

# Degree Programme Documentation Master's Programme in Rail and Urban Transport

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: Rail and Urban Transport
- 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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- Additional information: TUM Degree offered at TUM Asia in Singapore
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# 1 Degree Programme Objectives

## 1.1 Purpose

Mobility is a basic need of every human being, an impression of individual freedom and a fundamental element of an economic system and of each society. Efficient rail and urban transport systems are an immediate requirement of these mobility needs. This is even more important, since it is difficult to create additional capacity for road or railway transport infrastructure since nowadays criticism against changes to the natural environment exists widely (e.g. noise emissions, air pollution or land-use and soil sealing). To implement innovative and sustainable transport concepts new action strategies inside transportation planning for goods and people must be developed and introduced at the same time. Transport planning for goods and people is increasingly becoming a management and composition task of a very complex overall system.

The current working environment and development show that transportation professionals must have more skills than just the traditional engineering knowledge of designing and operating transport infrastructure. Besides, they need skills and knowledge about economics and project appraisal, ecology and the concepts of sustainability, so that they can cope with current and future environmental challenges. Transport and mobility relate to many social phenomena; they influence social structures and processes (e.g. social exclusion, changes in urban spatial structures). Hence, transport engineers must know about transport sociology and psychology, so that they are able to consider the social aspects of transport (e.g. social impacts of transport investments, accessibility and reachability). In general, the transportation system must be considered as part of a complex system if there shall be provided optimal transport conditions for people and goods as well as a good quality of living in urban areas. Therefore, transport planning strategies must consider and include the various interactions between transport, economy, land-use, and the natural environment.

The Masters' Programme in *Rail and Urban Transport (RUT)* offers all these facets of transport planning to provide students with a general but integrated approach, from demand management, transport planning, infrastructure design to transport management. Due to the complexity and diversity of the transport challenges two major specializations "*Transport*" and "*Railway*" are needed. The two major specializations complement each other and require similar skills.

The specialization *Railway* addresses how to realize new and further developed planning concepts for railway transport of goods and persons. It is especially designed to meet the challenges of large urban megacities in providing an efficient and high-capacity railway based public transport network. Its focus lays on the design, construction and operation of railway transport systems. This includes all kinds of passenger rail systems such as Mass Rapid Transport (MRT) (i.e. metro), Light Rail Transport (LRT) (i.e. streetcars), as well as regional and long-distance rail transport systems. This covers topics like the design, construction, maintenance, and the renewal of tracks for a variety of rail infrastructures (urban, conventional and high speed, train control and signalling systems, rolling stock and network planning for railway based public transport).

The specialization *Transport* addresses the area of planning, design and operation of modern passenger transport systems, both private and public. This includes urban planning and urban transport infrastructure, telematics, modelling, simulation, operation and control of passenger land transport, design of highways etc. The students will learn how to analyse and assess the various

traffic scenarios of the different transport modes and be trained in finding appropriate solutions. They will learn to design and operate modern transport systems.

Taking all these aspects into consideration, the TUM School of Engineering and Design established a special and worldwide Masters' Programme in *Rail and Urban Transport* that reflects and critically examines the new challenges of modern and efficient transport, and railway systems. 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 Singaporean 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 Singapore, extensive research is conducted in the field of urban transport and railway systems, which will also be shown and used in the teaching.

In summary, the programme is designed to enhance the classical training for transport and railway engineers 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 transport and mobility.

## 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.

The *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 *Rail and Urban Transport* supports the mission statement of the entire TUM and the School of Engineering and Design. It strengthens TUM in one of the most relevant academic fields of our modern life, transport and mobility.

The transport industry is internationally oriented and changing in terms of global value chains, markets and collaborations. The trends of globalisation and international value chains are affecting the transport networks for people and goods. The industry trends are also affecting international collaboration and research and should be part of a Master of Science course.

The curriculum of the Masters' Programme *RUT* is based on research and teaching competence of various chairs and departments of the School of Engineering and Design. The topics of sustainable development, environment and energy, together represent the central issues addressed by TUM as well as by the School of School of Engineering and Design and it is also one of the leading topics on the international agenda. The Masters' Programme *RUT* is closely related to Masters' Programme Logistics Engineering and Management (*LEM*) by splitting two distinctive teaching goals which were once forged together by necessity. Earlier all 3 specializations- Railway, Transportation and Logistics were housed under the Masters' Programme in Rail, Transport and Logistics. However, now it is

deemed necessary to tackle transportation problems from two similar but specific angles in the form of specialized programmes in MSc. RUT and MSc.LEM

Graduates interested in research work and wish 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.

