# A Descriptive Analysis for Education and Training on Automation 4.0 in Thailand

**Erwin Rauch and Matteo De Marchi**
Industrial Engineering and Automation (IEA)
Free University of Bozen-Bolzano
Bolzano 39100, Italy
erwin.rauch@unibz.it; Matteo.DeMarchi@natec.unibz.it

**Prajaks Jitngernmadan**
Digital Media and Interaction Laboratory
Faculty of Infomatics
Burapha University
Chon Buri 20131, Thailand
prajaks@buu.ac.th

**Felipe M. Martin**
Department of Electrical Engineering
Universidad de Oviedo
Área de Ingeniería de Sistemas y Automáticah
Gijón 33204, Spain
fmateos@uniovi.es

## Abstract

Industry 4.0 has strongly influenced the last decade and the industrial environment. A major aspect of Industry 4.0 is automation. In recent years, great efforts have been made in Europe to promote Automation 4.0 in education and training, thus enabling the qualification of skilled workers. This has made it possible to lay the foundation for modern and smart factories of the future. With its Thailand 4.0 strategy, Thailand is pursuing a major goal to ensure long-term prosperity, safety and sustainability. The implementation of this strategy also includes the introduction of new and advanced production methods and thus to make significant progress in the area of Automation 4.0. This paper presents the project ETAT, which aims to establish Training Centers ad so called Smart Labs for Automation 4.0 in Thailand to train young and qualified professionals. This should succeed with the support of European project partners involved in the project. The paper contains the results of a survey involving the three target groups, which means students, teachers and professionals from industry, who were asked about their current knowledge on Automation 4.0, their needs in this direction and possible teaching formats for the future.

## Keywords
Industry 4.0; Automation 4.0; Engineering Education, Needs Analysis; Survey.

## 1. Introduction
Thailand has fostered cooperation and partnership at bilateral and multilateral levels, and continuously participated in regional and international forums so as to enhance quality of education through sharing knowledge and experiences within the region and beyond. In this context the Association of Southeast Asian Nations (ASEAN) have been observing the development of the Bologna Process and viewing the Bologna Process, European Higher Education

Area (EHEA) and European Research Area (ERA) as a useful model for their regional higher education reforms (Dang, 2015).

2018 was signed the Thailand Country Program with a key strategic pillars for Thailand's future (OECD, 2020). To achieve this key strategy, the country's government and business leaders have set in motion a transformation plan known as Thailand 4.0 (Royal Thai Embassy, 2020), the next stage of long-term growth after progressing through export dependent 1.0 agriculture, 2.0 light manufacturing and 3.0 heavy industry. Thailand 4.0 will be characterized by a digitized integrated business and social system and an advanced infrastructure. The plan emphasizes technological innovation and education, assisting digital entrepreneurs, boosting internet access and retraining workers by support and help of East Economic Corridore - Human Resource Development Centre (EEC-HDC) (nxpo, 2020). The government is also cooperating with small and midsize companies and large businesses to ensure that fast-changing industries, such as the financial and telecom sectors, are up to international standards (ASEAN, 2020; SME4.0, 2020).

A key component of Thailand 4.0 is the Eastern Economic Corridor (EEC), an area of more than 13,000 square kilometers straddling the three provinces of Chonburi, Rayong and Chachoengsao southeast of Bangkok. The government has earmarked US$45 billion to build extensive road, rail, aviation and shipping infrastructure and assist in developing so-called smart cities, which provide an efficient, self-contained environment for fostering production and innovation (Forbes, 2020).

The focus of economic development in the EEC is among others digital industries, electronics, robotics, aviation and automotive. The technologies used are intended to implement the principles of Industry 4.0 in order to develop a flagship Special Economic Zone in Thailand that will ensure the economic growth of the EEC region for the future. The industrial sectors and industries to be developed require a high degree of modern technology in order to be able to realize the used technical processes economically. The close connection of information technology with classic automation technologies in the sense of a digital transformation of Industry 4.0 (Automation 4.0) is therefore of particular importance for the efficient development of the EEC.

An essential basis for the implementation of the EEC project is the availability of highly qualified professionals who can develop, operate and maintain the relevant production, manufacturing and logistics technologies. Thereby, the educational institutions in the EEC, especially the universities, play an important role. Here, the future engineers and specialists for the EEC industries are to be trained and further educated. In order to do this modern education and training facilities for Automation 4.0 amongst others are needed in the universities, which can carry out a practical and competence-oriented education and training.

Thailand's higher-education sector is shifting gears towards the future – setting sights on new engines of growth as well as the much-vaunted EEC. Education courses need to be prepared, that respond to the development of target industries in the EEC. The demands and requirements to the Higher-Education in the EEC for Industry 4.0 industrial automation have led to the concept of the ETAT project (Education & Training for Automation 4.0 in Thailand), which is co-funded by the Erasmus+ programme of the European Union. In the ETAT project, the experience and outcomes gained from previous and similar projects will be used, which fosters the involvement and experience of leading EU universities in industrial automation in the development of new learning opportunities, instructional materials and smart laboratories. These will be directly related to Thai regional employment demands in EEC.

