

Degree Programme Documentation Master's Programme in Logistics Engineering and Management

Part A
TUM School of Engineering and Design
Technical University of Munich

General Information:

- Administrative responsibility: TUM School of Engineering and Design
- Name of degree programme: Logistics Engineering and Management
- Degree: Master of Science
(M.Sc)
- Standard duration of study and credits:
4 semesters of enrolment and 120 credit points (CP)
- Form of study: full time
- Admission: Aptitude assessment (EV – Master's)
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- Language(s) of Instruction: English
- Main Location: TUM Asia Campus Singapore
- Additional information: TUM Degree offered at TUM Asia in Singapore
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1 Degree Programme Objectives

1.1 Purpose

The efficient movement of material, goods, information and also people is an essential part of an efficient economy. The trends of globalisation and increasing international value chains requires efficient logistics processes. Logistics includes the planning, optimization, management and control of the flow of materials, goods and information. Logistics is part all stages of the value chain from procurement, production, sales, and disposal. The concept of supply chain management means the integration of the different logistic processes.

Logistics is increasingly seen as a competitive factor by industry and trade. The primary objective of logistics is to provide an adequate level of service. It covers ecological, economical and social aspects and includes the rethinking of traditional value chains and the design efficient of logistics chains on operational and strategical level.

Logistics contains different segments like contract logistics, global air and ocean cargo logistics, bulk logistics etc. They all have some different requirements. It is necessary to understand and optimize the different operations in logistics like transportation and turnover of objects, or the warehousing and picking and packing of goods.

Taking all these aspects into consideration, the *TUM School of Engineering and Design* established a special and international Masters' programme in *Logistics Engineering and Management (LEM)* that reflects and critically examines the new challenges of modern and efficient logistic systems.

Modern logistics engineers need to know about the transport, storage, and handling of goods and products throughout the process of manufacturing, distribution, consumption and disposal. They should be able to incorporate currently available mathematical modelling approaches into their decision making and utilize computed-based support for the solution of typical freight logistic decision problems. Therefore it is the goal to offer a master's programme, that provides society with graduates that understand the complexity of Logistics and Supply Chain Management with its current definitions and concept as well as practical applications.

This programme is offered at TUM Asia, which is an affiliate of the Technische Universität München (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)*.

In summary, the programme is designed to enhance the classical training programme for logistic professionals, towards an interdisciplinary and system-orientated education, including a shift in focus towards the basic and application research field. Taking all this into account, the programme prepares highly qualified professionals for the dynamically growing market of *LOGISTICS ENGINEERING AND MANAGEMENT*.

1.2 Strategic Significance

TUM's mission is to inspire, promote and develop talents in all their diversity to become responsible, broad-minded individuals and empower them to shape the progress of innovation for people, nature and society with the highest scientific standards and technological expertise, with entrepreneurial courage and sensitivity to social and political issues, as well as a lifelong commitment to learning.

TUM School of Engineering and Design consolidates expertise from the fields of mechanical engineering as well as civil, geo and environmental engineering, aerospace and geodesy and a part of electrical engineering and architecture.

The School's focus areas range from innovations for intelligent mobility both on and above the ground, transformation of the built environment, manufacturing and energy supply all the way to ecological and sustainable circular economies.

The Masters' programme of *LOGISTICS ENGINEERING AND MANAGEMENT* support mission statement of entire TUM and of the School of Engineering and Design. It strengthens TUM in one of the most relevant academic fields of our modern life, transport and supply chain management of goods, material, information and people. By focusing on international students and by offering this in Singapore under TUM Asia it's promotes the central elements of the TUM mission: innovation for people, nature and society, global mindedness and tolerance, learning without borders and entrepreneurial thinking and action.

The transport of goods and materials is internationally oriented. The trends of globalisation and international value chains are affecting the transport networks for people and goods. The industry is changing is structurer in terms of global value chains, markets and collaborations. This directly affects the logistics operation in all their different aspects from transport, warehousing and packing of objects.

The Masters' programme will show these uprising challenges and new solution in logistics engineering and management for the different logistics sectors like consumer goods, third party logistics service providers, health care, industrial and green logistics.

The topics sustainable development, environment and energy represents one of the central issues addressed by the TUM as well as by the School of School of Engineering and Design. Therefore, sustainability and learning how to go green in a holistic manner by applying green techniques which make companies 'greener' while increasing short- and long-term profits for the company is also part of the master programme. To understand the revolutionary new wave of business in the 21st century, Green supply chains including its drivers and objectives must be an essential part of the programme since it is also an fundamental part of the TUM mission.

The programme *LOGISTICS ENGINEERING AND MANAGEMENT* is based on research and teaching competence of various chairs and departments of the School of Engineering and Design. Graduates interested in research work and want to pursue higher studies can also benefit from this programme. TUM educates Ph.D. candidates to perform leading-edge, world-class research. Other universities and institutes are also glad to admit TUM graduates into their programmes.

The specialized MSc. programmes aim to be in pace with industry trends and needs, while constantly challenging the worldview of students with an Asian-European curriculum. Students can obtain a wealth of knowledge and experience from lecturers and professors coming from as far away as Germany. Students can complete their Master thesis and internship in any country of their choice.

TUM Asia fosters talented individuals irrespective of gender, nationality, religion, belief, disability, age, or sexual orientation. We support equal opportunities for men and women, acknowledge and promote the diversity and differences among our 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 our scholars, scientists, students, and employees makes TUM an innovative and dynamic university. With our motto, "Talents in Diversity" TUM Asia creates

a study and work environment where individual abilities can develop and flourish. The result is a study and workplace characterized by vibrant teams, fruitful debate, and outstanding research. Our Academic Service Team offers a broad range of advising and services to support students in all life circumstances.

Globalization is now an inevitable force that is here to stay. At TUM Asia, our classroom reflects this diversity with an enrolment of over 28 nationalities. This means that we foster a vibrant learning environment where the student learns not only from the textbook but also through the lives of their counterparts. Classroom ideas are synthesized across the diverse economic realities and students learn to see from multiple points of view, creating a capacity to solve problems creatively. The unique degree equips the student with not only technical and scientific knowledge but with an enriched curriculum composed of business and cultural modules.

