilitation thesis electronically on mediaTUM, the media server at TUM. mediaTUM is based on the open-source software mediaTUM to manage, present, publish, archive and retrieve digital images, documents and videos. mediaTUM was originally developed by the university library, in the framework of the DFG project IntegraTUM.

SIT Library Resources

To facilitate fast and easy access to resources, SIT Library focuses on building a robust online collection. Currently, electronic resources account for 99% of the library's collection. The library provides access to over 250,000 e-books, more than 115,000 online journals, 36,000 online standards and numerous databases. The SIT Community can access virtual resources anytime and from anywhere via the SIT Library website.

To facilitate the discovery of these resources, the SIT Library has implemented a One Search discovery service. This allows students and faculty to search across multidisciplinary databases using One Search box and refine their results using sophisticated filters. In addition to searching for subject specific databases, the discovery service searches across 147 indexes. This significantly expands the scope and coverage of discoverable resources available to SIT Faculty and Students. There are 25 databases relevant to this program that are available in the library's collection.

Access to the library collections and services is further extended via Inter-Library Loan & Document Delivery Service (ILL&DDS) arrangements. The library has established formal ILL&DDS arrangements with more than ten local libraries as well as with more than 250 overseas libraries through RapidILL resource sharing system. In terms of document delivery services, materials that are not available via these arrangements may also be bought directly from publishers e.g. online article purchase.

Learning Services

The library is staffed by experienced academic librarians holding professional qualifications such as MSc Library & Information Science. This is vital in providing value added services to SIT faculty and students. These services include: (1) Course Material Support, (2): Course Subject Guides (3) How-To Guides, (4) Information Service Desk & Research Consultations, (5) Information and Digital Literacy (IDL) Instruction, (6) Micro-modules.

6.2 Assessment

The TUM/SIT program is supported by a big variety of facilities and equipment convenient to satisfy the program learning requirements for students and teachers.

Classrooms:

SIT offers modern laboratories and classrooms with the necessary tools and technology to facilitate practical learning and experimentation. The classrooms are equipped with modern video projectors which teachers can use to show the teaching material they have prepared for their classes. Classrooms with have capacities, these resources are duplicated for a better view by the students who are attending the class. These classrooms are also equipped with audio systems that allow the teacher's explanations to be heard without any problems.

Laboratories:

The laboratories are also well equipped with experimental, instrumentation and even manufacturing devices. Although these laboratories are used in other programs, their equipment is sufficient to meet the needs of students enrolled in the Chemical Engineering

program. The electronics laboratory, which contains a sufficient number of workstations for students to work comfortably in pairs at the same time, stands out favourably. Each workstation is equipped with a signal generator, an oscilloscope and a multimeter. This instrumentation is considered to be very complete and allows a wide variety of practical work to be carried out.

The electronics laboratory also contains several machines for printing circuit boards (PCBs) and even an anechoic chamber for radio frequency experiments. The presence of these facilities is highly appreciated by the expert group.

TUM/SIT library:

The joint library offers a comprehensive collection of academic resources, including a wide array of books, journals, and digital databases suitable for the needs of chemical engineering students. The library provides various spaces for learning, including individual study areas and collaborative spaces. This versatility supports a range of learning activities, from focused solo work to group projects and discussions.

The library allows access to media studios and equipment like VR headsets and the integration of technology in education. These resources are particularly beneficial for the TCE program, as they can simulate real-world scenarios and provide hands-on experience with tools relevant to the industry.

The library contains a wide array of books, journals, and databases which cover the contents of the different subjects in the TCE program. The library's commitment to offering both foundational texts and cutting-edge research materials supports a well-rounded academic experience.

The library provides services like online reservations and smart lockers for equipment pick-up. This user-friendly approach is appreciated as it enhances accessibility and convenience for students.

Overall, the library is a cornerstone of the educational infrastructure for the program. It provides a comprehensive range of services and resources essential for supporting the students.

Administrative staff

The academic and operational aspects of the program are conveniently supported by a dedicated Academic Services Department. The team of this department is well-structured into the Academic Service Manager and the Academic Services Executive. The administrative staff has the qualifications and capabilities necessary to support the TCE program. Individuals showed excellent experience and education in academic administration during the site visit.