The ETAT project aims to enable the training and education of future Thai trainers for automation engineers, maintenance engineers, process workers and students using non-classic teaching methods such as learning by doing, remote and mobile teaching with innovative technologies as well as lifelong learning (LLL) and the experience of the European universities. Each Thai higher education partner is responsible for communication with Thai university students, teacher and enterprises allowing to conduct as a first step in the project to conduct a survey that shows the high demand/need of the specialists in modern Industry 4.0 technologies (Automation 4.0) and appropriate education programmes.

This work presents the results from the survey designed to analyses the needs of key target groups. After a short introduction the paper shows the methodology and survey design used in this first step. Afterwards, Section 3 summarizes the results and outcomes of the survey for each of the target groups: students, teacher and professionals from Thai industry. Section 4 shortly describes the concept of ETAT labs and ETAT training centers based on the results of the survey. Finally, Section 5 summarizes the conclusions and gives an outlook of future activities.

## 2. Methodology

### 2.1 Survey Design

The survey was elaborated based on the experiences in the project consortium with similar projects carried out before. The design of the questionnaire is divided into the following sections:

- Introduction and explanation of the objectives
- General information about the participant's background
- Specific part (per target group) for determining the current level of knowledge in Automation 4.0 and satisfaction in qualification
- Specific part (per target group) to determine the technical requirements and needs for qualification in Automation 4.0
- Specific part (per target group) to determine the requirements for future training formats

### 2.2 Sample Description

The survey participants where asked what their background is. A total of 94 participants took part at this survey: 50 of the participants were students from university in the greater Bangkok area, 17 of the participants were teachers/professors from Thai universities at Bangkok and 27 participants were professionals from Thai industry (see also Figure 1).

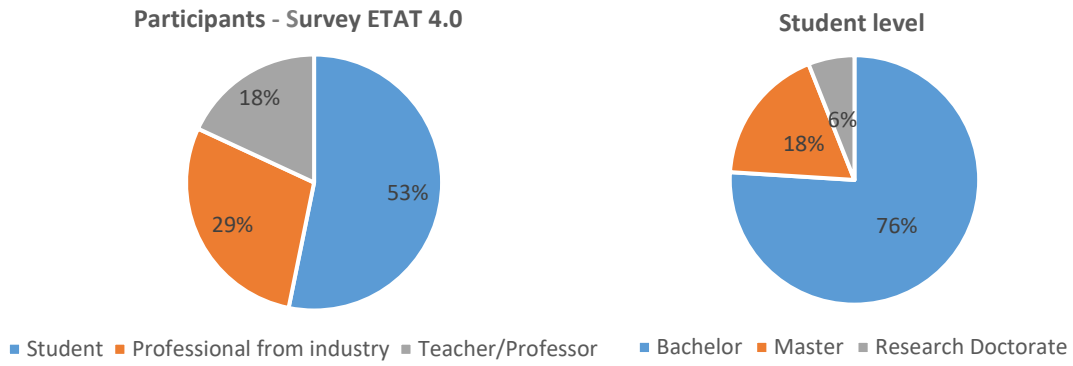


Figure 1: Participants' background (left) and students background (right)

The company participants were asked for the size and to which sector their company belongs to (see Figure 2).