2 Qualification Profile

After successful completion of the degree programme, graduates will receive the academic degree “*LOGISTICS ENGINEERING AND MANAGEMENT*” that qualifies them for professional work or academic research in the wide field of logistics. Graduates of this Masters’ programme possess a wide portfolio of relevant competences, abilities and know-how in logistics related areas and they are capable to apply this knowledge and skills when working in the dynamically growing market sector of logistics systems and management. For which they develop a professional self-understanding based on the objectives and standards of professional action in academia and society. This qualification profile is in compliance with the qualifications framework for German university degrees, which includes the four areas of competencies: *Knowledge and Comprehension (I)*; *Application and Generation of Knowledge (II)*; *Communication and Cooperation (III)*; and *Scientific/ Academic Self-Perception and Professionalism (IV)*;

On a general level, all graduates of the master programme have a profound knowledge in logistics engineering and management (*I*). They can employ their knowledge and understanding in terms of integrative planning, organisation, control, handling and monitoring of material and goods flow (*II*). The graduates can use methods on how to guarantee an affordable and sustainable freight transport network by using the available resources as efficiently as possible (*II*). They have a profound knowledge in the field of planning, design, and operating a transport system for materials and goods, which indicates their ability to determine appropriate scientific theories and methodological approaches in solving practical and scientific problems (*I*).

The graduates have the necessary knowledge and skills to successfully master the challenges faced in road and rail-based passenger and freight transport to achieve the required mobility for the sustainable support and the development of a modern, dynamic society in practical application as well as in research (*I*). Their knowledge and understanding enables the graduates to develop and apply their own ideas (*IV*). All graduates have the skills to use the integrated supply chain management concept for the flow of goods and materials in the different production stages of a product (*II*). They can acquire new knowledge and skills independently (*I*).

Graduates can enter a dialog with both academics and non-academics from various disciplines about viable alternatives to solving specific subject related problems (*III*). They can also choose from a range of non-technical modules, some of which include Business administration, Innovation and technology management, Project management principles which would inculcate them with basic management skills. They can use their skills in new and unfamiliar situations, which are broadly related to transport systems or in a multidisciplinary context (*III/IV*).

Graduates possess the fundamental skills in applying the most common methods in statistics and operation research, which they can apply to analyze data in practical applications in logistics processes(II). Further, they possess abilities to evaluate transport and logistics systems and theoretical knowledge in planning of intralogistics system and can determine the appropriate scientific theories and methodological approaches and use them to solve practical and scientific problems in the field of logistics systems(IV).

Graduates can formulate up-to-date mathematical modelling approaches and computer-based support for the solution of typical logistical decision problems (II). They can apply a selected number of algorithms which solve the formal problem models(II). This enables them to detect a known problem type in real life logistics, understand the limits of optimization and the value of decision support systems in logistics as well as understand and make use of statistical methods, such as packaging, labelling, and delivering of consumer goods(IV).

Graduates can use these statistical methods to analyse the data in practical applications as well(II). Furthermore, these statistical methods can be used to design and evaluate systems, mechanical equipment and related controls used to achieve the movement, storage, handling, control and protection of materials, goods and products throughout the process of manufacturing, distribution, consumption and disposal(IV). Graduates can use basic process models; methods & technologies and they know how they can give business a competitive advantage(II).

There is also an opportunity to have a view into the special aspects of logistics and supply chain management in the health care industry(I). This industry is currently undergoing a phase of deregulation, which leads to privatization, professionalization and internationalization. This framework will be discussed with the help of several decisions situations. They can develop a professional self-understanding based on the objectives and standards of professional action in academia and society(I). Besides, the time spent at TUM Asia helps them justify their own professional actions with theoretical and methodological knowledge and reflect on alternatives(III). Graduates understand strategic aspects of procurement and logistics in health care. Furthermore, on completion of the programme graduates have the following specific competencies:

- Knowledge and understanding of concepts, theories and principles of operations and project management and professional practice in an international Logistics and Supply Chain Management environment.
- The skills of analysis, synthesis, and decision-making in the resolution of international Logistics and Supply Chain Management problems.
- International Logistics and Supply Chain Management, methodologies, innovation and creativity in management across the extended enterprise in a global arena
- The structure of industrial systems and how these systems may be used to meet the varying demands placed on globally operating companies.
- Organizational configuration to achieve more rapid responsiveness to a changing global environment.

In short, this master programme enables graduates to recognize situation-specific and extra-situational conditions for professional action and reflect on decisions critically with ethical responsibility in the design, management and operation of freight logistics systems and supply chain management(I). Furthermore, they can design research questions in logistics engineering and management.

3 Target Groups

3.1 Target Audience

The Master of Science programme *LEM* is a consecutive degree programme open to students who possess a relevant Bachelors-degree from all over the world or a European / German FH Diplom. MSc. *LEM* is offered as a full-time degree programme. Classroom ideas are synthesized across diverse economic realities and students learn to see from multiple points of view, creating a capacity to solve problems in creative ways. The unique degree equips the students with not only technical and scientific knowledge but with an enriched curriculum composed of business and cultural modules.

3.2 Prerequisites

Applicants for this programme should have an engineering, management, economics or mathematical / physical background with at least grade C according to the European Credit Transfer System (ECTS) or its equivalent. This includes the following areas (but not limited): Logistics, Supply Chain Management, Business Administration, Civil Engineering, Transportation Engineering, Electrical Engineering, Geodetics, Mechanical Engineering, Geography, Computer Science, Communications Engineering, Economics, Mathematics, Physical Sciences, Architecture, Environmental Engineering, Tourisms.

For applicants without English as their native language or medium of instruction during previous studies (e.g. Bachelor), a proof of appropriate language skills is required, equivalent to the European Reference Guidelines level C1, such as the „Test of English as a Foreign Language“(TOEFL), „International English Language Testing System“ (IELTS) or the „Cambridge Main Suite of English Examinations“. With its international focus the programme aims not only at attracting the best candidates, but also at providing knowledge transfer as well as fostering the development of the transportation, logistics and railway sector in emerging and developing countries.

TUM will administer the aptitude assessment procedure according to FPSO (Examination and Academic Regulations for degree programme) within which the applicants prove their ability to work in a scientific or fundamental and method-oriented manner. Furthermore, they exhibit their existing expertise from the first-degree course in relation to the chosen specialization. This assures that the necessary background in certain engineering fields listed above is adequate to maintain a high quality of the programme.

3.3 Target Numbers

LEM is designed as a programme for a limited number of students to ensure close student teacher ratio and interaction. Lectures and exercises are laid out for about 30 students per intake. This target figure is set to ensure that during all lectures, the capacities of the facilities are not exceeded, and the student-teacher-ratio does not hinder close interaction between the students and lecturers. This degree programme is a derivative of the Master of Science in *RAIL, TRANSPORT AND LOGISTICS* which was started in the year 2009 with 14 students and is gaining interest from a growing number of countries, which is illustrated in Table 1.