The administrative staff is well-organized to efficiently handle the specific operational aspects of the program, ensuring targeted and expert support for both faculty and students. The staff

possess a high level of competence and were highly involved in all the program accreditation processes.

Student mobility is fundamental in this joint TUM-SIT program. The administrative staff conveniently assists students with the logistical aspects of studying abroad, including coordination with partner institutions, managing exchange agreements, and ensuring students meet the requirements for study trips and exchanges.

Administrative personnel also manage the recognition of credits and certifications obtained abroad, ensuring that students' mobility does not hinder their academic progression within the program.

The program provides a broad spectrum of learning materials, from traditional textbooks and academic papers to digital resources and multimedia content. This variety ensures that students with different learning preferences (visual, auditory, reading/writing, and kinaesthetic) can find materials that suit their style.

The program provides digital and physical resources. This way, students can access learning materials regardless of their physical location or time constraints, benefiting those who may be part-time students or international students. The program also combines traditional in-class instruction with online activities and project-based learning and flipped classroom approaches, to offer flexibility in how and when students engage with the given materials and real scenarios.

SIT provides mental health services and well-being initiatives to support students' overall health. It also includes support for students with disabilities while studying together.

The program provides a wide array of learning materials and comprehensive support services. This illustrates the commitment of SIT to a student-centred educational approach. Therefore, the program features modern, industry-standard equipment and facilities, ensuring that students have access to tools and resources that reflect current professional practices. Additionally, there are systems in place to ensure that all students, including those with disabilities, can access the necessary equipment, thereby supporting an inclusive learning environment. The program's commitment to regular updates and responsiveness to student feedback suggests a proactive method to maintaining the relevance and accessibility of their resources.

SIT utilizes multiple platforms such as email, learning management systems, social media, and dedicated portals to disseminate information about their services. It also offers introductory sessions for new students that cover all available services, from academic support to health and wellness resources.

The given information in the report and during the session did not specify particular actions for the further qualification of supervising/administrative staff. It merely outlines the program's general approach to staff development, or the quality of education provided, but does not detail specific strategies or methods for a general staff development. This topic could be strengthened in the future.

6.3 Conclusion

The criterion is **fulfilled.**

7 ESG 1.7: Information management

Institutions should ensure that they collect, analyse and use relevant information for the effective management of their programs and other activities.

7.1 Implementation

In their collaborative corporate study programs, TUM Asia and SIT integrate their information management systems to provide seamless and comprehensive support to students. This collaboration ensures that all information regarding joint programs are consistently and accurately communicated, leveraging the strengths of both institutions' systems. Joint efforts include coordinated updates to program details, shared access to student support services, and unified channels for feedback and inquiries. This integrated approach not only enhances the student experience but also strengthens the overall quality assurance framework in line with the ESG.

By following to these information management standards, TUM Asia and SIT demonstrate their commitment to upholding the highest levels of quality assurance and transparency, thereby ensuring that their corporate study programs in Singapore meet and exceed the expectations of students, industry partners, and regulatory bodies.

7.2 Assessment

SIT clearly identifies the sections in charge of collecting and analysing the information on the TCE program. The program's approach to collecting and analysing information is thorough, ensuring that decisions are informed by accurate and up-to-date data, with the ultimate goal of enhancing the educational experience and outcomes for students.

Data is available over the last four years as the program was setup in AY2020. Student numbers are fairly rising over the period AY2020 to AY2023. Yet, the number of students withdrawn from the program were also higher than in subsequent years. It is appreciated that

no students were dismissed from the program during AY2022 and AY2023 due to a Corona relief.

Both students and employees are engaged in supplying and evaluating data as well as in the planning of follow-up activities. Their participation ensures that the data collected is relevant and that the resulting actions are well-informed and effective, considering the perspectives and experiences of those directly involved with the program. This inclusive approach leads to more comprehensive and actionable insights for follow-up activities, driving improvements that are aligned with the needs of all stakeholders.

7.3 Conclusion

The criterion is **fulfilled.**

8 ESG 1.8: Public information

Institutions should publish information about their activities, including programs, which is clear, accurate, objective, up-to date and readily accessible.

8.1 Implementation

TUM, TUM Asia and SIT regularly provide and update information about the institutions' activities, through various platforms to all stakeholders (including but not limited to prospective students, current students, alumni, stakeholders in academia and industry and so on). Stakeholders can find all relevant information on the study programs which TUM, TUM Asia and SIT offer.