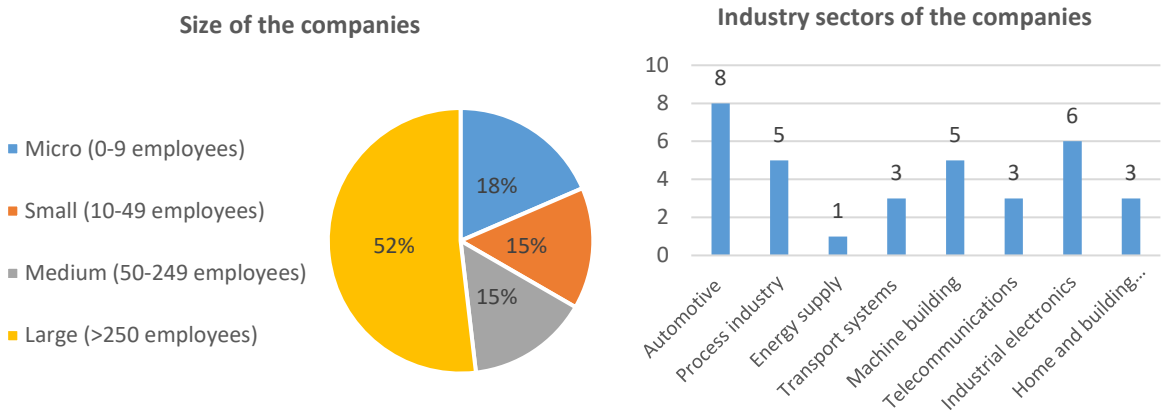


Figure 2: Companies' background

## 3. Results from Needs Analysis

### 3.1 Current Knowledge of Target Groups in Automation 4.0

In a first section of the survey participants were asked about how familiar they feel with typical technologies from Industry 4.0 and Automation 4.0. Figure 3 shows the results of this question for all three target groups. In most cases teacher have a more pessimistic view compared to students and professionals. It is of interest, that especially students (which are expect to already learn this technologies) feel to be most confident with Automation 4.0. Based on the average of the values for all three target groups, they see a good background in robotics, PLC programming, Industrial IoT. There is a medium-level knowledge in vision systems, cloud computing, feedback control, big data analytics and human-machine systems. The lowest impression of knowledge has been identified for cybersecurity, augmented reality, additive manufacturing, horizontal/vertical data integration and digital twin application.

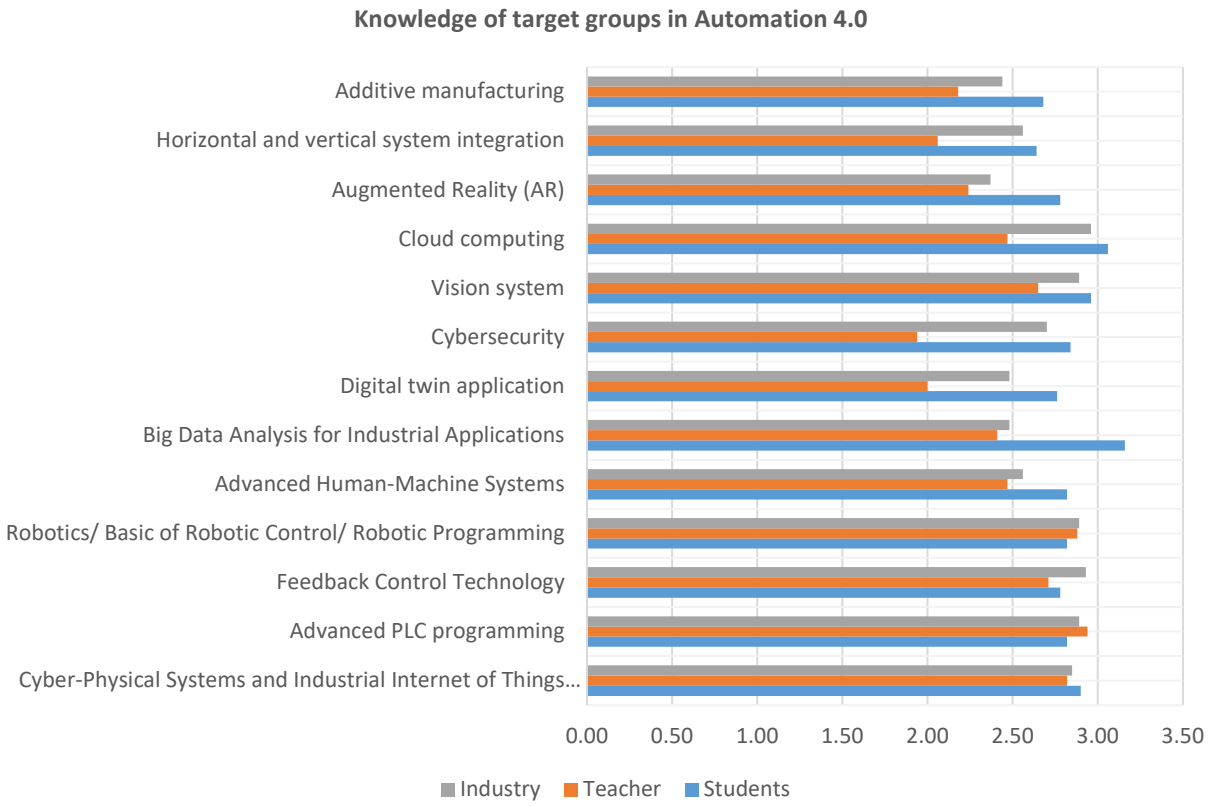


Figure 3: Knowledge of target in Automation 4.0

### 3.2 Status Quo Analysis of Qualification in Automation 4.0

In an analysis regarding the current state of qualification in Automation 4.0, the respondents gave slightly different answers (see Figure 4). Generally, there is a low to medium level of satisfaction regarding the current level of qualification of specialists in Automation 4.0.