Year	Number of applications	Countries of applicants
2009	37	China, Ecuador, India, Indonesia, Mexico, Pakistan, Panama, Singapore, Turkey
2010	82	Azerbaijan, China, Finland, Germany, India, Lebanon, Malaysia, Nicaragua, Panama, Tanzania, Venezuela.
2011	87	Bulgaria, Cameroon, China, Colombia, Georgia, Germany, Ghana, Greece, India, Iran, Jordan, Morocco, Pakistan, Russia, Singapore, Thailand, Turkey, UAE, USA, Uzbekistan
2012	128	Cameroonian, Chinese, Danish, German, Ghanaian, Indian, Kenyan, Latvian, Malaysian, Mexican, Pakistani, Russian
2013	140	Chinese, Colombian, German, Indian, Jordanian, Singaporean, Sri Lankan, Taiwanese, Thai
2014	160	Austrian, Chinese, Colombian, Ecuadorian, Filipino, French, German, Guatemalan, Indian, Iranian, Kazakhstani, Mexican, Pakistani, Russian, Saudi, Serbian, Sri Lankan, Taiwanese, Vietnamese
2015	157	Bolivian, Chinese, Colombian, Ecuadorian, German, Guatemalan, Indian, Japanese, Kenyan, Malaysian, Mexican, Nicaraguan, Pakistani, Russian, Saudi, Singaporean, Spanish
2016	143	American, Bangladeshi, British, Chinese, Egyptian, German, Ghanaian, Indian, Indonesian, Italian, Mauritian, Portuguese, Singaporean, South Korean, Spanish, Sudanese, Vietnamese
2017	221	American, Chinese, Colombian, Egyptian, Filipino, Ghanaian, Indian, Indonesian, Iranian, Malawi, Mexican, Nigerian, Pakistani, Russian, Taiwanese, Thai, Vietnamese
2018	118	Chinese, Indian, Indonesian, Singaporean, Taiwanese, Egyptian, Jamaican, Kenyan, Malaysian, Pakistani, Russian
2019	118	Chinese, Indian, German, Indonesian, Mexican, Singaporean, South Korean, Thai
2020	126	Chinese, Indian, Taiwanese, Indonesian, Vietnamese, Singaporean, Thai
2021	116	Chinese, Indian, Taiwanese, Canadian, Malawi, Singaporean, Thai

2022	88	Chinese, Indian, Singaporean
2023	95	Chinese, Indian, Singaporean, Bangladeshi, Ghanaian, Indonesian, Filipino, French, Russian, South African, Uzbekistani

Table 1 Yearly Applications vs Country of origin

The table below gives an overview of the development of the degree programme regarding the number of students and their countries of origin. This programme has attracted students predominantly from two countries- India and China. This can be attributed to the location of the Masters' coursework as well as the job opportunities that present themselves upon successful completion of the programme.

Year	Number of students in new intake	Country of origin (and number of students)
2009	14	China (9), India (2), Indonesia (1), Singapore (2)
2010	25	China (16), Germany (2), India (4), Lebanon (1), Malaysia (1), Singapore (1)
2011	17	Bulgaria (1), China (7), Colombia (1), Germany (2), Ghana (1), India (3), Russia (1), Turkey (1)
2012	29	China (15) India (8) Russia (1) Germany (2) Mexico (1) Denmark (1) Latvia (1)
2013	28	China (2) Colombia (1) Germany (2) India (21) Thailand (1) Taiwan (1)
2014	29	China (3) India (20) Russia (1) Germany (1) Ecuador (1) Colombia (1) Austria (1) Saudi Arabia (1) Russia (1)
2015	24	Bolivia (1) Colombia (1) Germany (2) India (16) Malaysia (1) Saudi Arabia (1) Singapore (2)
2016	20	China (1) Germany (1) India (16) Singapore (1) Spain (1)
2017	35	China (4) India (28) Mexico (1) Thailand (1) Taiwan (1)
2018	24	China (4) India (15) Indonesia (1) Taiwan (2) Malaysia (1) Russia (1)
2019	30	China (1) India (22) Colombia (1) Malaysia (1) Indonesia (1) South Korea (1) Jamaica (1) Mexico (1) Singapore (1)
2020	12	China (4) India (6) Singapore (1) Tanzania (1)

2021	25	China (9) India (10) Malawi (1) Singapore (2) Taiwan (1) Thailand (1) Canada (1)
2022	21	China (10) India (10) Singapore (1)
2023	22	China (19) India (1) Singapore (2)

Table 2 Number of students enrolled vs Country of Origin

The table below highlights the number of students in each specialization since 2009. The numbers for railway students are available only since the year it was launched, 2016. Similar numbers are expected for the Logistics specialization offered under MSc. LEM.

Year	Specialization			Total number of students
	Transport	Logistics	Railway (launched in 2016)	
2009	0	14	n/a	14
2010	8	17	n/a	25
2011	2	15	n/a	17
2012	2	27	n/a	29
2013	4	24	n/a	28
2014	8	21	n/a	29
2015	4	20	n/a	24
2016	1	16	3	20
2017	6	23	6	35
2018	2	12	10	24
2019	6	18	6	30
2020	1	8	3	12
2021	8	11	5	25
2022	6	12	4	21
2023	5	15	2	22