8.2 Assessment

TUM Asia and SIT provide comprehensive information about the structure and content of the study program on their respective websites, serving as the main source for any needed information. Administrative procedures are handled via the standard SIT application process on the SIT website. Although all relevant information were clearly addressed and mentioned on the existing website, there is always room for improvement with regard to whether the information is clear, accurate, objective, up-to date and readily accessible to everyone.

8.3 Conclusion

The criterion is **fulfilled.**

9 ESG 1.9: On-going monitoring and periodic review of programs

Institutions should monitor and periodically review their programs to ensure that they achieve the objectives set for them and respond to the needs of students and society. These reviews should lead to continuous improvement of the program. Any action planned or taken as a result should be communicated to all those concerned.

9.1 Implementation

Program Constituent Stakeholders

The following two groups of stakeholders closely related to the programs are identified by the HEI:

a) TUM and SIT constituencies: Current undergraduate students ("students"); Faculty members of the School ("faculty"); Administrative staff supporting the programs' operations; Other administrative departments of TUM and SIT such as the Academic Program Administration, Office of Admissions, TIE. ("SIT Administration")

b) External constituencies: Alumni; Employers; Members of the Industrial Advisory Committee (IAC); Ministry of Education; Community

Process for Establishing Program Educational Objectives (PEO)

The PEOs are established based on the needs of the program's various constituencies. Specifically, the following requirements have been incorporated into the PEOs:

1. The definition of the PEOs as given by the EAB guidelines. (Engineering Accreditation Board, 2020)
2. Both formal and informal feedback from the program's industrial partners on the required skill set for the chemical engineering graduates
3. The recommendations from the Industrial Advisory Committee (IAC) on the desired curriculum content of program

Achievement of Program Educational Objectives

There are three feedback loops. The first inner loop assesses the effectiveness of teaching and learning at the individual module learning outcomes (MLOs), the second middle loop assesses the student learning outcomes (SLOs) while the third outer loop assesses the PEOs. The third loop is closed over a longer cycle (three to five years) through external assessment and review with various stakeholders such as faculty and Industry Advisory Committee (IAC).

The achievement of the PEOs will be assessed and evaluated every 3-5 years. The assessment will be based on alumni survey, employer survey and focus group discussions

between faculty and the IAC. For alumni survey, the assessment will use data gathered from surveys of alumni 3-5 years after their graduation and their employers. The survey will ask the alumni questions on their perceptions of their abilities and attributes as engineering graduates. These questions will be mapped to the four PEOs. For each PEO, the percentage of positive responses to each question related to that PEO will be averaged. This average of percentages will be taken as an indicator of attainment as perceived by the alumni.

Similar questions will also be used in a survey for the employers. Their responses will be evaluated in order to arrive at the attainment of the PEO as seen from the employers' perspective.

The Programme Leads regularly evaluates the curriculum and teaching processes to identify areas of improvement and corrective actions which can help the programme to better meet its goals. The process comprises three feedback loops, the inner loop takes place at the individual module level fulfilling the Module Learning Outcomes (MLOs), the middle loop evaluates the effectiveness of the programme in delivering the Student Learning Outcomes (SLOs) for students at the point of graduation, and the outer loop monitors the success of the programme in terms of Programme Educational Objectives (PEOs) over the longer term by monitoring the progress made by its graduates three to five years after graduation.

Evaluation of Curriculum and Teaching Processes

The Program Leads regularly evaluate the curriculum and teaching processes to identify areas of improvement and corrective actions which can help the program to better meet its goals.

Inner Feedback Loop at Module Level

At the end of every trimester, before the final exams start, students will be asked to provide feedback for every module through the online Module Feedback and Teaching Feedback survey forms. At the end of every run of a module, the faculty who is the Module Lead is expected to evaluate the assessment results and Module/Teaching Feedback data to identify what had gone well in the module and what areas would need improvement for the next run. The Module and Teaching Feedback data inform the Module Lead about how well classroom teaching has been received by the students. The MLO feedback gives an indication of students' confidence in achieving the MLOs. In this way, the Module Lead has a comprehensive view of how students have performed in the module from different perspectives. The Module Lead will also provide his/her own reflections of the module. Possible actions for improvement may include changes to teaching pedagogy, changes to type of assessments, assignments, etc. which can help the whole class to fully attain the MLOs. Relevant samples of students' work (homework, midterm and/or final exam solutions, lab and project reports) are saved on a regular basis for future comparison and evaluation. This allows

the Module Leads to compare the results between consecutive student intakes to assess if the teaching intervention introduced is effective for the attainment of the MLOs so that they can recommend changes necessary for improvement.