Figure 5 illustrates the opinion of target groups regarding the needs and problematic aspects in teaching Automation 4.0. Professionals from industry and teachers have a homogeneous view and see the most critical problems in providing knowledge and practical skills in modern automation equipment (e.g. controllers, actuators or sensors) and less in providing basic theoretical training or knowledge and practical skills in industrial communication technology. The view of students is quite different as they see a problematic aspect in the provision of basic theoretical training and basic knowledge in modern automation equipment as well as industrial communication technology. Such a different view may be caused also by the fact, that students have already not finished their degree and are still in the phase of being qualified in theory on industrial automation.

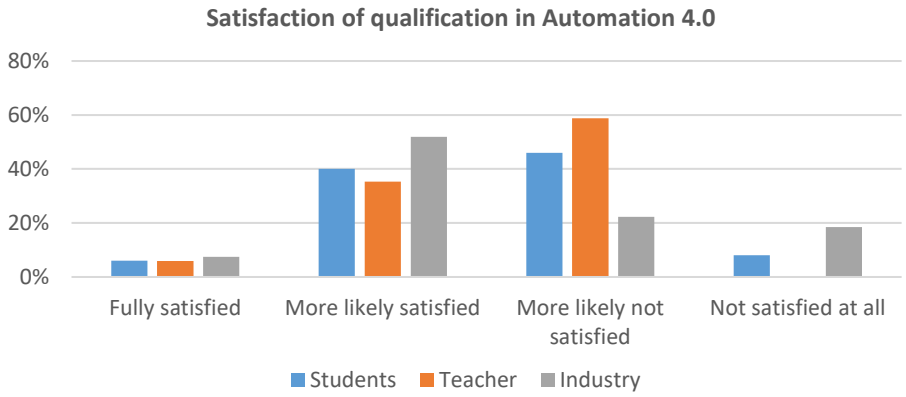


Figure 4: Satisfaction of qualification in Automation 4.0

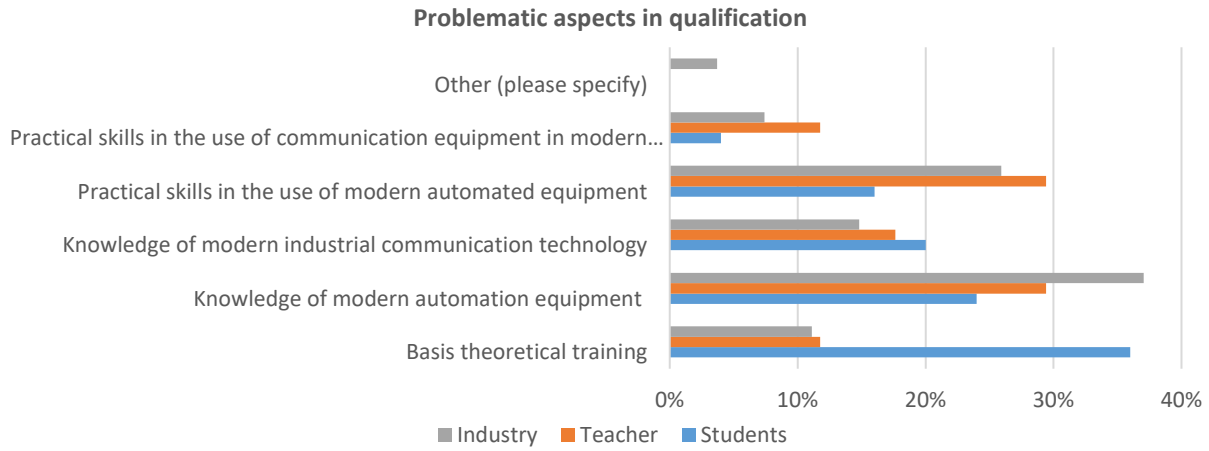


Figure 5: Problematic aspects in qualification

### 3.3 Technical Requirements and Needs for Education in Automation 4.0

The most important IoT communication protocol for Thai industry is MQTT, while teacher opt for OPC UA. According to students REST API is the most important communication protocol. This shows that the opinions differ a lot between the single target groups (see Figure 6).

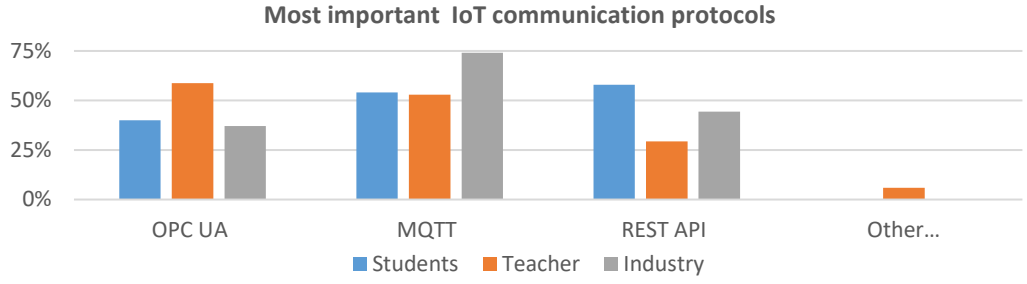


Figure 6: Most important IoT communication protocols

Figure 7 shows the opinion of the target groups according to the most widespread industrial telecommunication technologies in Thailand. In industry, the most widespread ones are Ethernet IP, ModBus and IO-Link.

