

Are the Knowledge and Skills Achieved by Students through the University Study Congruent with their Future Career Choice?

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Abstract

Engineering professionals work in wide variety of industries and deal with many types of works including design, manufacturing, construction, management of products, processes, services, and supply chains considering the effective and efficient utilization of resources. Unlike other majors, content of engineering major could be very wide and vast and involve day to day real life activities. Engineering students, therefore, need to develop specific types of skillsets and prepare themselves for the real workplace. Although there has been increasing emphasis in the universities to provide more real-life learning experience to their students, there is a lack of studies on the establishment of relationship between students' career choices and related skills and whether universities are able to provide such skills to their students. No recent study in Australia has investigated whether universities are properly equipping their students with necessary skills and knowledge with contemporary industries. A sample of mechanical and civil engineering students were surveyed using a well-designed questionnaire to address this research gap. Results show that engineering students surveyed intend to pursue diversified professions and they require specific set of skills. It was found that level of skills achieved by the students widely varied- ranging from 40% to 85%. This study also examined the relationships between skill achievement and gender, cumulative GPA, country of origin and engineering majors.

Keywords

Mechanical Engineering; Civil Engineering; Career Choice; Skills; and Engineering Education.

1. Introduction

Higher education refers to a continuous process of learning by students in specialised disciplines of a university or similar tertiary institute. Academic disciplines are well-versed across universities. Each discipline in arts, business, science, and technology designs its own curriculum meeting accreditation requirements for stipulated knowledge and skills to be reflected through the graduate attributes of students. Industries create job market for students and make critical appreciation of those knowledge, skills, and graduate attributes.

Students are the primary stakeholders of university education systems. They invest in their education with dual objectives, primarily to gather knowledge and skills, and ultimately to find a job in accordance with their career choice. Universities in the developed countries like Australia have a formal process of having student evaluation about various

aspects of learning and teaching, including the quality of teaching resources, teaching style, assessments and constructive or summative feedback to students. However, the learning and teaching approaches and evaluation systems do not create any opportunities for students to provide opinion of whether the knowledge and skills they achieve through the university are adequate and congruent with their career choice or would be able to meet expectations of the industries where they would like to commence their career. There is a lack research in examining whether the university students' skills are adequate for the industry and how students assess the link of knowledge and skills to their career choice. The present study addresses this gap and aimed at securing a deeper understanding of the students' career choices and their perception about skills and knowledge required for their aspired career path. Using a highly reliable survey questionnaire, a questionnaire survey was conducted among the civil and mechanical engineering students at Queensland University of Technology (QUT), Brisbane, Australia. About 63 engineering students out of 300 responded in the survey resulting in a response rate of 21%.

The paper is structured with five sections. Section two reviews relevant literature. Section three outlines the research approach. Section four discusses the research findings. Finally, section five concludes on the paper with policy recommendations and suggestions for future research.

2. Literature Review

Connections between engineering study and skills required in the real workplace have been studied by different researchers. Stiwne and Jungert (2010) examined engineering students' experiences of transition from study to work in Sweden. The authors found differences in the way students expressed opinion about their curricular design, career plans, job search and job satisfaction. During interviews, students opined that general skills and cultural values are best learned in extracurricular activities and in work contexts. The findings suggest that subject-specific knowledge, math skills, problem-solving skills and research project-based experiences are critical to career choice decisions.

Lins et al. (2014) argued that engineers may leave engineering careers due to non-attractiveness of engineering profession. Because of their diverse training in science and mathematics, they have possibilities to work in non-engineering occupations. This may result in shortage of engineers in job market. However, the authors did not dig into the deep to investigate whether or not engineering curricula were interesting to students and motivating to choose engineering career.