At the end of each trimester, the Programme Lead/Director convene with all the module leads to discuss examination results. The discussion centres around overall performance of students, best practices in teaching and assessments, and recommendations for changes.

Middle Feedback Loop at SLO Level

The middle feedback loop monitors the effectiveness of the programme in delivering the Student Learning Outcomes. The data from the EAB Outcomes Survey for graduating students is the main instrument for assessing the attainment of the SLOs at the point of graduation. This survey is conducted every year for all graduating students. Furthermore, feedback sessions with students, IAC members, alumni and industry partners can also provide insights on improving the programme.

Outer Feedback Loop at PEO Level

The outer feedback loop evaluates the effectiveness of the programme's graduates several years after graduation. For this, the Programme plans to use surveys of alumni and their employers as well as focus group discussions with both groups.

Actions to improve the Program

As TCE is a new programme and has yet to graduate their first cohort of students, there has not been major corrections which arose from the feedback loops. Feedback will be collected from the students if the modules offered in study year 1, 2 and 3 have prepared them well for TCE3031 Plant Design 2.

As the current direct and indirect assessments were conducted only for the modules in study years in AY2020-21 and AY2021-22, the assessment exercises will be continued to cover all modules in the TCE curriculum as the students completed them and also to cover more cohorts of students. At the end of every run of the module, the module will reflect on what went well and also those that need improvement for the run and recommend changes to teaching pedagogy, type of assessments, assignments, etc. to better achieve the MLOs and SLOs.

In AY2223, SIT implemented the Undergraduate Programme Structure (UPS) as part of the university-wide effort to harmonize their programmes, UPS formally incorporates interdisciplinary learning and transferable skills components into the curriculum, better preparing the students for the workplace. The goal is to meet the demands of the evolving work landscape by developing the students` ability to take on multiple perspectives, and synthesise solutions to complex, multifaceted problems. The UPS introduced major changes

in the programme including efforts to improve based on past student feedback. The major changes include the increase in modular credits for each module from 5 SIT CR to 6 SIT CR as well as the reorganization of modules for a better knowledge transfer to the students.

9.2 Assessment

TUM Asia and SIT exemplify excellence in higher education through their meticulous attention to quality assurance practices. Both institutions have established formal policies for quality assurance that serve as pillars supporting their commitment to academic excellence and continuous improvement.

At TUM Asia, the quality assurance policy is a cornerstone of its academic framework, reflecting the institution's unwavering dedication to delivering world-class education. Developed in consultation with faculty members, administrative staff, and external experts, this policy encompasses a wide array of areas crucial to ensuring educational quality. From curriculum design and teaching methodologies to assessment practices and student support services, every aspect is meticulously outlined to uphold the highest standards of academic integrity and excellence.

Similarly, SIT boasts a comprehensive quality assurance policy that underpins its reputation as a leading institution in higher education in Singapore. This policy, developed in alignment with international accreditation standards and best practices, is readily accessible to all stakeholders, ensuring transparency and accountability. Covering essential areas such as curriculum development, pedagogical innovation, and student engagement, the policy serves as a guiding framework for maintaining and enhancing the quality of education offered at SIT.

Both TUM Asia and SIT recognize the importance of making their quality assurance policies publicly available. These policies are easily accessible through the institutions' official websites and handbooks, ensuring transparency and providing stakeholders with clear guidance on the institutions' commitment to quality education.

The quality assurance policies of TUM Asia and SIT comprehensively cover all relevant areas essential to academic excellence and program quality. From the initial design and development of curricula to the delivery of courses and assessment of student learning outcomes, every facet of the educational process is strictly addressed.

Both institutions recognize the importance of staying up to date of emerging trends and best practices in higher education. Their quality assurance policies are regularly reviewed and updated to reflect the evolving needs of students, industry partners, and society at large, ensuring that they remain at the forefront of educational innovation and excellence.

