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Strengthening Curriculum Structure of the Information Systems Programme

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ABSTRACT

The emergence of the Fourth Industrial Revolution (4IR) in Malaysia was led by a modern lifestyle and new employment market demand. 4IR indirectly has impacts on higher education, particularly in Malaysian higher education. Therefore, the Ministry of Higher Education of Malaysia is forging ahead by revamping the Malaysian education system to prepare future-ready graduates that fit 4IR. In line with the mentioned efforts by other public universities in Malaysia, Universiti Malaysia Sarawak (UNIMAS) also responds to the need for this education transformation. This paper presents a discussion on the experience and processes during the development of the new curriculum structure specifically for the Information Systems Undergraduate Programme at UNIMAS. This paper aims to restructure the existing curriculum into a new curriculum that is in line with MQA requirements.

1. Introduction

The Information Systems (IS) undergraduate programme was established back in 2003 at the Faculty of Information Technology (FIT), Universiti Malaysia Sarawak (UNIMAS). The curriculum has been updated regularly revised to carried out the market needs. A number of changes have occurred since the programme's inception. There was an increase in emphasis on computer science, which resulted in the name change to FCSIT. In addition, the degree changed from a 3-year programme to a 4-year programme with the inclusion of new courses. The development of IS curriculum has been based on the inputs from external examiner, industry advisor panels and in line with the MQA requirements.

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2. Background of Study

The Malaysian Qualifications Agency (MQA) oversees the quality assurance practices and accreditation of national higher education. As part of their responsibilities, the Malaysian Qualifications Agency (MQA) conducted an audit of programme. In 2018, among the feedback was that MQA panels have commented that the current name of the award or degree conferred to IS graduates is not compliant with MQA standards.

Therefore, the faculty decided to take immediate action in renaming the programme major, ensuring that the name is part of the Computer Science field. According to MQA Programme Standards for Computing 2023 [1], subject to majoring in a Bachelor's Degree and its nomenclature, specific learning outcomes for the four disciplines are identified in this programme. The four disciplines are computer science, software engineering, information technology, and information systems. For instance, Computer Science: Bachelor in Computer Science (subject area). The requirement for the name must reflect a subject area in computer science. The name "Information Systems" is not suitable because it is a discipline of its own. For now, the faculty has declared that the IS programme at FCSIT is based on the computer science discipline. Currently, the IS programme complies with more than half of the Body of Knowledge for Computer Science. Thus, it is very important for the programme to decide on a suitable name for our programme major, and the changes will address the future-ready curriculum framework introduced by *the Jabatan Pendidikan Tinggi (JPT)* Ministry of Education (MoE).

In order to accomplish these important tasks, the programme has decided to apply for the Scholarship of Teaching and Learning (SoTL) Grant, an internal university grant. In addition, this scholarly approach can assist in assessing the quality assurance and enhancement of the new curriculum, which will have a significant impact on students' learning. This research aims to restructure the existing curriculum into a new curriculum that is in line with MQA requirements and geared towards a future-ready curriculum. This study also needs to align the new curriculum content with appropriate teaching and learning delivery and alternative assessment practices. Throughout this process, challenges are identified. Furthermore, the significance of the newly designed curriculum for future-ready curriculum will be assessed to ensure that requirements are fulfilled and students benefit from the new curriculum.

The research is based on grounded theory methodology, which is a widely used mode of carrying out qualitative research via focus groups, interviews, and expert panels. It involves the collection and analysis of data. The expected outcome of this research will contribute towards a future-ready curriculum with distinctive features in terms of its potential courses, teaching and learning approaches, and assessment.

3. Literature Review

The designed curricula in the higher education institution (HEI) play a critical role that may affect students' professional skills upon completion of the study. In line with the Malaysian Government's agenda towards the Fourth Industrial Revolution (4IR), as compiled in the National 4IR Policy (2021), the Malaysian Ministry of Higher Education (MOHE) has outlined several strategies for preparing the future generation for the 4IR [2,3]. In this section, the importance of compliance with CS2013 in designing new or existing curricula is discussed. The preparation of the future-ready generation for 4IR will then be discussed further.

3.1 Compliance with CSBOK

The Computer Science Curriculum 2013 (CS2013) serves as curriculum guidelines for undergraduate degree programs in the computer science field. The computing curricula steering committee consists of a joint task force, which is the Association for Computing Machinery (ACM) and IEEE-Computer Society. Both have a long history of sponsoring efforts to establish international curricular guidelines for undergraduate programs in computing over a roughly ten-year cycle, starting with the publication of Curriculum 68 over 40 years ago. The CS2013 guidelines include a redefined body of knowledge as a result of rethinking the essentials necessary for a computer science curriculum. It also seeks to identify exemplars of actual courses and programs to provide concrete guidance on curricular structure and development in a variety of institutional contexts [4,5].