Paolillo and Estes (1982) undertook an empirical analysis of career choice factors among accountants, attorneys, engineers, and physicians. They investigated the time for career choice decision during pre-high school, high school, freshman or sophomore year of college, junior or senior year of college and post baccalaureate. They found that while accountants tend to decide on their profession during the first two years of college, most prospective mechanical engineers and physicians choose their career track by the time they finish high school. This implies what mechanical engineers do study during their engineering degree may not have substantial effect on their career choice decisions as they already have made up their mind. The authors tested 12 factors that may have influence on the selection of a profession. These factors include earning potential, association with others in the field, parental influence, cost of education, social status attainment, job satisfaction, years of formal education required, aptitude for subject matter, peer influence, previous work experience and availability of employment. It was found in their study that employment availability is the most influential factor to accountants and mechanical engineers while social status attainment appears to be less important to them. The authors argue that accountants and engineers require similar analytical skills and their career choice decisions are much influenced by the same factors. However, this study was undertaken about 40 years ago. It is imperative that a new study is conducted on current students' perception of the time and factors of career choice.

Margolis and Kotys-Schwartz (2009) report that as of 2002, while 2.2 million people in the US workforce had a degree in engineering, approximately 1.2 million of them were in engineering-related jobs, and as a consequence, approximately 1 million people with engineering degrees did not practice engineering in the USA. The authors opined that the College of Engineering and Applied Science of the University of Colorado at Boulder conducted a graduation survey, but little is known about intended career plans of graduating engineers and how their career plans are influenced by their educational knowledge and skills. They suggest that research should be conducted on the educational experience of undergraduate engineering students by determining strengths and weaknesses in student abilities. The authors suggest case study interviews and focus groups for further studies to assess the factors related to post-graduation attrition.

Meijers and Kuijpers (2014) acknowledged that universities have responsibility to guide students to simultaneously achieve academic growth and develop career. In their view, universities being funded by the government have responsibility to prepare students for the society and labour market. However, in authors' view, universities often lack knowledge and motivations to guide students to choose their career paths. Although these authors' study did not consider specifically engineering students, their findings can be generalised for an overall understanding of universities' role in shaping students' career goals and choices.

Jung and Yoo (2022) conducted a study on career education needs of Korean nursing students and professionals. Using two surveys, the authors found that career awareness and development are affected by a customised career education program based on priority items. As the study was conducted on nursing students only, its findings have limited generalisability. This provides impetus for conducting a study on engineering students to examine whether inclusion of career development programs and training in the university curricula would be conducive for future career of engineering students.

Overall, the review of literature in this section unfolds the lack of recent studies examining the rigor of university curricula and its relationship with the students' development of skills and knowledge required in the real-life engineering jobs in Australia. Here lies the justification of the present study.

3. Methods

A key research question guides the present study: Are the knowledge and skills achieved by students through the university study congruent with their future career choice? To address this research question, the study uses a questionnaire survey approach. Queensland University of Technology (QUT) is selected as a case for data collection and in-depth evaluation of research findings. Students who have been selected for this study are 3rd and final year students from the Mechanical Engineering and Civil Engineering disciplines, from the Faculty of Engineering. A questionnaire-driven survey is conducted to collect students' opinion about their career, their thoughts about the skills required for the expected jobs, level of those skills they were getting from the university study and the teaching-learning approaches. It is assumed (hypothesised) that students' satisfaction with the university study depends on whether the skill and knowledge they gather from the university meet their career expectations. Upon developing the proposed questionnaire, it is directed to 300 engineering students selected, applying simple random sample technique, from the Faculty of Engineering (FoE), Queensland University of Technology (QUT). The recommendation of Oke et al. (2012) and Karim et al (2019) regarding the sample size is considered in this paper.

A traditional paper-based survey questionnaire was distributed among the students during the last week of the academic semester. The first section of the questionnaire consisted of the demographic and background information of the students, and the 2nd section consisted of statements related to their career plans after graduation, what skills they thought would be required for those jobs, how much of those skills they think they achieved during the university study, and any suggestions to improve the engineering course learning outcomes.

A limitation of the study is that it is conducted on a single university and based-upon survey of mechanical and civil engineering students only. The students are from 3rd and 4th year of their study, which means that there are still learning. It is expected that the opinion they expressed at this stage of their study might change when they complete their study. As a consequence, the findings of this study may not be generalised. However, given the lack of studies on engineering students, the study would significantly contribute to the literature and lead to further studies on this important topic.