Table 3 Yearly student number for each specialization

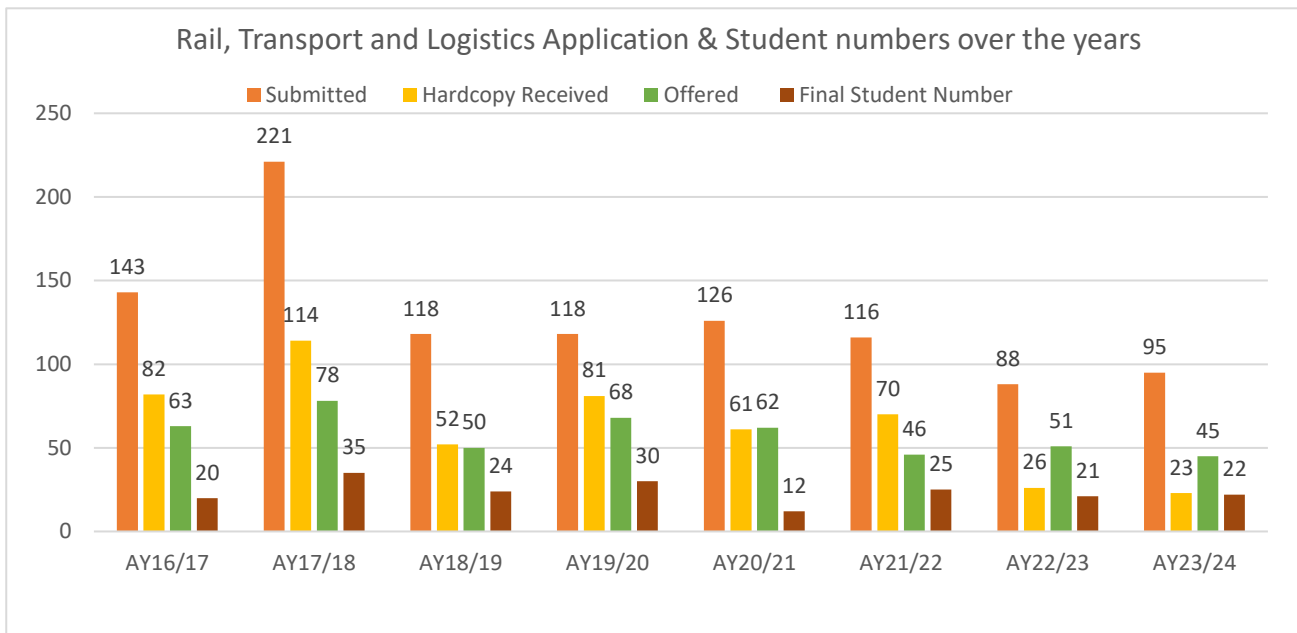


Figure 1 Overview of number of applications and enrolled students for RTL since AY2016

An overview of the development of student's application numbers and number of enrolled students can be seen in

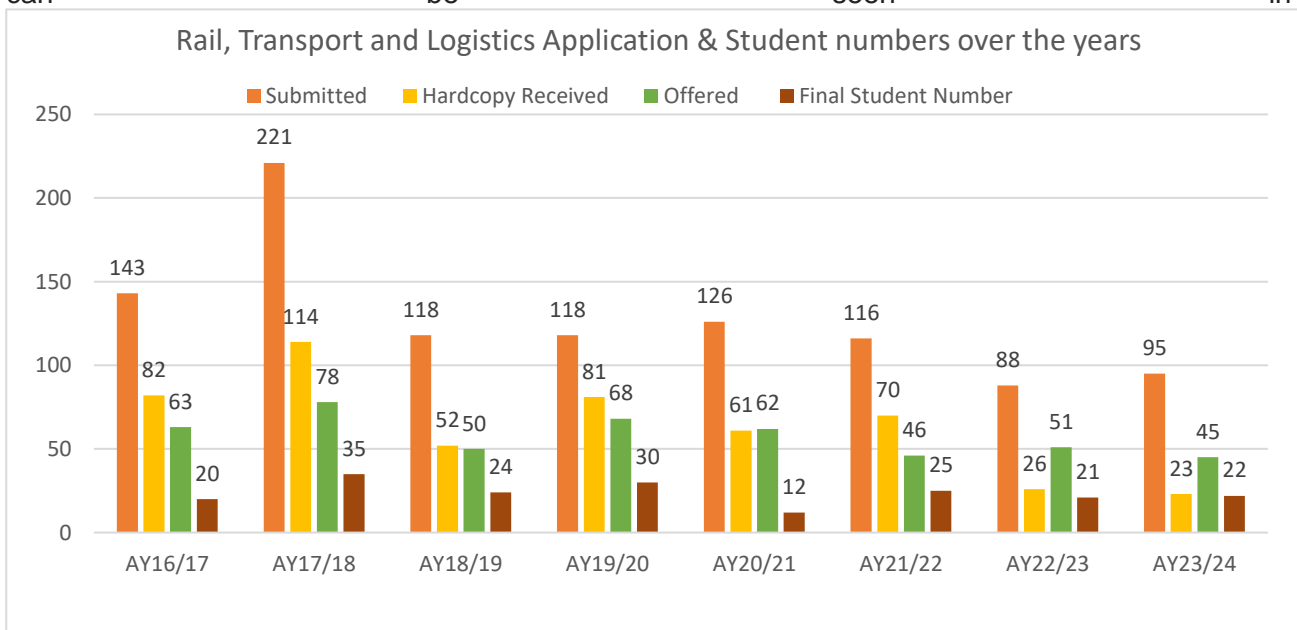


Figure 1. The number of applicants who submitted an online application remained relatively constant with a significant spike for the academic year 2017/18, however, the number of admissions offered decreased by about 36% the following year. The final number of matriculated students in AY20/21 was 12, a significant drop compared to AY19/20, due to the restrictions arising from COVID-19 pandemic. An overview of the male to female ratio is given in

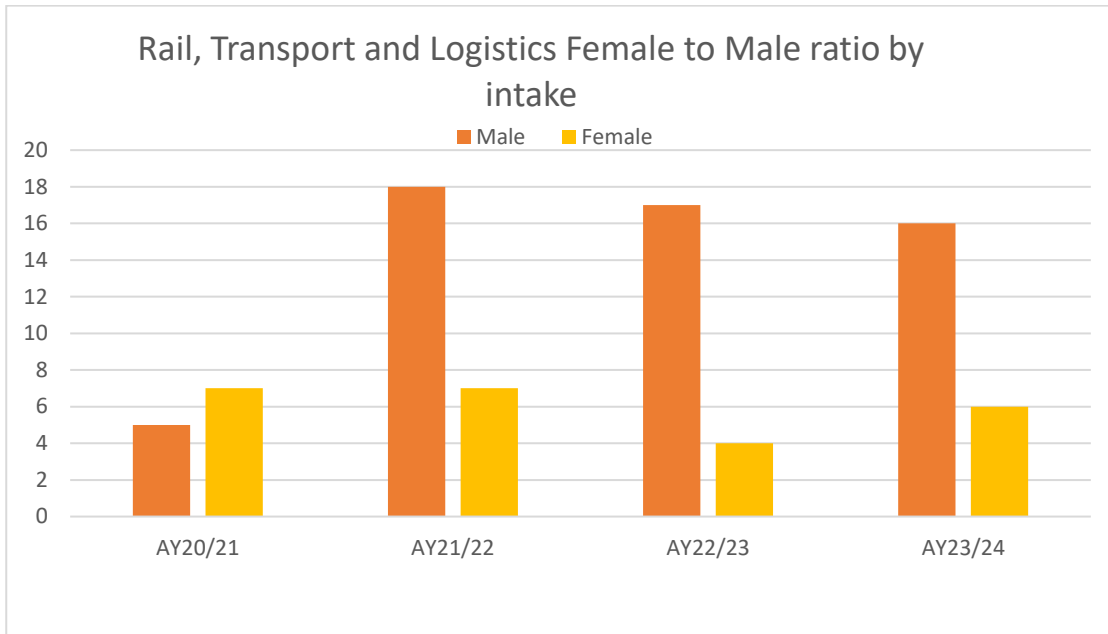


Figure 2. The number of female students has been consistently lower than male students across the previous 4 intakes, except for AY20/21 where the number of female students was more than the male students.