The Body of Knowledge (BOK), a highly utilized feature of the CS2013 guidelines, organizes knowledge into areas (KAs) that encompass related topics, reflecting a thoughtful reconsideration of what is vital for Computer Science education [3]. The BOK serves as a map for critical subject coverage in courses or programs. Consequently, alignment with the CS2013 standards assures recognition and accreditation from the Malaysia Qualifications Agency (MQA), as it is acknowledged globally by other international institutions [6]. MQA, as detailed in "MQA's Guidelines on Accreditation," serves as the accrediting entity for programs offered by Higher Education Providers (HEPs) in Malaysia [1]. Case studies and comparative analyses also underscore the importance and global acceptance of CS2013 in modern Computer Science curricula [7,8].

3.2 Towards IR4.0

Industry 4.0 was first publicly introduced as "Industrie 4.0" by Germany in 2011 [9]. Industry 4.0, which combines the physical, digital, and biological worlds, has brought a new fundamental paradigm shift in the ways we work, communicate, and live. These fusion technologies impact our society across all disciplines, which includes the field of education. The Industry 4.0 revolution led to changes in professions and employment trends. Industry 4.0 is revolutionising the way companies manufacture, improve, and distribute their products. Manufacturers are integrating enabling technologies, including the Internet of Things (IoT), cloud computing and analytics, artificial intelligence (AI) and machine learning, into their production facilities and throughout their operations. These smart factories are equipped with advanced sensors, embedded software, and robotics that collect and analyse data and allow for better decision-making. As mentioned by Ma *et al.,* [10], AI is "the branch of computer science devoted to solving cognitive problems typically associated with human intelligence, such as learning, problem-solving, and pattern recognition".

There are some important works that have been done by the computer science field to support other domains. For instance, Islam *et al*., [11] mentioned IoT has been used in some significant medical science studies to track patients' health. In addition, Li *et al*., [12] apply cloud computing to share data between individual users and enterprises. Data sharing becomes an incredibly appealing service offered by cloud computing platforms because of its simplicity and affordability. Hence, the emerging workforce is expected to have the top 15 skills by the year 2025, which are analytical thinking and innovation, active learning and learning strategies, complex problem-solving, critical thinking, and analysis, as highlighted in the report The Future of Jobs (2020), published by the World Economic Forum (WEF).

In response to the rapid development of digitalization and the impact of 4IR nowadays, the landscape of educational technology has been transformed by IR 4.0. According to Palestina [13], IR 4.0 has become one of the significant drivers of Education 4.0 and is mandatory to be implemented

and integrated into the curriculum. Educators believed that education 4.0 was the response of academia to meet the requirements of IR 4.0. Shahroom and Hussin [14] investigated new and creative approaches for educational innovation to upgrade future learning to meet the Education 4.0 requirements. Penprase [15] stated that the emergence of 4IR demands a drastic reconsideration of the curriculum within HEI to enable students to comprehend both the technical and soft skills required by the industries. Therefore, the need to re-design the existing curriculum is critical, focusing mainly on transforming the teaching and learning strategies. There are some previous studies that are taken from [16-20]. They also mentioned that the HEIs are to respond to these requirements since emerging technologies have an impact on what students need to learn. This not only involves familiarising students with new technologies but also building their skills in computational thinking and their ability to design digital solutions.

Based on the survey reported by [2], Figure 1 presents a selection of technologies organized according to companies' likelihood to adopt them by 2025. Cloud computing, big data and e-commerce remain high priorities, following a trend established in previous years. The adoption of these technologies has transformed the way teaching and learning in education which led to the rise of Education 4.0. Therefore, we need to update our curriculum (to be future-ready) to ensure that our future graduates can fulfil the demand.