By focusing on international students and offering this in Singapore under TUM Asia, it 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 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 “*Master of Science in Rail and Urban Transport*” that qualifies them for professional work or academic research in the wide field of transport systems, mainly in the areas-transport and railway. Graduates of this Masters’ programme possess a wide portfolio of relevant competences, abilities and know-how in transport and railway related areas and they are capable of applying this knowledge and skills when working in the dynamically growing market sector of transport systems, for which they develop a professional self-understanding based on the objectives and standards of actions 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)*.

### 2.1 General competencies and Abilities

On a general level, all graduates of the master programme have a profound knowledge of the interdependencies and intricacies of transport systems, economy and city development (I). They can employ their knowledge and understanding in terms of population, space, income, and terrain (II). The graduates, regardless of their specialization, can use methods on how to guarantee an affordable and sustainable transport network for freight and passengers by using the available resources as efficiently as possible (II). They have a profound knowledge in the field of planning, designing, and operating a transport system, whether for persons or freight (I), which indicates their ability to determine appropriate scientific theories and methodological approaches in solving practical and scientific problems (II). 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 (II/IV). Their knowledge and understanding enables the graduates to develop and apply their own ideas (II).

All graduates have the skills to use an integrated transport system approach, from demand management, transport planning, infrastructure design to transport management for transport services for passengers and goods (II). They can acquire new knowledge and skills independently and possess the fundamental skills in applying the most common methods in statistics, which they can apply to analyze data in practical applications in transport processes (II/IV). They also possess abilities to evaluate transport systems and theoretical knowledge of traffic flow and are able to determine the appropriate scientific theories and methodological approaches and use them to solve practical and scientific problems in the field of transport systems (II). Moreover, they are finally able to understand the relationship between transport and urban planning and city development (IV).

Depending on the specialization, graduates can enter a dialog with both academics and non-academics from various disciplines about viable alternatives to solving specific subject related problems (III). The railway specialization is strongly focused on engineering skills to plan and operate railway systems and less on management skills, whereas the transport specializations emphasize more on the management of passenger and freight transport systems. However, graduates of both specializations can choose from a range of non-technical modules, including- Business administration, Innovation and technology management and Project management principles which

would inculcate them with basic management skills (I-IV). They can use their skills in new and unfamiliar situations, which are broadly related to transport systems or in a multidisciplinary context (II).

## 2.2 Specialization Railway

Graduates of the Masters' Programme RUT who have selected *Railway* as their specialization have the knowledge and skills to plan, construct, operate, and maintain modern railway systems such as *MRT*, *LRT*, regional or long-distance railway systems (I). They are focusing on engineering skills to plan and operate railway systems and less on management skills (I).

These graduates have attained the necessary knowledge on the interactions between vehicle and track, the general requirements and tools for track layout (line and station), planning and installation of rail infrastructure (urban, conventional and high speed) (I). *Railway* graduates have a strong knowledge in civil engineering subjects like the design, construction, and maintenance of railway transport systems (I). The global relevance of rail transport requires a strong interdisciplinary and international background knowledge of graduates, which is intensively fostered by the content spread across a wide variety of Railway modules (I).

Graduates can demonstrate their understanding of rail track engineering required for the urban rail infrastructure design, construction, maintenance and the renewal of tracks for urban rail infrastructure, the specific requirements as well as the tools to handle specific problems of urban rail transport (II). The Master graduates can explain the special features of Metro and light rail systems, the specific train-track interactions, the track lay-out and alignment for urban rail systems, the track cross section design including trackside equipment, and the ballastless track systems design for urban rail (I). They can apply their problem-solving skills in new and unfamiliar situations related to the conceptual design and detailed planning of urban rail tracks covering specific environmental requirements like noise and vibrations (II).

The ability to plan and develop railway vehicles according to different requirements will also be inculcated (II). Graduates will also have the knowledge of rail vehicles, either to order, or operate and maintain them (I). After graduation they can evaluate and deal with the specific wheel-rail interaction, running behavior in curves and straight track, propulsion systems diesel, electricity AC and DC, energy efficiency including regenerative braking, and running gear and vehicle construction (II). This includes primary and secondary suspension devices, wheel sets, bogie frames and bogie shells relevant norms and design rules.

The graduates have in-depth knowledge about safety issues such as collision safety, derailment safety, fire safety, environmental aspects like external and internal noise, particle emission, space consumption, reliability, availability, maintainability, diagnosis systems and their environment benefits (I).

The Master graduates will also know how to plan and develop train control and safety systems for different rail platforms (II). They will know the rail safety engineering required for development of signaling and train control systems for urban, conventional or high-speed rail systems (I). They will also be able to perform conceptual design and detailed planning of all equipment for safe and high-performance rail transport (II).