4. Results and Discussion

4.1 Response rate

After sending the 300 questionnaire, 63 completed responses from the selected undergraduate mechanical and civil engineering students at QUT were returned to the authors. The sample size of in this study is considered appropriate for further analysis as per recommendation of Oke et al. (2012). Thus, based on the number of the submitted surveys and the acceptable returned questionnaire, the response rate was 21 %, which was considered acceptable compared to other studies in relevant field (Karim, 2010a). Reliability tests were conducted for all the variables studied as a measure of the internal consistency of the research instrument employed to measure concepts. A minimum a value of 0.60 for variables is indicated as identifying that the variables are internally consistent and are good measures of the concept

studied (Sarhan et al., 2020). Reliability of the instrument used was 0.721 and all the variables studied have significant F values ($p < 0.05$).

4.2 Demographic information

About 70% respondents were Australian and 30% were international students from 9 countries. Majority of engineering students at Queensland University of Technology are male, which is also reflected in the survey response as 81% respondents are male, and the rest are female. The average age of the respondents was 24 years. Although most of the respondents are regular students with age range 20-23, there are some matured students with age up to 39 years. The students were asked to mention their average GPA and the reported GPA were between 4 and 7 in the scale of 1-7. The demographic data shows that the respondents were similar to the student population of the Faculty of Engineering at QUT.

4.3 Career Aspiration

As the universities aspire to equip their students with the knowledge and skills to work in the real industry, it is critical for them to know what industries the students are destined to and the skills they expect from university graduates. The students were asked to opine what their career aspiration would be after the graduation. The responses from the mechanical and civil engineering students are presented in Figures 1 and 2, respectively. It can be seen that the students expected to take diversified career paths. It is interesting to see only about 36% of the mechanical engineering respondents intend to pursue a pure mechanical /manufacturing or industrial engineering jobs and 26% want to work either in oil and gas industry or in design. The other 38% are interested in different other jobs including IT, project management and mining industries. This result supports the findings of Margolis and Kotys-Schwartz (2009) who reported that 45% of engineering graduates in USA were working in different fields.

On the other hand, the career choices for civil engineering student seem to be very discipline oriented as 75% respondents said that they want to do a civil engineering job. In fact, construction is also a civil engineering job and if we merge this with civil engineering jobs, the proportion of respondents aspired for civil engineering job becomes more than 80% (Figure 1 and Figure 2).