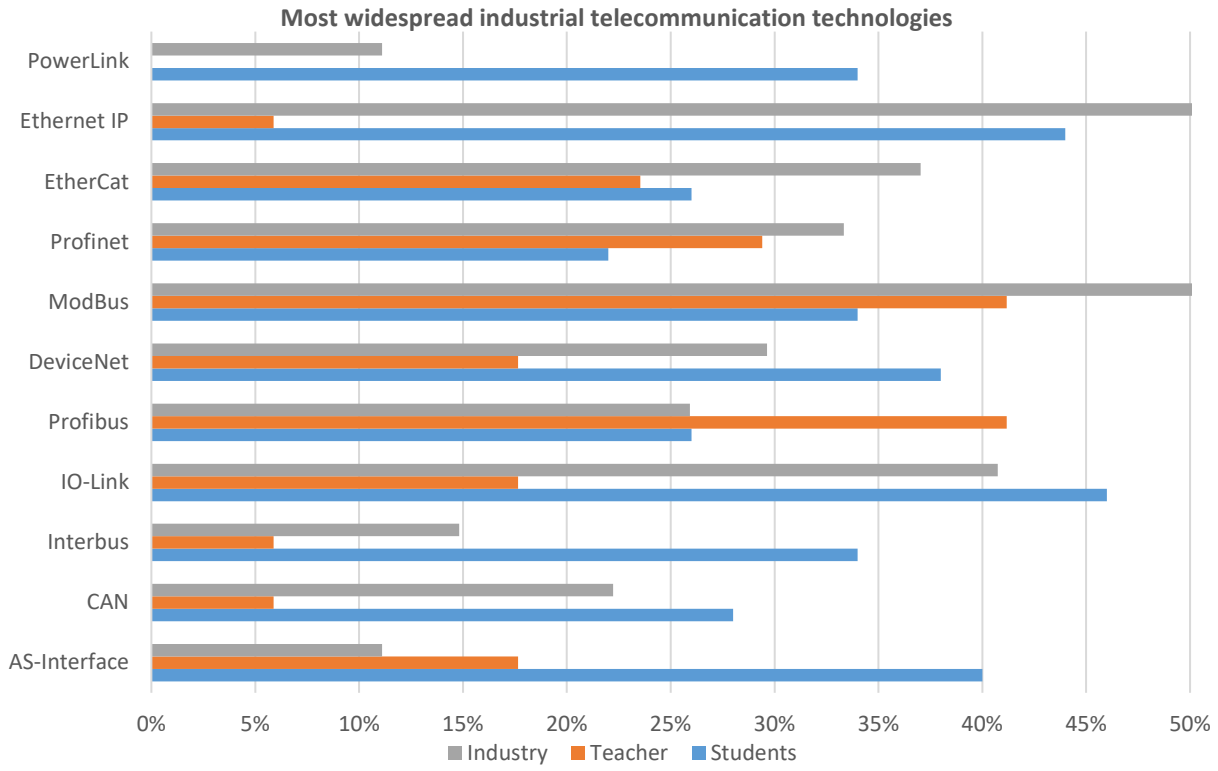


Figure 7: Most widespread industrial telecommunication technologies

Figure 8 illustrates the most promising wireless technologies. All target groups agree that Wi-Fi is the most promising technology followed by Bluetooth and GSM.