They have attained in-depth knowledge of planning and organizing public transport networks, methods to schedule trains, plan convenient transfers and increase the operation speed of railway

systems to improve the passenger convenience and the efficiency of the entire public transport network, thereby providing constructive and conceptual input to bring about situation specific solutions for conflicts occurring within the collaborative process (I).

On completion of the programme with specialization in Railway, graduates can demonstrate the following learning outcomes:

- The respective general requirements for the design and construction of rail infrastructure.
- Rail track engineering required for the track design, construction, maintenance and renewal of tracks for a variety of rail infrastructures, the understanding of the forces acting between vehicle and track as well as environmental impacts.
- To identify advantages / disadvantages and the functional characteristics of different transit modes and their capacity, integrate the transport modes into one multi- modal public transport system to guarantee a smooth and seamless transport ride for passengers.
- Knowledge of rail safety and train control engineering required for development of signaling and train control systems for urban rail, conventional or high-speed rail systems are strengthened. The students demonstrate their judgments in designing train control and safety systems for different rail systems, conceptual design and detailed planning of all equipment for safe and high-performance rail transport.
- Application and training of learning outcomes is done during internship in co-operation with rail industry, suppliers, operators and administration.

To summarize, this specialization lays emphasis on the design, construction, and operation of railway systems enabling graduates to critically reflect their professional actions related to social expectations and develop their professional actions further. The graduates can design research questions regarding topics concerning railway.

## 2.3 Specialization Transport

Graduates of the MSc. RUT programme who have selected *Transport* as their specialization have insights into traffic flow with its numerous facets, coherencies and interdependencies; use of distributions for the modeling of delay and queuing processes; traffic modeling, microscopic and macroscopic modeling (I).

The graduates understand travel demand modeling which, for example, implies a 4-step algorithm for travel demand estimation (I). They can evaluate and deal with the specific features and dynamic behavior of typical vehicles used for different transportation modes, the respective conditions at the interface between vehicle and track/pavement and the demands of operators and users (comfort and safety) for specific requirements for lay-out, design and construction of traffic infrastructure systems (II).

The master's graduates have attained the necessary knowledge of airports and harbors components and the planning processes for developing these sites (I). Apart from these, they have understood several methods for operating airports and harbors and evaluating their efficiency. It covers aspects of the pre-planning process like environmental impacts that lead to the choice of location (I). They have in-depth knowledge about which operation and maintenance procedures are necessary to run

airports and harbours efficiently and in a timely manner, thereby making scientifically founded decisions and critically reflecting possible consequences (I).

On completion of the programme with specialization in Transport, graduates can demonstrate the following learning outcomes:

- Apply integrated understanding of the principles and methods enabling transport of passengers and freight to be planned, delivered and funded in sustainable ways.
- Synthesize understanding of the range of strategic systems, which underpin multiple modes of transport to demonstrate critical awareness of ways these systems interact.
- Combine conceptual understanding of different approaches to service design and the selection of key technologies, through analysis of the methods and measures of risks used by practitioners engaged in the improvement of transport systems.
- Communicate transport systems, technology and management concepts by bringing together the often-contrasting vocabularies of transport stakeholders, taking account of industry-standard terms, both individually and as a member of a group. This is based on a strong today's Asian – European relations back-ground knowledge, which can be fostered by a voluntary stay at TUM-Munich.
- Apply transport related business management methods enabling economic and competitive analysis and evaluation of transportation concepts.

In short, this specialization emphasizes on the design, management, and operation of passenger transport systems which leads to graduates assessing their own abilities, make use of their freedoms of disciplinary design and decision making independently and further develop them under supervision. Furthermore, the graduates can design research questions regarding these transport topics.

## 3 Target Groups

### 3.1 Target Audience

The Masters' Programme *RUT* 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. *RUT* 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): 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 the Examination and Academic Regulations for the degree programme (FPSO) 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. An engineering background is necessary for both the specializations due to the nature of the offered modules.

### 3.3 Target Numbers

*RUT* is designed as a programme for a limited number of students to ensure close student-teacher-ratio and interaction. Lectures, labs 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, Ghanian, 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. Based on this trend, similar numbers are expected for both transport and railway specializations in MSc. RUT.