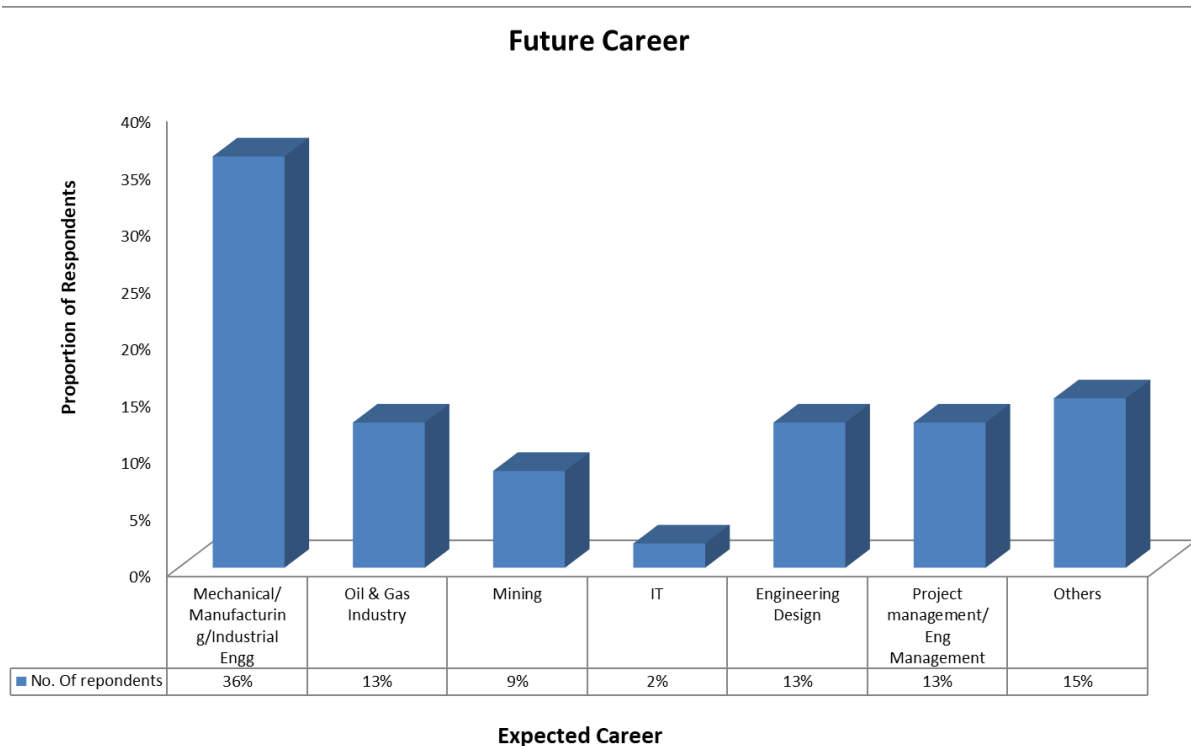


Figure 1. Career aspiration of mechanical engineering students

A comparison of Figure 1 and Figure 2 above reveals that mechanical engineering students have more diverse career choices than civil engineering students. While 36% of mechanical engineering students aspire to commence career in the mainstream mechanical, manufacturing, and industrial field, most (74%) of them would like to be employed in varying fields such as oil and gas, mining, engineering design, project management, IT, etc. To the contrary, only 18.7% would like to commence career in diversified fields including project management and architecture. Again, these fields can also be related to civil engineering.