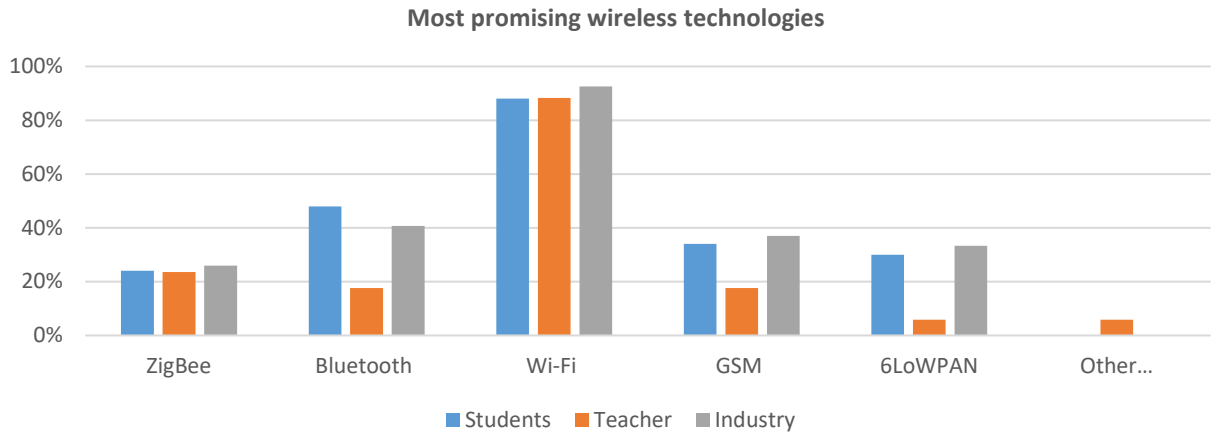


Figure 8: Most promising wireless technologies

Students and professionals from industry find that Python, C-programming and Java are the most important programming languages for a future career as Automation 4.0 specialist (see Figure 9). According to teacher, Java is less significant and positioned equal to Matlab and Simulink.

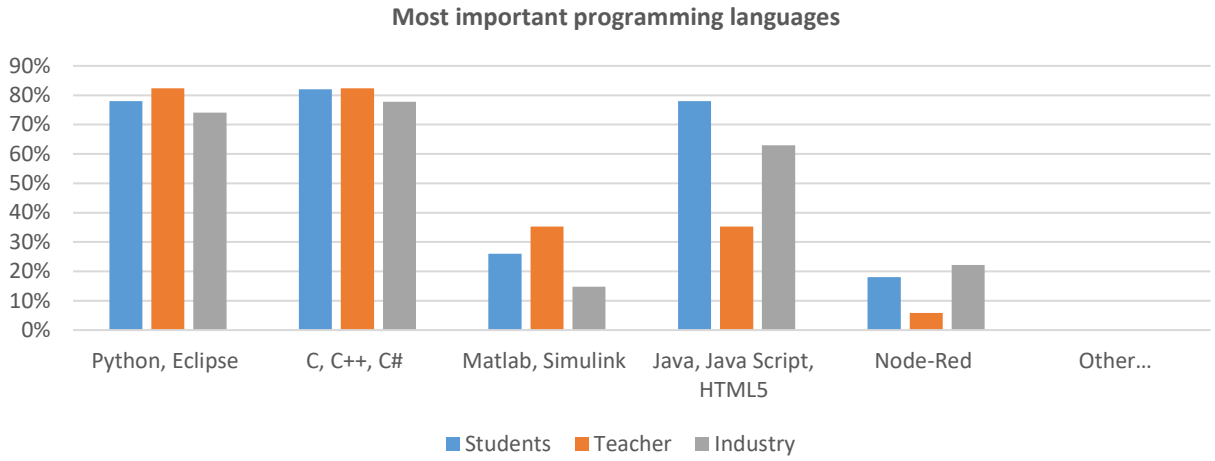


Figure 9: Most important programming languages

According to all target groups Google Cloud is the most useful cloud system for the future career of specialists in Automation 4.0, followed by Microsoft Azure and IBM Cloud (see Figure 10).

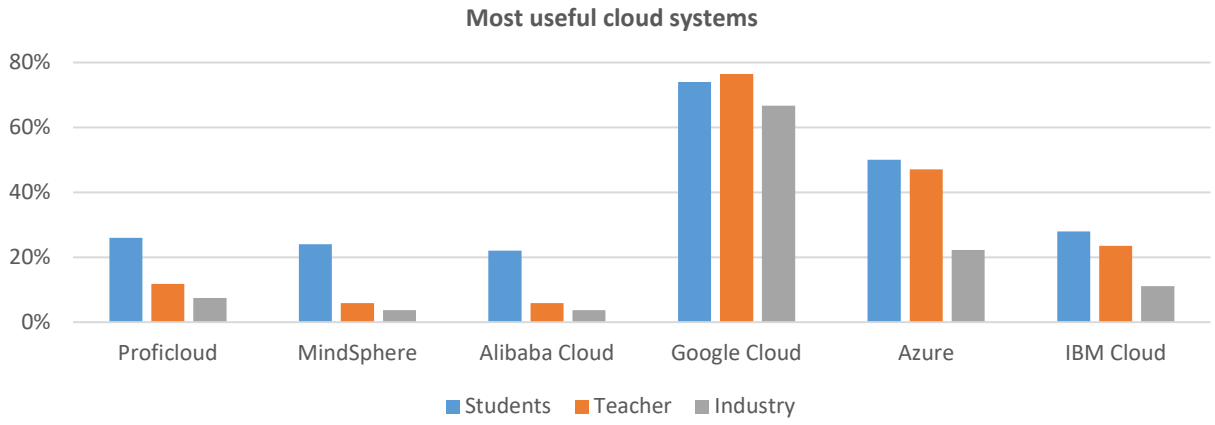


Figure 10. Most useful cloud systems

All target groups confirm that it is important that training materials are based on specific manufacturers (see results in Figure 11). For industry and students, this aspect is of high relevance, while teachers from university are more flexible in the selection of manufacturers.