| 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

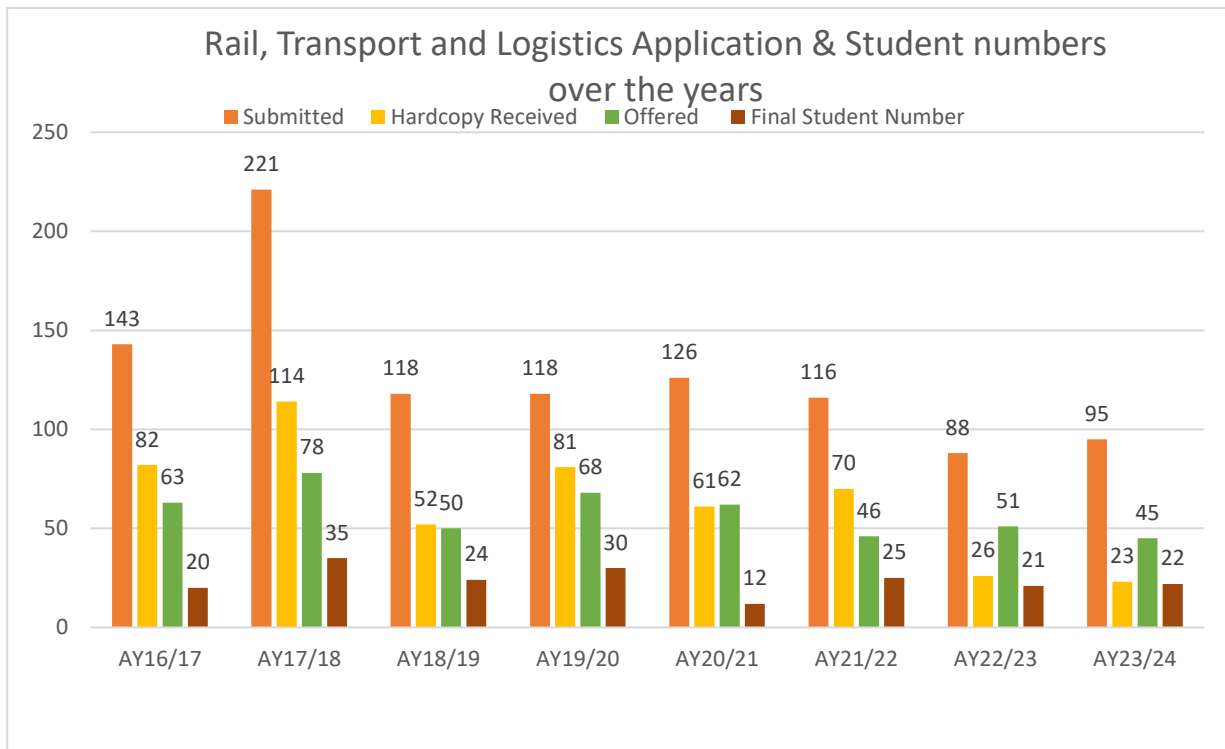


Figure 1 Overview of number of applications and enrolled students for RTL since AY2016

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.

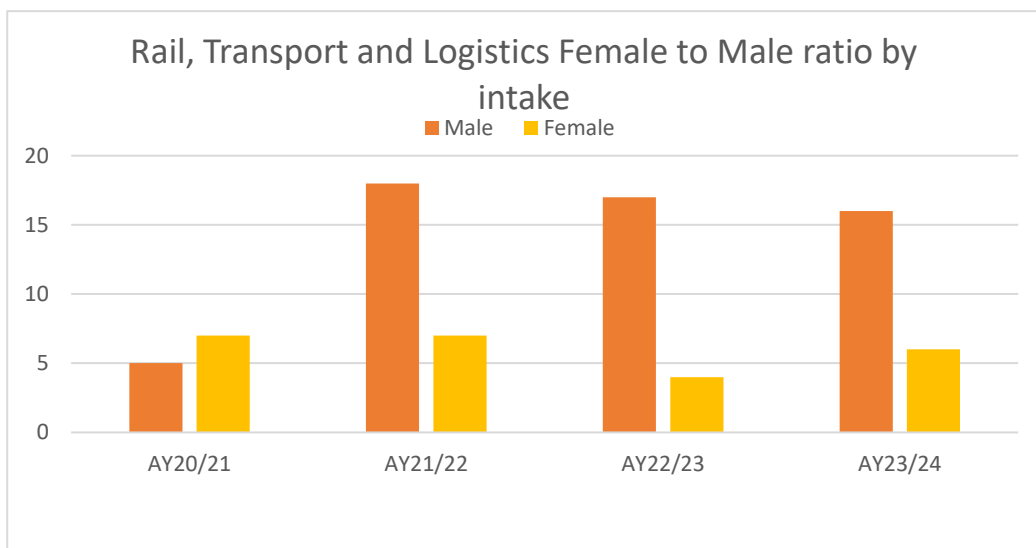


Figure 2 Overview of Female to Male ratio from past intakes

## 4 Demand Analysis

Societies and national economics of almost every country are getting increasingly connected with each other. Transportation and railway 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, logistics and railway system is growing continuously. Therefore, the demand for young professionals who are experts in managing, setting up and improving modern transportation, logistics and railway systems are bound to grow in the future as well.