Transparency of the Quality Assurance Policy

TUM Asia's quality assurance policy emphasizes the importance of curriculum design that is responsive to industry needs and aligned with global best practices. It outlines procedures for the development and review of academic programs, ensuring that they meet the highest standards of quality and relevance. Similarly, SIT's quality assurance policy places a strong emphasis on curriculum development that is informed by industry trends and stakeholder feedback. It emphasizes the integration of real-world experiences and practical learning opportunities into the curriculum, preparing students for the demands of the global workforce. TUM Asia and SIT demonstrate a strong commitment to the effective implementation, monitoring, and revision of their quality assurance policies. Both institutions have dedicated quality assurance teams responsible for overseeing the implementation of quality assurance measures and ensuring compliance with established standards. Besides this it was seen that the policy should have more transparency and accessibility internally for everyone to participate. This will allow TUM Asia and SIT to substitute greater trust, accountability and collaboration within their academic communities. [Recommendation 9]

Continuous evaluation of the workload

In the discussion with the students, it became clear that the goals for the program are well structured but at some levels also very ambitious and demanding. This could lead to an uneven workload for the students in the first two trimesters. A continuous evaluation of the workload of the first two trimesters should be carried out in order to derive a more balanced workload (if possible) over all trimesters. [Recommendation 10]

9.3 Conclusion

The criterion is **fulfilled.**

The expert panel suggest the following recommendations:

Recommendation 9: The Transparency of the Quality Assurance Policy should be increased.
Recommendation 10: A continuous evaluation of the workload should be carried out.

10 ESG 1.10: Cyclical external quality assurance

Institutions should undergo external quality assurance in line with the ESG on a cyclical basis.

10.1 Implementation

The TCE programme is a 4-year Bachelor of Engineering degree with Honours. This joint degree will follow both TUM's and SIT's degree regulations. The program will be accredited in Germany according to Bavarian regulations. A detailed timeline will be established with the Bavarian Ministry for Science and the Arts' approval. This program has received provisional accreditation and will later be fully accredited by the Singapore Engineering Accreditation Board (EAB).

TUM External Quality Assurance

TUM as whole institution is system-accredited in Germany. The internal quality management ensures that all structures and processes relevant to studying and teaching meet high quality requirements. The current system-accreditation is valid through 30 September 2028. The accreditation procedure essentially consists of an internal self-evaluation followed by a series of external appraisals conducted by an agency certified by the Accreditation Council. Besides evaluating the specific degree programs, an evaluation of the Schools (former Departments) at TUM takes place. The School evaluations are held every 6 to 8 years and include external evaluation in the form of an "Informed Peer Review". In this way, external expertise is engaged in the strategic development of School profiles and their degree programs. With regard to external quality assurance, the programs taught in Singapore at TUM Asia such as the TCE program undergo an individual program accreditation. The Master's programs offered at TUM Asia received accreditation in 2020.

Industry Advisory Committee (IAC)

As a university of applied learning, Singapore Institute of Technology (SIT) strives to integrate learning, industry, and community. To remain industry-relevant, SIT continually fine-tunes its curricula and pedagogy. This is vital to the success and growth of SIT's programs and to equip SIT's students with employment ready knowledge, skills and competencies.

The Industrial Advisory Committee (IAC) provides a platform for on-going exchange of information between the industry and the university. The principal purpose of the IAC is to provide feedback and advice concerning the development, maintenance, and stakeholder acceptance to the degree programs offered by the University. SIT considers IAC as instrumental in understanding the industries' needs with respect to the type of talents that they require. With these needs, SIT is thus able to develop and equip its students with the right skills and traits that the industries require. The IAC meeting is held twice a year, where the programme improvements were discussed based on statistics on the programme along with major feedbacks from the students, teaching and administrative staff, in order to align the programme towards industry/employers' needs and expectations. The IAC include major

industry players such as GSK, Evonik, Linde Gas, Emerson as well as representatives from Statutory Boards of Singapore.