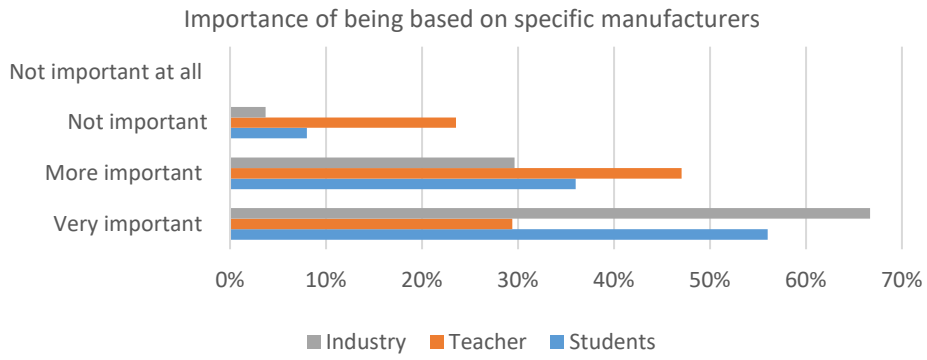


Figure 11: Importance of training materials/hardware to be based on specific manufacturers

### 3.4 Needs and Requirements for Future Training Formats

All target groups have been asked regarding their preferences in learning methods (see results in Figure 12). While students would be in favor of e-learning formats, teacher and professionals from industry seem to be less convinced of this new learning methodologies. All target groups confirm that practical exercises in laboratory and the conduction of case study work are promising learning methodologies. The face-to-face lecture is still one of the most preferred formats for teaching.

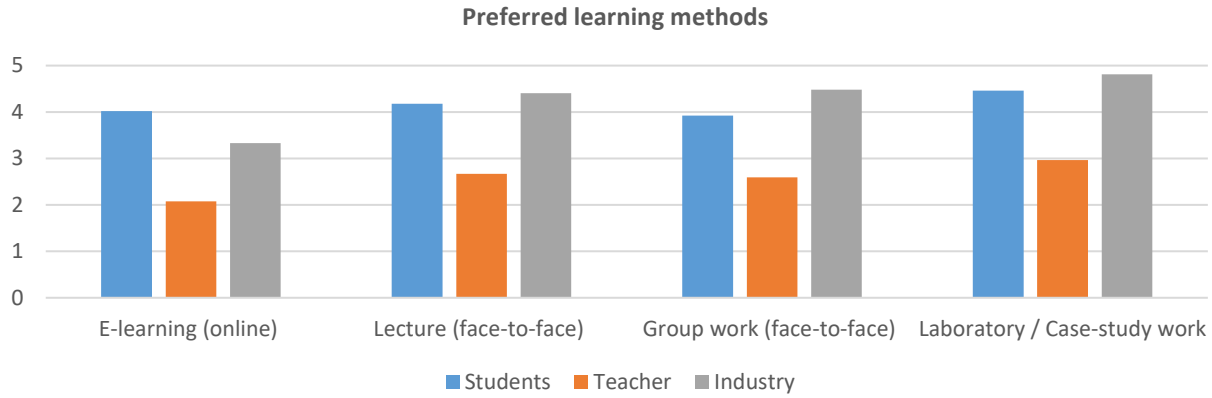


Figure 12: Problematic aspects in qualification

In order to get direct feedback regarding preferred training formats for professionals in industry the survey included also questions regarding how to organize such qualification evets like seminars or short-courses for employees. The first question was related to the interest of companies in sending employees to such courses and how many employees they estimate to send (see results in Figure 13). Three quarters of the companies are very much interested in the offer of short courses for industry while the other quarter of the companies confirmed still a high interest. Nearly two third of them would be able to send between 3 and 10 employees to such courses. Some companies could send less and other companies also more than 10.

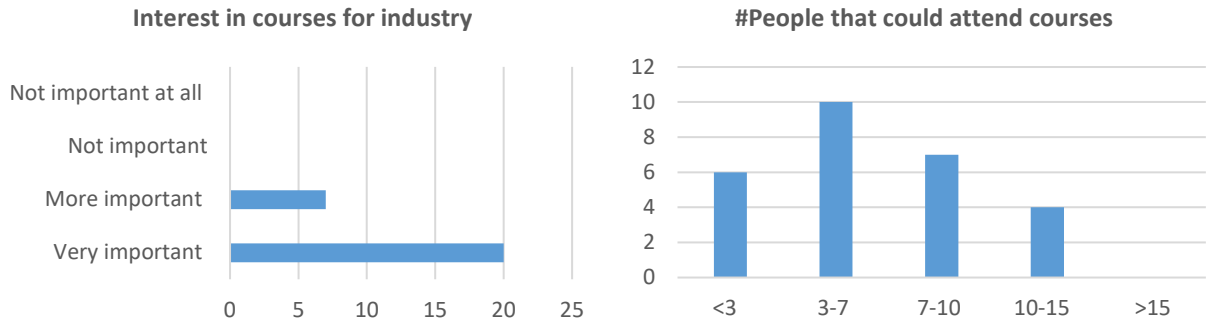


Figure 13: Interest in courses for industry (left) and number of people that could attend courses (right)