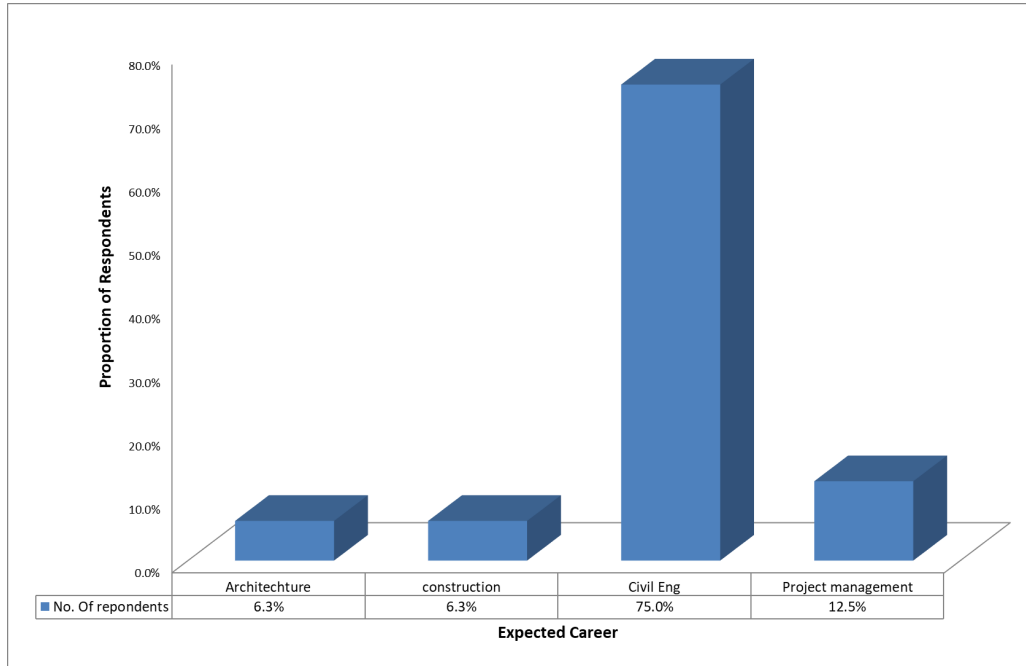


Figure 2. Career aspiration of civil engineering students

4.4 Skills Required

University students expect that they will gather necessary skills from their undergraduate study to successfully work in the jobs they aspire to pursue. The students were asked what skills they think required for the job they selected. They needed to list up to four skills they think are most critical for that job. The results are presented in Figures 3 and 4 for mechanical and civil engineering students respectively.

Figures 3 and 4 show that while top five required skills for mechanical engineers are (in order) communication skill, teamwork, project management skills, management skills and operations management; civil engineering students ranked (in order) the communication skill, engineering knowledge, management/ operations skills, teamwork and report presentation as their main required skills. It is interesting to see that students from both majors ranked communication skill, management skill and teamwork as the most important skills required in their career. If the project management skills, management skills and operations management skills mentioned by mechanical engineering students are grouped as management skills, top four skills for both majors would be same, which are communication skill, engineering knowledge, management skills and teamwork. It is surprising that only 15% of civil engineering respondents and 9% mechanical engineering respondents thought engineering knowledge was important. The possible reason could be that, they thought, during successful completion of the courses, the students would have gained engineering knowledge anyway.

Mechanical engineering students also mentioned problem solving skills, planning, time management and programming skills as other impotent skills required. On the other hand, the civil engineering students thought that report writing/presentation, industry experience, software, motivation and construction knowledge as essential skills. These are understandable as civil engineering students need to continuously report the project progress and therefore report writing and presentation skills are important for them. Most civil engineers use software in design, construction

and project management jobs and skill in software is therefore essential. Many civil engineering students engage in design and construction projects at some stage of their career and therefore construction and project quality/reliability knowledge are important. It can also be seen that civil engineering students mentioned ‘industry experience’ as necessary skill. It implies that they civil engineers are expected to be directly involved in the field work and therefore a prior industry experience will be critical.