Furthermore, the MSc. *RUT* is offered in TUM Asia, the subsidiary of TUM, located in Singapore. 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 transportation and rail industry, these propositions provide a strong foundation for Singapore as a vibrant, multimodal hub that develops and delivers innovative transportation solutions for the global economy.

Singapore and most other countries in Asia are expanding their railway systems. This applies to all kinds of railway systems (LRT, MRT, regional, long distance and high-speed rail transport systems). For example, in Singapore the *Land Transport Authority (LTA)* has officially announced plans to double the MRT lines up to 360 km and increase the workforce in the railway sector to 8000 by 2030. Jakarta and Bangkok are discussing new railway projects. China is building for almost all large cities MRT and or LRT systems. The high-speed railway lines in China are growing as well. This is creating a high demand for experts in this sector who can plan, build, operate and maintain such railway systems.

Singapore has already a world class transport system with a strong focus on public transport. Singapore can be used as a show case for controlling the usage of private cars and encourage the people to use public transport system. Governments from all over the world are coming to Singapore to learn how to plan, build and maintain public transport infrastructure in an efficient way. The Government of Singapore is actively promoting and selling their knowledge in this area. This policy creates an excellent environment for studying transportation and railway systems.

Graduates who have chosen their specialization in *Transport* can showcase their technical skill sets in the following focus areas: city & urban planning departments, intelligent transportation companies, government transportation departments and transportation consultancies.

Finally, graduates who have obtained sufficient knowledge in *Railway* systems can work for both public and private sector, specifically in the following job scopes: MRT and LRT transport operators, regional, long distance and high-speed railway operators, government agencies and city planning departments in charge of planning and control railway infrastructure, transportation consultancies, railway construction consultancies and rail systems suppliers.

Further efforts will be undertaken to gain insights from graduate surveys in positions or professional activities of graduates of the programme. Especially in the Asia Pacific Region, there are many countries with growing infrastructures with the need for experts or specialist in the transport and railway fields. Particularly in Singapore, local companies such as *SBS* and *SMRT* and the Singapore *Land Transport Authority (LTA)* are cooperating closely with TUM providing an opportunity for graduates to enter the labor market in the form of internships and Master Thesis opportunities.

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 transportation planners, traffic engineers in companies like *RAMBOLL*, *PTV*, *SIEMENS*, *LTA*, *SYSTRA MVA*; while the other part of the graduates decides to proceed subsequently with a Ph.D. research project in German or local universities. Therefore, there is a big market for the graduates majoring in *Rail and Urban Transport* programme in Singapore, Southeast Asia and continental Asia.

## 5 Competition Analysis

### 5.1 External Competition Analysis

The Masters' Programme in *Rail and Urban Transport* provides a distinctive fusion of academic coursework encompassing railway and urban transport components, allowing students the flexibility to specialize in one of these areas at a later point in the programme. In terms of external competition, there are no similar programmes offered in the region.

Similar training programmes are available in Singapore. For example, *SMRT*, Singapore's largest railway operator, has partnered with the University of Birmingham to offer a postgraduate certificate in Urban Railway. This course spans three years and is designed for working professionals, in contrast to TUM Asia's 2-year programme tailored for Master students. Furthermore, the *SMRT* programme combines insights from a higher education institution specializing in railway research with hands-on experience from a real-world operator, whereas the Masters' Programme in *Rail and Urban Transport* is conducted by lecturers from an academic institution (TUM) and includes a mandatory internship component at relevant companies for students.

Another instance can be found in a series of programmes collaboratively organized by *Workforce Singapore (WSG)*, *SMRT*, and *SBS TRANSIT*, with a focus on training station managers, executive engineers, and assistant engineers. Unlike MSc. *RUT*, this programme has a different objective, aiming to support individuals looking to make a mid-career switch and create opportunities for older workers. In summary, the goal of specializing in railways is to provide training for students aspiring to advance their careers in the industry or pursue research, while also catering to industry professionals who can attend specific modules to acquire valuable skill sets beneficial to their careers.

The *National University of Singapore (NUS)* only offers a rather general MSc. programme in civil engineering with an option of specialization in Transport and Urban Mobility which only includes 20 units from limited courses.