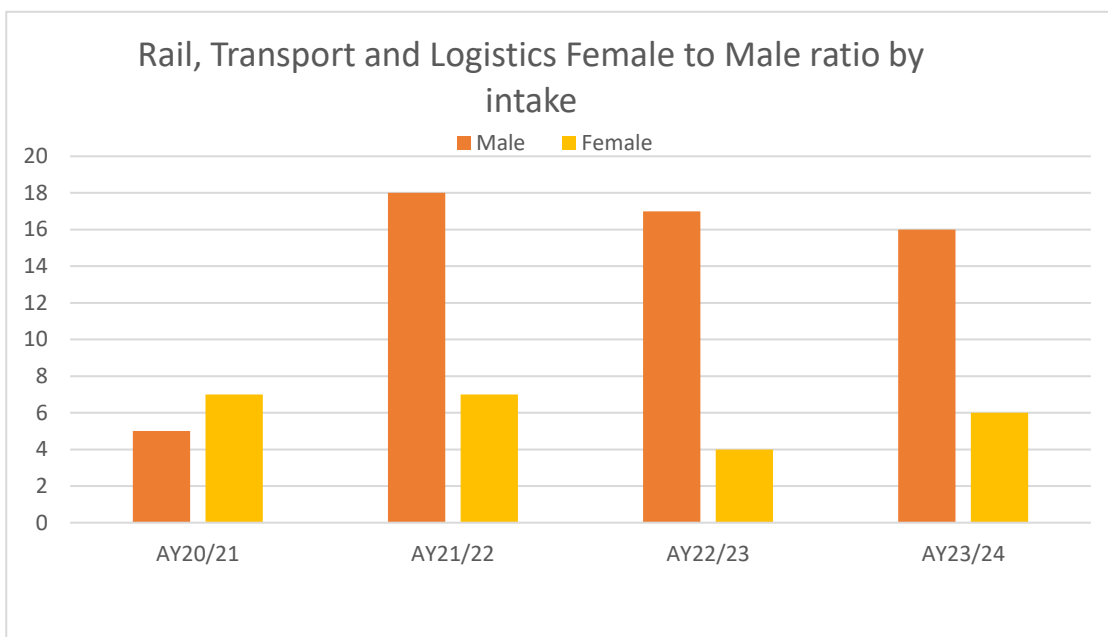


Figure 2 Overview of Female to Male ratio from past intakes

4 Demand Analysis

Societies and national economics of almost every country are getting increasingly connected with each other. Logistics and transportation systems are the foundations for such globally connected enterprises and economies. The efficiency of these systems are highly important factors guarding the competitiveness and profitability of a single product, an enterprise or an entire economy and country.

The demand for an efficiently structured and managed transportation and logistics system is growing continuously. Therefore, the demand for young professionals who are experts in managing, setting

up and improving modern transportation and logistics systems are bound to grow in the future as well.

Furthermore, the MSc. *LEM* is offered at TUM Asia, the subsidiary of TUM, located in Singapore. According to 2023 Logistics Performance Index, Singapore is ranked as the no.1 logistics hub in the world, ahead of Denmark, United Kingdom and Asian heavyweights such as Hong Kong and China.

Singapore offers world-class infrastructure and excellent connectivity, a base of leading industry players and customers, as well as thoughtful leadership/knowledge in logistics/supply chain management. Backed by an integrated, whole-of-government approach towards growing the logistics industry, these propositions provide a strong foundation for Singapore as a vibrant, multimodal hub that develops and delivers sustainable supply chain solutions for the global economy. Singapore provides access to the world's best solutions, with several third-party logistics (3PLs) companies having established significant operations in Singapore. Most of them have established regional or global headquarter functions in Singapore. These include *DHL*, *GATI*, *KUEHNE + NAGEL*, *SANKYU*, *SCHENKER*, *TOLL*, *UTI* and *YUSEN LOGISTICS*.

Graduates specialized in logistics can enter the job market in the following fields of activity: logistics strategy, management of logistics operations, engineering tasks such as facility design and implementation of logistics technology, operations management, logistic service provider & supplier, warehousing, industry logistics, Import and Export consultancies, Supply Chain Management, Air & Sea Freight Operations, Sales, Procurement, Quality Management, Material Planning, and Logistics Consultancies.

Further efforts will be undertaken to gain insights from graduate surveys in positions or professional activities of graduates of the programme. Although the original Master of Science RTL was only recently established with its first intake in 2009, all our students have found permanent placements in companies such as TATA Singapore, Daimler, BASF, DB Schenker, IATA Switzerland, Pan Asia Logistics, Rhenus Logistics, DHL almost immediately after graduation. Similar outcomes are expected for graduates of *MSC.LEM*.

Our students were often, sought after for internships by various companies such as *BASF*, *BOSCH*, *PAN ASIA LOGISTICS*, *DHL*, *DB SCHENKER AND LUFTHANSA CARGO*. The employment opportunities attest to the credibility of this Master programme as well. A major part of the graduates from this programme choose to work in the industry primarily as Logistics and Warehouse assistants, logistics executive, transportation planners, traffic engineers in companies like *PAN ASIA LOGISTICS*, *PEPPERL+FUCHS*, *DHL*, *MEDTRONIC*, *BOSCH*, *RHENUS LOGISTICS*; while the other part of the graduates decides to proceed subsequently with a Ph.D. research project in German or local universities. Moreover, Singapore's logistics sector is a major employer with employees having the highest skills with a sizeable remuneration among all manufacturing industries. Therefore, there is a big market for the graduates majoring in *Logistics Engineering and Management* programme in Singapore, Southeast Asia and continental Asia.

5 Competition Analysis

5.1 External Competition Analysis

The Masters' programme in *LOGISTICS ENGINEERING AND MANAGEMENT (LEM)* offers a unique programme in one of the main global hubs, Singapore. Globally, many prestigious universities are offering similar programmes, including the *MASSACHUSETTS INSTITUTE OF TECHNOLOGY (MIT)*, *STANFORD UNIVERSITY*, *UNIVERSITY OF CALIFORNIA, BERKELEY*, *UNIVERSITY OF*

MICHIGAN, GEORGIA INSTITUTE OF TECHNOLOGY, AND ETH ZURICH. Yet, these universities do not provide any existences in Singapore and the region.