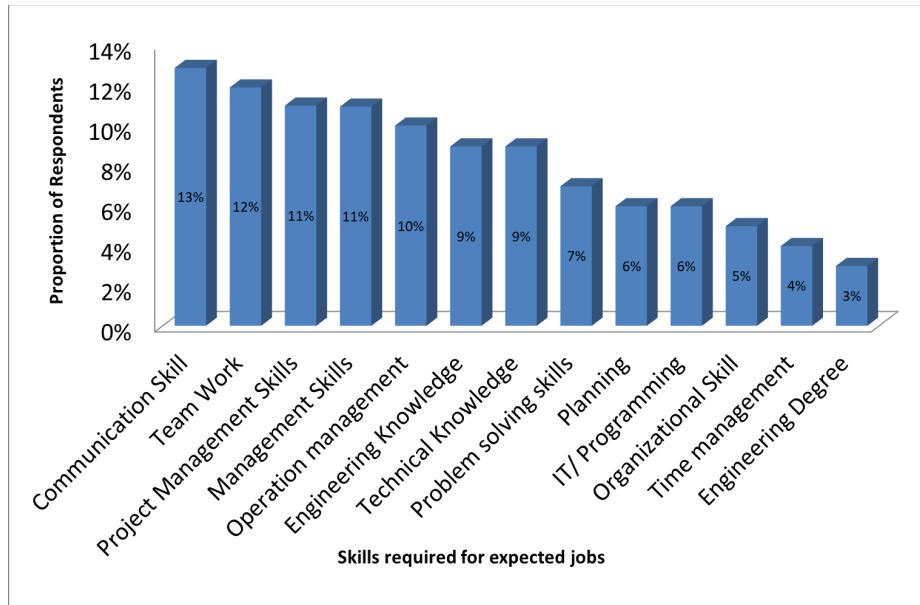


Figure 3. Required skills selected by mechanical engineering students

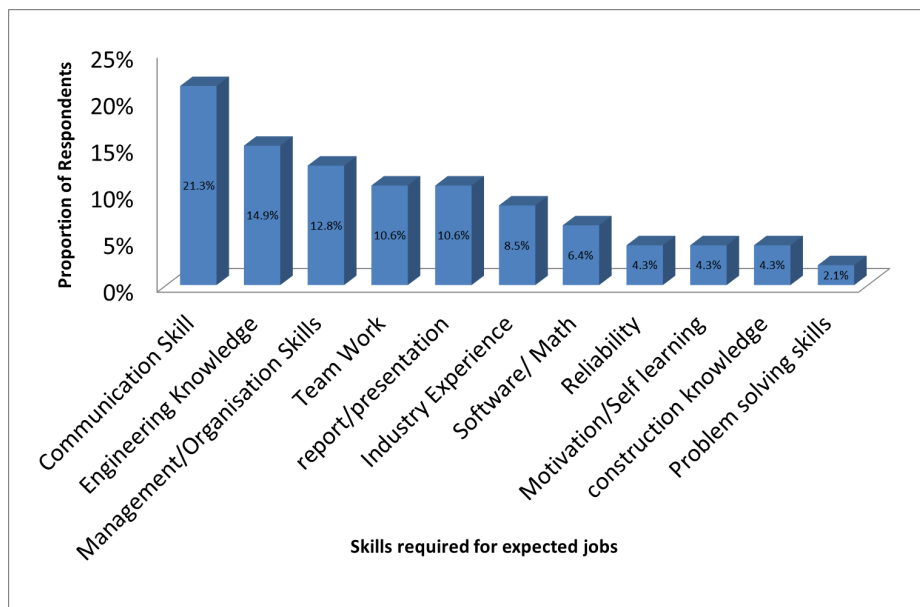


Figure 4. Required skills selected by civil engineering students

4.5 Achievement of skills

After getting the students’ opinion about their career aspiration and necessary skills for their career, the critical question is whether universities are able to equip their students with those skills. The students were asked to estimate what proportion of the required skills they thought they achieved. From the responses, it can be seen that students

achieved these skills at various levels ranging from 40% to 85%. Only 27% students reported that they achieved 80% and above the skills required for their jobs. More than 70% reported that they achieved 60% or lower of these skills. The interesting part of the results is that the achievement of skills is influenced by several factors including gender, GPA, engineering major, and country of origin. Average skills achievement by male students was 66% compared to 59% for female students. A direct relationship between cumulative GPA and skill achievement was evident as students with average GPA between 4-5, 5-6 and 6-7 have reported to have achieved 61%, 65% and 71% of their expected skills. It is interesting, however, females having higher average GPA (5.9) achieved lower level of skills compared to their male counterparts (5.8). This discrepancy worth further investigations.

Similarly civil engineering students reported to have achieved lower (60.31%) skills compared to mechanical engineering students (65.36%) despite their higher GPA (6.35) compared to their mechanical engineering counterparts (5.7). This might be related to their year of study as civil engineering students were 3rd year students while mechanical engineering students were from the 4th year cohort. It is expected that by the time they reach final year, they will acquire further skills. Interestingly, international students reported to achieve much higher skills (67.81%) compared to local Australian students (62.43). Other studies (Karim, 2010b) reported that international students are more regular in attending their lectures and tutorials compared to their local counterparts. The difference in skill achievements, therefore, can be related to the attendance to teaching and learning sessions.

5. Conclusions

This paper examined engineering students' potential career choice decisions and their perception of the achievement of the required skills and knowledge in pursuit of their career-choices. Working on the data collected from the mechanical engineering and civil engineering students at QUT, Australia, the study finds that mechanical engineering students have more diverse career choice decisions than the civil engineering students. Surprisingly, a number of students opt for non-mainstream engineering careers.