A further question reveals the preference regarding the appropriate length and form of training for professionals from industry (see Figure 14). Most of the companies are for a training with at least 4 days of training in order to get not only a superficial overview of Automation 4.0 and related technologies. Regarding the form of training most of the companies prefer to send their employees to seminars at training centers in universities during non-working hours as well as to seminars organized directly on site during working hours.


Figure 14: Appropriate length of training (left) and form of training (right)

## 4. Concept of ETAT Training Centers and ETAT Smart Labs

The ETAT project aims to create exemplary Education & Training Centers in the field of engineering education at participating EEC universities that are able to support as education hubs in the EEC region for industry-related education and training for engineers and young specialists. The following objectives are to be achieved with it:

- Modernization of higher education in Thailand based on the experience of European countries.
- Increase the employment rate of university graduates and implement the concept of life-long learning with the help of special training modules in the field of industrial automation.
- Development of partnerships with Thai enterprises and European technology providers.
- Improve the quality and relevance of higher education in Thailand in the field of industrial automation.
- Establishment of 6 certified ETAT Training Centers at partner universities, which will be equipped with 24 special training places (respectively 4 ETAT Smart Labs per Thai university).
- Establishment of a platform for distance learning and cooperation between the partners for providing e-learning & cloud-based learning courses and for exchange of didactical documents and information.

ETAT Training Centers will be provided with teaching materials and certificated courses for different target groups like students, Thai trainers trained by EU university partners during the ETAT project and Thai industry.
The ETAT Smart Labs integrate different hardware for industrial automation in the context of Industry 4.0 considering different topics of Automation 4.0:

- Basics of Cyber-physical Systems and Industrial Internet of Things (IIoT).
- Advanced PLC programming.

- Feedback Control Technology.
- Robotics/ Basic of Robotic Control/ Robotic Programming.
- Man-Machine Systems.
- Big Data Analysis for Industrial Applications.

The ETAT Smart Labs will be designed in strong collaboration between EU and Thai partners based on the needs already shown in the Section before. The ETAT Smart Labs will then be assembled in Europe and shipped to the Thai university partners. After the installation, testing and validation of the ETAT Smart Labs in Thailand project partners from Europe will accompany them by providing train-the-trainer trainings and supporting the start of using didactic materials as well as the hardware for qualification of all target groups.

## 6. Conclusion and Outlook

This analysis shows, based on a survey of students, teachers and industry professionals, which needs prevail in Thailand regarding Automation 4.0. These results are important findings for the ETAT project, which will be used to build ETAT Training Centers with ETAT Smart Labs and thus take the qualification for Automation 4.0 to a new level. In a next step, the project consortium will now develop a concept for the ETAT Smart Labs and the didactic material. As part of the development and planning of the labs, different demonstrators will be defined, which will allow different application simulations from smart city to smart robot and smart farming or smart traffic to smart home. All Thai universities will be closely involved in the project, and at the same time the experience of the European partners will be utilized.

## Acknowledgements


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## Biographies

**Erwin Rauch** is an Assistant Professor in Manufacturing Technology and Systems at Free University of Bolzano, Italy. He was Visiting Researcher at Worcester Polytechnic Institute (WPI) in Worcester, MA (USA) and Chiang Mai University in Thailand. Further, he is Head of the Smart Mini Factory laboratory for Industry 4.0 application at the Free University of Bolzano. His research interests include industry 4.0, axiomatic design, agile and reconfigurable manufacturing systems as well as optimization in SMEs.

**Matteo De Marchi** is doctoral student at the Smart Mini Factory lab for Industry 4.0 at the research group Industrial Engineering and Automation (IEA) of the Free University of Bolzano (Italy). His research interests are in digital twin, industry 4.0, automation 4.0, collaborative robotics and intelligent manufacturing systems.

**Prajaks Jitngernmadan is** vice head of Digital Media and Interaction Research Laboratory (DMI) and deputy dean of Faculty of Informatics at Burapha University. His teaching and research focuses include didactic virtual learning environment including remote access, process data visualization and analysis, remote education in automation technology. He has participated national and international research projects and published a number of papers in international journals and conference proceedings.

**Felipe M. Martin** is an Associate Professor, vinculated to ISA since nov 1988. Dr. Mateos has participated in is multiple I+D projects in industrial automation. Coordinator of the Master Program in Industrial Automation and Computer Engineering. In the last year he deals especially with Industry 4.0 projects and with the development of a Industry 4.0 lab platform.