The term of references for IAC are as follows:

1. Review the program educational objectives and statistics/data to ensure that they meet the needs of business, industry and society as well as the relevant accreditation criteria;
2. Advise, recommend and assist in identifying the need for new majors/specialisations to be offered by the degree program;
3. Evaluate strengths, merits, and weaknesses of the program and propose strategies for continuous improvement of the program;
4. Provide recommendations related to the curriculum so as to improve the relationship between academic and best professional practices;
5. Provide inputs and feedback on new program(s) that are of similar domains proposed by SIT;
6. Advise on current and future employment opportunities, industry trends and employer needs;
7. Assist in identifying and creating opportunities that will be of benefit to the degree program, for example, student placements, and partnerships with industry majors, scholarships, endowments, etc.;
8. Promote and enhance the visibility of SIT and its degree program both locally as well as internationally; and
9. Explore and connect SIT and Industry on possible collaboration in applied research.

The IAC will meet at least twice every Academic Year but may meet more frequently when necessary. Individual members of the IAC may also be approached on an ad-hoc basis, subjected to his/her availability, for advice or further discussions of specific matters arising from meetings. IAC meeting agenda could cover (but is not limited to): Existing and/or new academic programs and development; How to equip students with the relevant skills to meet industries' needs; Ensuring current academic curriculum meets industry needs; Recommendations for Integrated Work Study Program (IWSP); Securing scholarships for students in the industry; and Possible areas for applied research projects/consultancy/collaboration. Members of IAC are selected for their expertise and leadership in their respective fields and sectors. They are invited as individuals to represent their professional standing within an industry; members do not represent their company.

10.2 Assessment

The external quality assurance practices of the TUM Asia and SIT are evaluated very positively from a holistic view, demonstrating a robust commitment to ensuring excellence across all aspects of its operations.

Comprehensive Coverage

The quality assurance framework of the HEI is appropriately designed to cover different organizational levels and status groups within the institution. It encompasses a wide range of activities, including teaching, research, administration, and support services, ensuring that all areas crucial to the institution's functioning are subject to rigorous evaluation and improvement.

Alignment with Legal Framework

The quality assurance mechanisms of the HEI are meticulously aligned with the relevant legal framework governing higher education. By adhering to national regulations and standards, the institution ensures compliance with legal requirements while upholding the integrity and credibility of its academic programs and services.

Confirmation and Improvement

The external quality assurance processes serve to both confirm the internal quality assurance practices of the HEI and stimulate continuous improvement. External evaluators provide valuable feedback and recommendations based on thorough assessments, validating the institution's existing quality assurance measures and identifying areas for enhancement. This iterative approach fosters a culture of continuous improvement, driving the institution towards higher levels of excellence and effectiveness.

Transparency and Accountability

The quality assurance mechanisms of the HEI are transparent and accountable, providing the university community and the public with comprehensive information on the quality of its activities. Reports, evaluations, and accreditation outcomes are made readily available to stakeholders, facilitating informed decision-making and promoting accountability at all levels of the institution.

Overall, the external quality assurance practices of the HEI demonstrate a strong commitment to excellence, accountability, and continuous improvement. By ensuring comprehensive coverage, alignment with legal requirements, and transparency in reporting, the institution upholds the highest standards of quality and integrity in its academic endeavours.

10.3 Conclusion

The criterion is **fulfilled.**

IV Recommendation to the Accreditation Commission of ACQUIN

1 Assessment of compliance the Standards and Guidelines in the Higher European Area (ESG) in the actual official version

The study program „Chemical Engineering“ ((B.Eng. (Hons)) were assessed on the basis of the "Standards and Guidelines for Quality Assurance in the European Higher Education Area" (ESG), and the national or other relevant regulations.

The expert group concludes that the **ESG standards** 1.1 (Policy for quality assurance), 1.2 (Design and approval of programs), 1.3 (Student-centred learning, teaching and assessment), 1.4 (Student admission, progression, recognition and certification), 1.5 (Teaching staff), 1.6 (Learning resources and student support), 1.7 (Information management), 1.8 (Public information), 1.9 (On-going monitoring and periodic review of programs) and 1.10 (Cyclical external quality assurance) are fulfilled.

The assessment criteria are as follows:

Standard 1.1 Policy for quality assurance: Universities have a publicly accessible quality assurance strategy, which is part of their strategic management. This strategy is developed and implemented by internal stakeholder representatives through appropriate structures and processes, involving external stakeholders.