In Asia, there are big names of universities offering programmes in logistics and supply chain management, including the *UNIVERSITY OF HONG KONG, TSINGHUA UNIVERSITY, AND KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY (KAIST).*

In the level of south-east Asian countries, few universities provide similar programmes but with different objectives and methodologies. *MALAYSIA UNIVERSITY OF SCIENCE AND TECHNOLOGY* offers a Masters' Programme in *TRANSPORT AND LOGISTICS*. *CHULALONGKORN UNIVERSITY* in Thailand offers study in logistics and supply chain management programmes, *VIETNAM NATIONAL UNIVERSITY*, Hanoi offers a master's degree in *LOGISTICS AND SUPPLY CHAIN MANAGEMENT*.

Singapore, as one of the main global hubs of logistics, is a hot spot for talents in the respective field. The local universities are playing roles in capacity building and offers similar programmes. The Nanyang Technological University offers MSc. in Supply Chain and Logistics targeting both full-time and part-time students who are seeking employment or advancing their career in supply chain and logistics related roles that include procurement, order fulfilment, operations planning, scheduling, distribution, inventory management. The National University of Singapore offers a similar programme called Master of Science in *SUPPLY CHAIN MANAGEMENT*. The Master of Science in Supply Chain Management programme is hosted jointly by the *DEPARTMENT OF INDUSTRIAL SYSTEMS ENGINEERING AND MANAGEMENT*, The Logistics Institute – Asia Pacific and the *DEPARTMENT OF ANALYTICS & OPERATIONS FROM NUS BUSINESS SCHOOL*. The *SINGAPORE UNIVERSITY OF SOCIAL SCIENCES* offers a Graduate Diploma in *LOGISTICS AND SUPPLY CHAIN MANAGEMENT*.

5.2 Internal Competition Analysis

Internally, there is no direct competition between the offered MSc. *LOGISTICS ENGINEERING AND MANAGEMENT (LEM)* and other MSc. programmes back at TUM in Germany. However, MSc RUT is a direct derivative of MSc RTL which houses the railway, transport and logistics specializations. Now, MSc RTL is split into 2 new Master programmes namely, MSc *Rail and Urban Transport (RUT)* and MSc *LEM*. Both programmes are meant to cater to 2 sets of different audiences and not act as direct competition to each other. Although both programmes have a common set of core modules, the specialization modules and accompanying electives are varied. The Chair of Logistics and Supply Chain Management offers Bachelor Courses in *TRANSPORTATION LOGISTICS* and Master Courses in *SUSTAINABLE SUPPLY CHAIN MANAGEMENT*.

6 Programme Structure

The Master of Science in *LOGISTICS ENGINEERING AND MANAGEMENT (LEM)* is a 2-year full-time research and application focused programme. Students need to complete 120 ECTS and a total of 15 modules during their 1st to 3rd semester. This list also includes 2 modules of a cross-discipline nature which comprises of one module of soft skills and a non-technical module. Students are required to select one non-technical module from a total of 3 modules. After the coursework, the

students must complete a 12-week internship followed by 6 months Master Thesis. All modules are taught by lecturers from TUM or experts and freelancers from the industry.

The study takes place at TUM Asia which is a 100% subsidiary of TUM, located in Singapore. Since the students enrolled for this programme come from a diverse background, they are required to complete a set of core modules to gain a general understanding of the programme. These core modules include decision support methodology to solve logistics and transportation problems, an introduction to statistical methods and its applications as well as traffic impact and evaluation concepts. These modules set a solid platform for the following stage of the Master programme which consists of 7 logistics modules and include 1) Introduction to Supply Chain Management, 2) Introduction to business logistics, 3) Planning of Intralogistics Systems, 4) Industrial Logistics, 5) Consumer Industry Supply Chain Management, 6) Logistics Service Provider (LSP) Management, and 7) Health Care Logistics. The aim of these modules is to help students understand the main challenges, theories and planning methods in supply chain management and develop awareness for the real-world relevance and complexity of business logistics, prior to the more detailed nature of concepts in the electives of the second semester.

Once the students have completed the core modules, they can choose their electives. Three elective modules must be selected. Students can choose from a module catalogue that will be updated for every intake. This catalogue includes modules like Green supply chains & risk management, Design and applications of material handling systems and Airport and harbour design.

Additionally, students will undertake a Soft Skills module which consists of Scientific paper writing and German language skills. Upon completion of this module, students are familiar with the international usage of the English language in technical terms. Social, interdisciplinary and self-competencies are decided whether a graduate is hired or not, while professional knowledge is presupposed. The offered module aims for training and improving the different styles of communication in a business environment. This module helps students write scientific reports and aims to provide the basics in communications styles. As a first step towards introducing German culture to students of LEM, the Soft Skills module also provides an insight into the German language. Apart from the obvious benefits that come with learning an additional language, this initiative provides an answer as to why German culture is part of the world heritage.

During the 2nd and 3rd semesters, students are required to complete one out of three non-technical elective modules. Besides the logistics related modules students will widen their knowledge in fields like Business Administration, Innovation and Technology Management and Project management principles. Students can choose from a module catalogue that will be updated for every intake. This will enable graduates to be more versatile, especially if they seek employment opportunities in multi-national companies.

During the latter part of the course, students must undergo a compulsory Internship relevant to their course of study. The duration of the internship is normally 3 months and students must write a report about the internship. The report is handed to the supervisor after completion of the internship. This report includes a profile of the company, the tasks carried out by the students during the internship and the individual achievements. The internship allows students to immerse themselves in a research environment or industry in the form of day-to-day logistic operations. Hence, the graduate students are familiar with the daily operations in the industry and/or research projects. During the internship, students have the chance to implement the knowledge from their courses from the Master in LEM into practical aspects of work. They gain insights of the daily business routines and the procedures of everyday business. Furthermore, students gain an understanding of the respective company and the industry field. After the successful completion of the internship the students are familiar with application processes, they have experience in dealing with feed-back on their performance in a professional working environment, and gain insights of the needs of commercial enterprises. Moreover, the internship enables the students to enhance their communication and team working skills.

Finally, the Master Thesis allows the students to work on a real-world engineering or scientific problem, using the gained scientific knowledge and approaches to solve it. These experiences will be essential for the future work within the industry or the scientific community. The results of the work must be documented and presented in accordance with good scientific practice.