At the level of southeast Asian countries, there are similar programmes but with different objectives and methodologies. Chulalongkorn University in Thailand offers a Master of Engineering (M.Eng.) Programme in *Railway Vehicles and Infrastructure Engineering (RVIE)* which is a three-year, multidisciplinary, international programme that focuses on the engineering aspects of design and research and development of the complete rail systems including the rail vehicles and rail infrastructure. Two areas of concentration are offered: (1) Railway Vehicles Engineering, and (2) Railway Infrastructure Engineering. *Universiti Teknologi Malaysia (UTM)*, Malaysia offers a Master of Engineering (Transportation) providing a full-time mode and is based on a 3 Semester Academic Session. However, this programme does not focus on railways but rather on transportation in general. Ho Chi Minh City University of Transport offers two related programmes including a Masters' Programme in *Transport Engineering*, and *Transport Organization and Management*.

## 5.2 Internal Competition Analysis

Internally, there is no direct competition between the offered MSc. *RUT* 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 *RUT* and MSc Logistics Engineering and Management. 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. TUM in Munich campus, in particular, the School of Engineering and Design, offers a Masters' programme in *Transportation Systems* which includes different modules and specializations. The *Transportation System* programme offers different options in specialization, including (1) Transportation Infrastructure, (2) Intelligent Transportation Systems (ITS), and (3) Transportation Demand Management. The second closest programme to MSc. *RUT* is the MSc. Programme in Civil Engineering (MSc. *Bauingenieurwesen*). Even though MSc. in *Civil Engineering* offers a few modules related to transportation e.g., Traffic Control and Transport Planning, this programme is meant to provide a general overview of Rail and Urban Transport studies.

## 6 Programme Structure

MSc. *Rail and Urban Transport* 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's 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, i.e., the requirement to complete a set of core modules depending on the choice of specializations.

Certain modules are chosen with the intention that they serve as prerequisites for students before they select the electives from their choice of specialization. For instance, 7 modules have been selected as core modules for *Transport* specialization dealing with introductory concepts which are expanded upon in the electives selected during the following semesters. This exact approach is followed for the *Railway* specializations as well. Once the students have completed the core modules common to all and the core modules related to their specializations, they can choose their electives. Following sections give an explanation behind the selection of specific modules for the respective specializations:

### **Transport specialization modules**

The 7 core modules to be completed by students under transportation engineering include- 1) *Transport and Urban Planning*, 2) *Transportation Modelling and Simulation Tools*, 3) *Basics Of Traffic Flow and Traffic Control*, 4) *Highway Design*, 5) *Rail Transport and Rail Planning* 6) *Public Transport Planning*, 7) *Traffic Operation and Control (ITS)*. Students deal with the concepts of planning and design of safe, sustainable road infrastructure linking cities. Also, an insight into the description of traffic flow and urban traffic management along with macro- and micro simulation to assess traffic engineering will be provided. These modules serve as pre-requisites for the

transportation 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 *Planning of Intralogistics Systems*, *Airport and Harbour Design*, *Introduction to Business Logistics* and *Introduction to Supply Chain Management*.

### **Railway specialization modules**

The following 7 modules have been selected to provide fundamentals in railway - 1) *Rail transport and Rail Planning*, 2) *Rolling Stock*, 3) *Trackworks*, 4) *Train Control and Signalling Systems* 5) *Ballastless Track Systems* 6) *Public Transport Planning* and 7) *Transportation Modelling and Simulation Tools*. The basic concepts of rail infrastructure planning based on the running behaviour of rail vehicles, requirements for designing track alignment and layout will be discussed. Also, the basics of wheel-rail interaction, track performance, turnouts, signals, train propulsion systems, and the main components and systems of rolling stock will be taught in these modules. Students in Railway specialization must also select three modules as electives from a list. This list includes Modelling of Rail infrastructure using CAD-FEM-MBS, Tunnel works and geotechniques and Transport and urban planning. This list will be updated every year.

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.

During the 2nd and 3rd semesters, students are required to complete one out of three non-technical elective modules. Besides the Transport/Railway 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 transport planning projects or focus on rail alignment/infrastructure planning. 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 the individual specialization and their courses from the MSc. *RUT* 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's 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's 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 and Table 6. 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's programme. The 3rd and the 4th semester are designed in such a way that, students can do their internship and/or Master Thesis overseas, 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 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 Grading Scale

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 reexamination 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 charts for the two specialisations are shown below:

Specialization Railway:

| Semester | Module  |  |   |  |   |  | Number of exams Credits |
|----------|---|--|---|--|---|--|-------------------------|
| 1        | BGU002TL<br>Statistical methods for Transport and Logistic processes<br><br>K<br>5 CP | BGU003TL<br>Traffic impacts, Evaluation of Transport and Logistic Processes<br><br>K<br>5 CP | BGU008TL<br>Decision support Systems for Transport and Logistics Processes<br><br>K<br>5 CP | BGU102TL<br>Trackworks<br><br>K<br>5 CP  | BGU106TL<br>Rail Transport and Rail Planning<br><br>K<br>5 CP | BGU101TL<br>Rolling Stock<br><br>K<br>5 CP               | 6<br>30                 |
| 2        | BGU015TL<br>Public Transport Planning<br><br>K<br>5 CP                                | BGU103TL<br>Ballastless Track Systems<br><br>K<br>5 CP                                       | BGU014TL<br>Transportation modelling and simulation tools<br><br>K<br>5 CP                  | BGU104TL<br>Train Control and Signalling Systems<br><br>K<br>5 CP  | BGU010TL<br>Soft Skills<br><br>K<br>5 CP                      | CM5105<br>Non-technical module<br><br>K<br>5 CP          | 6<br>30                 |
| 3        | BGU012TL<br>Internship<br><br>15 CP   |  |   | BGU108RTL<br>Modelling of Rail Infrastructure Using CAD-FEM-MBS<br><br>K<br>5 CP   | BGU107RTL<br>Tunnel Works and Geotechniques<br><br>K<br>5 CP  | NM6625<br>Introduction to Power Systems<br><br>K<br>5 CP | 4<br>30                 |
| 4        | BGU0MTTL<br>Master's Thesis<br><br>W<br>30 CP   |  |   |  |   |  | 30                      |
| Legend   | grey = Core Module<br>light blue = Elective Module<br>dark blue = Master's Thesis     |  |   | CP = Credit Points; K = Klausur (written exam);<br>L = laboratory assignments; LP = learning portfolio;<br>R = report; W = research paper; CW = coursework |   |  |                         |

Table 5 Exemplary degree chart for the *Railway* specialization

Specialization Transport:

| Semester | Module  |  |   |   |   |   | Number of exams  | Credits |
|----------|---|--|---|---|---|---|--|---------|
| 1        | BGU002TL<br>Statistical methods for Transport and Logistic processes<br><br>K<br>5 CP | BGU003TL<br>Traffic impacts, Evaluation of Transport and Logistic Processes<br><br>K<br>5 CP | BGU008TL<br>Decision support Systems for Transport and Logistics Processes<br><br>K<br>5 CP | BGU005TL<br>Transport and Urban Planning<br><br>K<br>5 CP | BGU106TL<br>Rail Transport and Rail Planning<br><br>K<br>5 CP | BGU004TL<br>Basics of Traffic Flow and Traffic Control<br><br>K<br>5 CP | 6  | 30      |
| 2        | BGU015TL<br>Public transport planning<br><br>K<br>5 CP                                | BGU013TL<br>Traffic Operation and Control (ITS)<br><br>K<br>5 CP                             | BGU014TL<br>Transportation modelling and simulation tools<br><br>K<br>5 CP                  | BGU010TL<br>Soft skills<br><br>K<br>5 CP                  | BGU105TL<br>Highway Design<br><br>K<br>5 CP                   | CM5105<br>Non-technical module<br><br>K<br>5 CP                         | 6  | 30      |
| 3        | BGU012TL<br>Internship<br><br>15 CP   |  |   | BGU018TL<br>Urban Road Design<br><br>K<br>5 CP            | BGU016TL<br>Airport and Harbour Design<br><br>K<br>5 CP       | BGU027TL<br>Introduction to Business Logistics<br><br>K<br>5 CP         | 4  | 30      |
| 4        | BGU0MTTL<br>Master's Thesis<br><br>W<br>30 CP   |  |   |   |   |   |  | 30      |
| Legend   | grey = Core Module<br>light blue = Elective Module<br>dark blue = Master's Thesis     |  |   |   |   |   | CP = Credit Points; K = Klausur (written exam);<br>L = laboratory assignments; LP = learning portfolio;<br>R = report; W = research paper; CW = coursework |         |

Table 6 Exemplary degree chart for the *Transport* specialization

## 7 Organization and Coordination

*RUT* 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](mailto: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 a 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. Constantinos Antoniou, Constantinos Antoniou, Head, Chair of Networked Traffic Systems, TUM
  - Prof. Dr.-Ing. Johannes Fottner, Chair of Materials Handling, Material Flow, Logistics, 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 *RUT* programme offered at TUM Asia. The programme is helmed by Prof. Dr-Ing Constantinos Antoniou 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.