The results show a varying level of skill achievement for the student surveyed. While only 27% of the respondents opined that they achieved 80% or above skills required for the chosen careers, more than 70% reported that they achieved 60% or lower of these skills. Interestingly, the skill achievement widely varied across gender, students' GPA, country of origin and engineering major. The results warrant further comprehensive studies to extract key factors related to students' skill achievement. Such findings will help universities in moderating curriculum and student support mechanisms to improve students' knowledge and skills required in pursuit of their career choices. As it is a preliminary study with some limitations mentioned above, concrete conclusions cannot be made and/or findings cannot be generalized. It is expected that further research in this area will help universities in re-engineering the curricula and teaching-learning approaches so that real-life profession-oriented education, knowledge and skills are achieved by students during their study. As this study has been conducted on a single university, future research needs to be undertaken considering larger sample, in particular on the engineering students of more universities in the state or country.

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Biographies



Sabrina Fawzia: Dr Sabrina Fawzia is a structural engineering expert at QUT. Her research focuses on development of the high-performance structural members by using recycled or waste materials and structural strengthening/ retrofitting by using Carbon Fiber reinforced polymer (CFRP) material technology. Through her scholarly, innovative, high-quality research she has established her national and international standing. Dr Fawzia's excellence in research has been demonstrated by high quality refereed publications (100+ publications, 2784 citations, h-index=28 Google Scholar), two ARC LIEF grants (\$1.9M), two international grants (\$143K), five QUT internal grants (\$79K), QUT's Science and Engineering Faculty award and Civil Engineering school award for Excellence in postgraduate research supervision, ten PhD's and three Master's by research completions, being invited by reputed universities for seminars and the establishment of national and international collaborative research relationships.



Kazi Saidul Islam: Dr Kazi Saidul Islam is currently working as a Lecturer in Accounting in the Department of Accounting, Economics, Finance and Property of the School of Business and Law at Central Queensland University (CQU), Australia. Prior to this appointment, he worked several years in the Department of Accounting (now Accounting and Information Systems) at the University of Rajshahi in Bangladesh. Kazi has PhD in Accounting from Central Queensland University. He examined accounting manipulation (fraudulent financial reporting) in selected US and Australian banks and financial organisations by applying social-psychology/criminology theories. He holds Higher Education Teaching Certificate from Harvard University and Graduate Certificate in Business degree from the University of Wollongong (UOW), NSW, Australia. He studied Australian Taxation Law for Continuing Accounting Education from the University of Sydney (USYD), Australia. Kazi also holds MPhil, MCom and BCom (Honours) in Accounting from the University of Rajshahi in Bangladesh. In his MPhil dissertation, he examined financial reporting in commercial banks in Bangladesh. Kazi completed Banking Diploma (I) when he worked in the banking industry in Bangladesh prior to commencing teaching at universities.



Azharul Karim: Azharul Karim is currently working as Professor in the Mechanical Engineering Discipline, Science and Engineering Faculty, Queensland University of Technology, Australia. Prof Karim has authored over 225 peer-reviewed articles, including 130 high quality journal papers, 13 peer-reviewed book chapters, and five books. His papers have attracted about 7200+ citations with h-index 46. He is editor/board member of six reputed journals including Drying Technology and Nature Scientific Reports. Dr Karim has supervised 20 PhD students to completion and is currently supervising 8 PhD and 3 MPhil students. He has been keynote/distinguished speaker in 23 international conferences including International Drying Symposium 2022 and invited/keynote speaker in seminars 21 reputed universities worldwide including Oxford University, University of Illinois and National University of Singapore. He has won multiple international awards for his outstanding contributions in multidisciplinary fields. He is the recipient numerous national and international competitive grants amounting \$3.36 million, including Advanced Queensland Fellowship (AQF), ARC Linage and ARC Discovery as 1st Chief Investigator. He is also a leader in innovatively applying 'Lean Manufacturing' concepts in hospital emergency departments to reduce long waiting

times and optimize resources. His current research areas are multiscale and multiphase modelling of food drying, Nano fluid solar thermal storage, concentrating PV-thermal collector, Engineering Education and Lean Healthcare Systems.