During their stay and study in Singapore as well as during their Internship and Master Thesis, students meet colleagues from all over the world. They can adapt to different cultures and work in a multicultural team. The graduates will not only accumulate the knowledge and understanding in transportation planning, and railway but also the ability to apply the acquired knowledge, learning and research skills to receive an appropriate qualification to work for leading transport/logistics/railway companies or to proceed for an academic career after their graduation.

Each module is conducted in a block structure mainly because TUM Asia is working with the system of flying faculty. This means that academics come to TUM Asia for some weeks to teach. Therefore, the studies are organized in a block structure: one module is taught for consecutive determined number of days. After one module has been completed, the next module begins, and this process continues. The exemplary degree charts for each specialization are shown in Table 5. Through the block structure the students have the benefit to go very deep into one lecture topic during the lecture period. Further, after the lecture period is over and before the exam takes place towards the end of the respective semester, students have time for self-study. Moreover, the block teaching approach ensures a more cohesive and intensive student-teacher interaction over the course of few weeks for each module.

High mobility has been one distinguishing feature of this TUM's offshore Master programme. The 3rd and the 4th semester are designed in such a way that, students can do their internship and/or Master Thesis over-seas, without having to prolong their studies. TUM Asia encourages this to expose the students to different work environments, i.e. multinational companies, research laboratories, universities in different countries.

The grading scale ranges from 1 to 5: 1.0 to 4.0 are passing grades and 4.3 to 5.0 are failing grades. The following table provides you with a guide to awarded points in an exam.

Grade Description	Very good		Good			Satisfactory			Sufficient		Failed		
Grade	1.0	1.3	1.7	2.0	2.3	2.7	3.0	3.3	3.7	4.0	4.3	4.7	5.0

Table 4 Allocation of grades

A student has a maximum of 6 semesters to complete his/her study. During this time, he/she is free to take as many re-examinations as necessary (one re-examination per semester is offered). It is required for a student to obtain a minimum of 120 credits, credits are awarded when the student passes his/her examinations, i.e. to obtain at least a 4.0 in any exam. The degree chart is shown below:

Semester	Module						Number of exams Credits
1	BGU002TL Statistical methods for Transport and Logistic processes K 5 CP	BGU003TL Traffic impacts, evaluation of transport and Logistic processes K 5 CP	BGU008TL Decision support Systems for transport and logistics processes K 5 CP	BGU027TL Introduction to Business Logistics K 5 CP	BGU028TL Introduction to Supply Chain Management K 5 CP	BGU019TL Industrial Logistics K 5 CP	6 30
2	BGU109RTL Planning of Intralogistics Systems K 5 CP	BGU020TL Consumer Industry Supply Chain Management K 5 CP	BGU021TL Logistics Service Provider (LSP) Management K 5 CP	BGU022TL Health Care Logistics K 5 CP	BGU010TL Soft skills K 5 CP	CM5105 Non-technical module K 5 CP	6 30
3	BGU012TL Internship 15 CP			BGU026TL Green Supply Chains & Risk Management K 5 CP	BGU009TL Design and Applications of Material Handling Systems K 5 CP	BGU016TL Airport and Harbour Design K 5 CP	4 30
4	BGU0MTL Master's Thesis W 30 CP						30
Legend	grey = Core Module light blue = Elective Module dark blue = Master's Thesis						CP = Credit Points; K = Klausur (written exam); L = laboratory assignments; LP = learning portfolio; R = report; W = research paper; CW = coursework

Table 5 Sample degree programme chart

7 Organization and Coordination

LEM is part of the TUM School of Engineering and Design. As it is an interdisciplinary degree programme, many other chairs and departments of the TUM are involved. Administrative matters and responsibilities are listed below:

- **Course Guidance**
Course Guidance is given by the TUM general student guidance office and by TUM Asia
TUM Asia: admission@tum-asia.edu.sg
TUM: <http://portal.mytum.de/studium/studienberatung/>
- **Application**
The application is directly submitted to TUM Asia and can be completed within two steps (Online Application and Submission of printed out online application and hardcopy required documents)
<https://tumasia.powerappsportals.com/en-US>
- **Enrollment**
Students are enrolled at TUM. The communication between the students and TUM is handled and coordinated by TUM Asia.
- **Academic Services**
TUM Asia is responsible for student management. An Academic Services Team was set up for this purpose. The department serves as contact point for lecturers and students. They are also responsible for handling all academic matters as well as classroom management.
- **Student Management Committee (SMC)**
The student management committee is composed of the class representatives from each programme. The SMC is the first contact point for all students, regardless of the nature of the inquiries, programme-related or personal. They are responsible for organizing events and outings as well as taking care of the junior batch of students. Additionally, representatives from the SMC are involved in the Quality Management of the degree programme.
- **Examination Committee**
The Examination committee is responsible for examination management. The committee comprises of the following members:
 - Chairman: Prof. Dr.-Ing. Johannes Fottner, Chair of Materials Handling, Material Flow, Logistics, TUM
 - Prof. Dr. Constantinos Antoniou, Head, Chair of Networked Traffic Systems, TUM
 - Prof. Dr.-Ing Stephan Freudenstein, Chair of Road, Rail and Airfield Research, TUM
 - Dr.-Ing Andreas Rau, Management and Specialist Consulting, RTL programme
 - Dr.-Ing Bernhard Lechner, Senior researcher and lecturer, Chair of Road, Rail and Airfield Research, TUM

The figure below shows the organization behind the Masters *LEM* programme offered at TUM Asia. The programme is helmed by Prof. Dr-Ing Johannes Fottner while the Management and Specialist Consulting department, headed by Dr.-Ing Andreas Rau and Mahesh Hariharan, is responsible for

programme related academic affairs in Singapore. There are two more committees- Examination and Admissions, which complete the organization. The Examination committee is responsible for examination management. All other administrative work, like timetable planning and admission processes, is done by TUM Asia staff. As it is an interdisciplinary degree programme many other chairs and departments of the TUM are involved. In addition, a strong cooperation with several industry partners exists. The industry partners provide selected students with scholarships and projects for their Master Thesis. TUM Asia's faculty prepares concept draft, degree programme documentation, module description and articles for each programme and the TUM School of Engineering and Design assures the quality of the programme to maintain TUM quality.