The criterion is **fulfilled.**

Standard 1.2 Design and approval of programs: Universities have procedures for the design and approval of their courses. The courses are designed in such a way that their objectives, including the desired learning outcomes, can be achieved. The qualification obtained during a degree program is clearly defined and communicated; it refers to the corresponding level of the national qualifications framework for higher education and, consequently, the qualifications framework for the European Higher Education Area.

The criterion is **fulfilled.**

Standard 1.3 Student-centred learning, teaching and assessment: Universities ensure that the courses offered are carried out in such a way as to encourage students to play an active role in the design of the learning process and that this approach is also taken into account when assessing students / examinations.

The criterion is **fulfilled.**

Standard 1.4 Student admission, progression, recognition and certification: Universities ensure that the courses offered are carried out in such a way as to encourage students to play an active role in the design of the learning process and that this approach is also taken into account when assessing students / examinations.

The criterion is **fulfilled.**

Standard 1.5 Teaching staff: Universities ensure the competence of their teachers. They use fair and transparent procedures for the recruitment and further training of their employees.

The criterion is **fulfilled.**

Standard 1.6 Learning resources and student support: The university has adequate funding to finance study and teaching and ensure that there is always a sufficient and readily available range of learning and support available for their studies.

The criterion is **fulfilled.**

Standard 1.7 Information management: Universities ensure that they collect, analyse and use the relevant data relevant to the successful conduct of studies and other activities.

The criterion is **fulfilled.**

Standard 1.8 Public information: Universities publish easily understandable, correct, objective, up-to-date and well-accessible information about their activities and courses of study.

The criterion is **fulfilled.**

Standard 1.9 On-going monitoring and periodic review of programs: Universities are constantly monitoring their courses and regularly reviewing them to ensure that they achieve the goals set and meet the needs of students and society. The tests lead to a continuous improvement of the courses. All affected parties will be informed about any measures planned or resulting from this.

The criterion is **fulfilled.**

Standard 1.10 Cyclical external quality assurance: Universities regularly undergo external quality assurance procedures in accordance with the ESG.

The criterion is **fulfilled.**

2 Accreditation Recommendation

The peer-review experts recommend an unconditional accreditation of the study program „Chemical Engineering“ ((B.Eng. (Hons)).

General recommendations for the study program:

1. The stakeholder engagement in the quality assurance processes within TUM and SIT should be enhanced and streamlined to strengthen the outcome of the feedback sessions.
2. The TUM Asia should streamline the joint monitoring and evaluation processes to ensure greater efficiency and effectiveness with their automated data and analytics tools.
3. More intercultural and academic mobility opportunities should be considered to enable students to immerse themselves with the German culture.
4. A better freedom of overlapping block modules in the design of the curriculum and associated regulations in Singapore should be taken care of.
5. The succession of the study program director and the managing director at TUM Asia should be considered very early to avoid short-term interims positions.
6. Consideration should be given to creating more transparency in quality assurance policies as a substitute for more trust, accountability and co-operation within the respective academic communities.
7. A continuous evaluation of the workload should be carried out in order to enable a better distribution of the workload in the first two trimesters and to harmonise it over the entire study period.

V Decisions of the Accreditation Commission of ACQUIN

Based on the evaluation report of the expert group and the statement of the Higher Education Institution, the Accreditation Commission of ACQUIN has made its decision on the 12 September 2024:

Chemical Engineering (B.Eng. (Hons))

The study programme "Chemical Engineering" (Bachelor of Engineering (Hons)) is accredited without any conditions.

The accreditation is valid until 30. September 2030.

The following recommendations are given for the further development of the study programme:

- The stakeholder engagement in the quality assurance processes within TUM and SIT should be enhanced and streamlined to strengthen the outcome of the feedback sessions.
- The TUM Asia should streamline the joint monitoring and evaluation processes to ensure greater efficiency and effectiveness with their automated data and analytics tools.
- More intercultural and academic mobility opportunities should be considered to enable students to immerse themselves with the German culture.
- A better freedom of overlapping block modules in the design of the curriculum and associated regulations in Singapore should be taken care of.
- The succession of the study program director and the managing director at TUM Asia should be considered very early to avoid short-term interims positions.
- Consideration should be given to creating more transparency in quality assurance policies as a substitute for more trust, accountability and co-operation within the respective academic communities.
- A continuous evaluation of the workload should be carried out in order to enable a better distribution of the workload in the first two trimesters and to harmonise it over the entire study period.