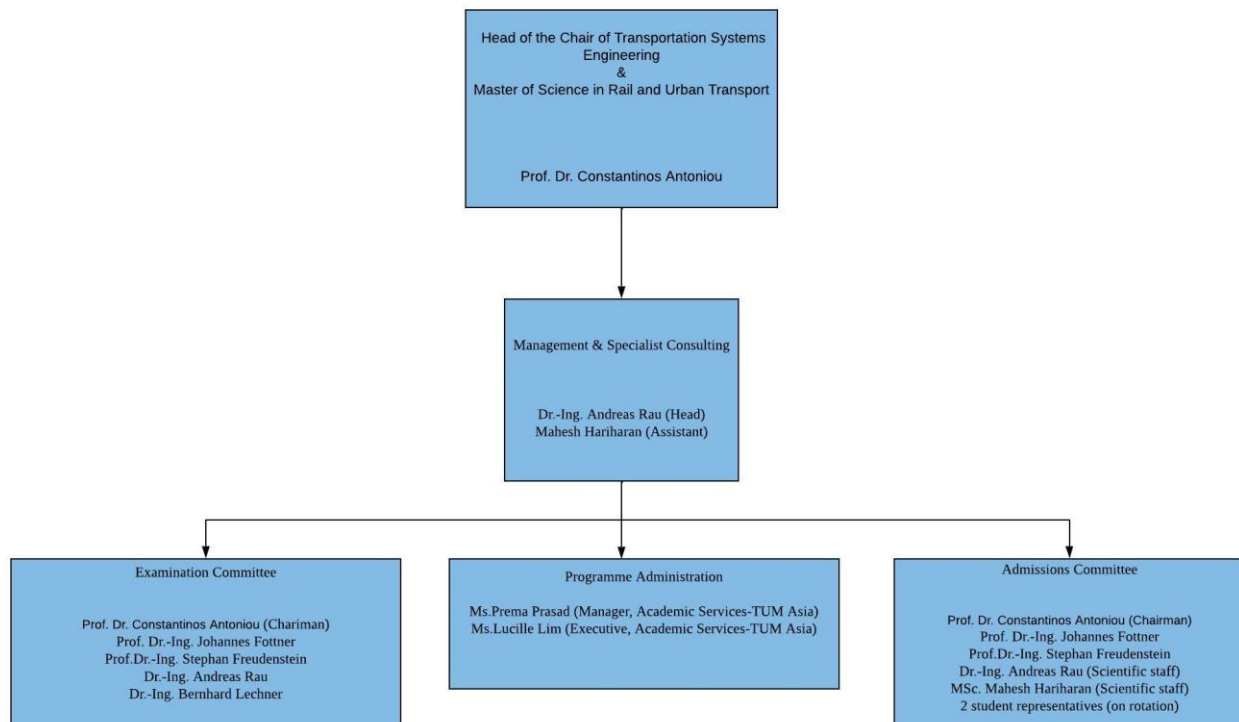


Figure 3 Programme organization

## 8 Enhancement Measures

Through TUM's 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 Industry 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.

Almost 7 years after the launch of the MSc. *RTL* programme in 2009, a third specialization in Railway was launched, giving students another option along with the already pre-existing specializations in Transport and Logistics. Now, it is deemed necessary to tackle transportation problems from two similar but specific angles in the form of two specialized programmes in MSc. *RUT* and MSc. Logistics Engineering and Management (*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*. Launching the railway specialization in 2016 was in fact the right move, since Singapore initiated a series of plans around that time, for example- the plan to double its existing MRT lines up to 360km in 2030. Not to mention the groundworks initiated by Land Transport Authority (LTA) for new lines to the existing MRT network; The Thomson-East Coast Line, in 2016; Jurong Region Line, in 2018 and The Cross-Island Line, in 2019. All three lines are slated to be fully operational by the year 2030.

As a result, there has been a steady demand of rail professionals in Singapore. So, in 2016 TUM Asia launched a programme in Professional certificate in Transport, Logistics and Railway, offering modules within the Masters' programme to help engineers upgrade their skill sets by learning from recognized experts. In 2019, a Graduate Diploma in Railway Engineering was launched to help engineers in the field to upskill themselves. This would also help them to enhance their professional network and make overseas contacts. The idea is to have the professionals attend these lectures along with full-time Masters' students, thereby presenting a unique opportunity for interaction with industry experts and increasing career prospects.

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 students in this field, is the transfer of knowledge to industrial applications. All cohorts have been a mix of students from civil engineering, mechanical engineering, electrical engineering, aeronautical engineering, (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 three 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 branch out to their specializations. 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.

While the sections above highlight the ways in which the *RUT* programme aims to serve industry professionals, it is equally important to enunciate the plans outlaid for full-time students. Ways are being explored to introduce the students to new areas of railway and transport. For instance, plans are being devised to include modules which focus on sustainable transportation network design and electro mobility. Plans to enable students to have access to numerical tools for microscopic and macroscopic modelling of transport networks wherein they can apply the theoretical concepts

acquired through lectures taught by professors from TUM and elsewhere are being laid out. This bodes well with their career prospects in the fields of city planning departments, high speed and conventional railway operators and railway construction consultancies.

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.