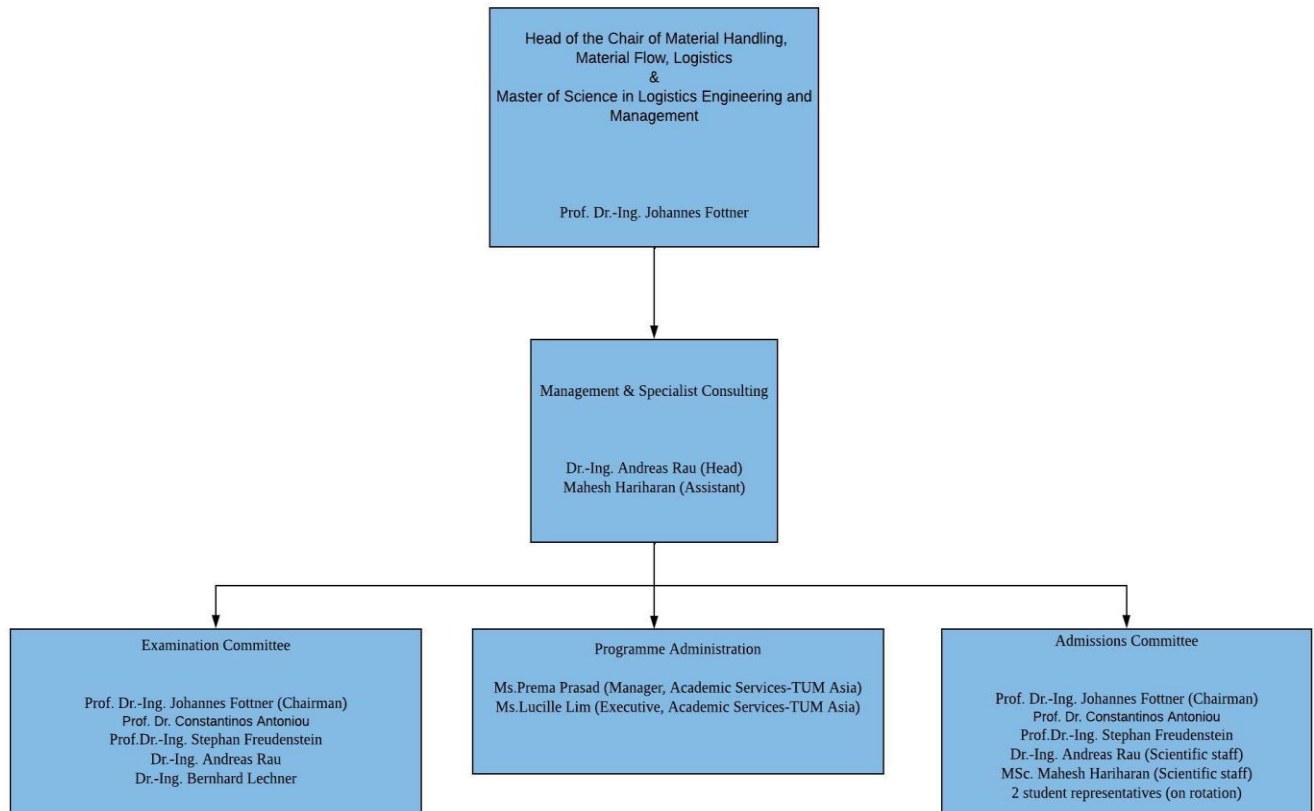


Figure 3 Programme Organization

8 Enhancement Measures

Through TUM's unwavering commitment to the betterment of society, TUM Asia was set up in 2002 as the first academic branch campus of any German university to bring German academic excellence to Singapore. Though situated in an Asian country, the academic model employed by TUM Asia is nevertheless German in its roots, with an emphasis on industry readiness and innovation. Blending German academic excellence with industry relevance in Asia, TUM Asia offers Bachelor and Master programmes in Singapore with partner universities such as *NATIONAL UNIVERSITY OF*

SINGAPORE (NUS), NANYANG TECHNOLOGICAL UNIVERSITY (NTU) and SINGAPORE INSTITUTE OF TECHNOLOGY (SIT).

By 2023, more than 2200 students have come through the doors of TUM Asia. Graduates go on to ply their trades in top research institutes and companies all around the world. On top of the Bachelor and Master programmes, TUM Asia now offers a new suite of Executive Education courses to deliver leading-edge curricula for the upskilling of industry workforces in areas such as Industrie 4.0 and Precision Engineering. With twenty-one years of experience, TUM Asia is committed to provide quality higher education programmes suited to the needs of the industry in Asia, producing graduates equipped to enter both industry and research sectors on a global level.

The MSc. *LEM* programme will include all modules (core + elective) of the logistics specialization from the original MSc *RTL* programme. Almost 7 years after the launch of MSc. *RTL*, it is now deemed necessary to tackle transportation problems from two similar but specific angles in the form of two specialized programmes in MSc. *RUT* and MSc. *LEM*. The MSc. *LEM* will include Logistics specialization while MSc. *RUT* programme will include transport and railway specializations from the original MSc. *RTL* programme. This presents an opportunity to students who wish to focus on specializing in Logistics to enrol in MSc. *LEM* and those interested to specialize in the field of transportation engineering can do so by enrolling in MSc. *RUT*. The revised curriculum offers a set of core modules common to all specializations and depending on their choice of specialization, some modules serve as pre-requisites for their electives. One key aspect in the education of a students in field, is the transfer of knowledge to industrial applications. All cohorts have been a mix of students from logistics management, finance, industrial engineering, supply chain management (to name a few) coming from different universities and countries. This unique feature of the programme demands a unique solution to ensure that all students, regardless of background, understand what the programme has to offer. Therefore, the programme is structured in such a way that 3 modules highlighting the basics in Transport, specifically in the field of statistics, decision support systems and traffic impacts have been selected to lay the foundation once the students focus on the logistics related core and elective modules. The interdisciplinary approach adopted during the choice of their electives prepares the students for the challenges they face during internship and master thesis. The lectures were streamlined also with regards to the workload of the students, each bearing 5 credit points.

Besides the technical education of the students, the non-technical aspects such as Business Administration and Innovation and Technology Management have gained an important criterion for the employability of the graduates. Most of the graduates do not remain in research and development or production units within a company, they rotate or migrate to different business units, marketing, business administration and management or sales, where such non-technical skills are required. Therefore, the feedback from alumni and industry partners led to a broader selection of non-technical modules to cover new topics, e.g. Project Management Principles.

Furthermore, the non-technical modules equip the students with the basic skills in business administration and management. The compulsory company visits should establish a direct contact between the students and the possible future employer. Concomitantly TUM and TUM Asia will sustain and strengthen current and future relations with industrial partners.