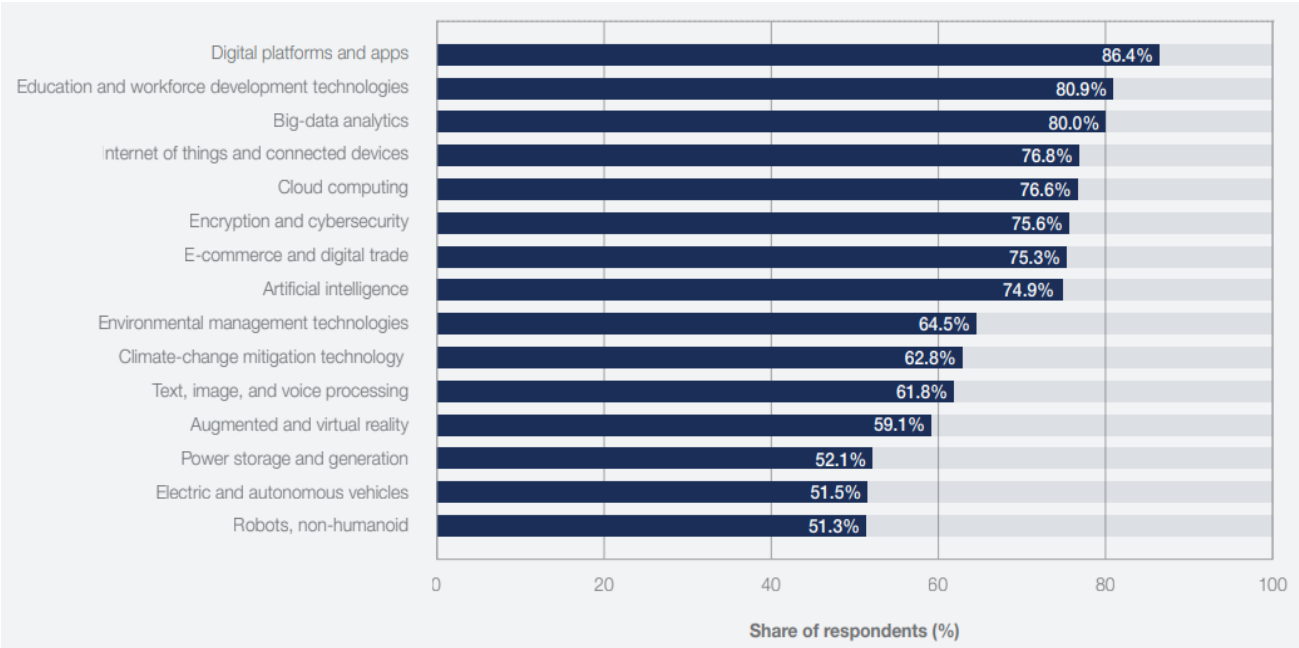

Fig. 1. Technologies likely to be adopted by 2023-2027 - by share of companies surveyed (The Future of Jobs Report 2023)

4. Methodology

This phase encompasses three major research activities: the initial study and planning (initiation of the research, development of a research plan), a review of the literature, and the construction of a preliminary theoretical framework for the Strengthening Information Systems (IS) Undergraduate Programme towards a Future-Ready Curriculum. A preliminary study was initiated. The purpose of the preliminary study is to determine whether to pursue a system development research project and, if so, to perform the necessary preparatory work. In this phase, a few steps were taken. The strategy that we applied to this research were based on the following research questions. There are three research questions for this study.

4.1 Research Question 1

It is essential to understand the term used in the title of the research. With ICT competency, a future-ready curriculum is closely tied to the technology used. Nevertheless, the literature review on RQ1: How to design a future-ready curriculum with distinctive features requires outlining the most influential methods applied and the technology used. Findings from RQ1 gave us ample information about the transformative nature of teaching and learning. Transformative teaching and learning is one of the approaches to future-ready curriculum elements [2]. This research employed a transformative teaching and learning approach and incorporated the principle of scholarship of teaching and learning (SoTL) that guided data collection from the participants. Apart from that, the definition of the future-ready curriculum needs to be understood thoroughly with the outline of the literature review. From the preliminary study, the research could determine information on the best practices for strengthening the programme.

4.2 Research Question 2

The second research question is RQ2: How can the curriculum content, transformative teaching and learning delivery, and alternative assessment practises be strategically aligned? A few processes have been conducted to map the curriculum content, transformative teaching and learning delivery, and alternative assessment. The process involved data collection, such as surveys, face-to-face meetings and discussions, and document analysis from CSBOK.

In this research, data collection as part of research strategies is divided into two smaller parts, which are quantitative research and qualitative research. Quantitative research is where statistics are made using large-scale survey research obtained from methods such as market surveys, while qualitative research studies attitudes, behaviours, and experiences through methods like interviews or focus groups with the aim of getting detailed opinions from participants [21]. The market survey was designed according to the standard guidelines given by *Pusat Pembangunan dan Pengurusan Akademik (PPPA)*. Extensive market surveys with various industries have indicated a very positive response to the curriculum of the programme.

Since user requirements are a key element in this research, the selection of qualitative methods is very effective. Qualitative research seeks to understand a given research problem or topic from the perspective of the local population it involves. For instance, involving industry representatives in a series of interview sessions and discussions to obtain specific information about the issues and opinions on innovative ways and means of improving the university-industry interaction would be more effective. Universities should partner with industries to offer a curriculum that makes students more valuable to industries.

The strength of qualitative research is its ability to provide complex textual descriptions of how people experience a particular research issue. When used along with quantitative methods, qualitative research can help us to interpret and better understand the complex reality of a specific situation and the implications of quantitative data.

4.3 Research Question 3

The third research question is RQ3: How to assess the significance of the redesigned curriculum practices. In ensuring validity, *Pusat Pembangunan dan Pengurusan Akademik (PPPA)* has appointed several expert panels to review and relate the output content to the method. The expert panels have

varying levels of expertise in restructuring a particular programme. They are from local universities and various industries.

4.4 Research Strategy and Design

In this research, we have designed a conceptual framework to have an overall concept, as shown in Figure 2. First and foremost, understanding the requirements for meeting the future-ready curriculum is important. By defining the needs, terms, and conditions and their content, we will ensure the curriculum is in the right direction and future-ready. In general, a future-ready curriculum should be able to prepare the student for the current scenario of market needs. In this research, we also investigate what other public universities in Malaysia prepare for their students, particularly in the IS programme. It is understood that not all universities use the programme name IS. Some might have changed from the IS programme to another name, such as data engineering, data science, or even information science. The possibility of rebranding the name of the programme is part of the marketing strategy to ensure the programme is up-to-date with the current scenario. Benchmarking the current existing curriculum with other universities' curricula would prepare for a better understanding of the needs of the programme. Each university has its own set of curricula, which differ from the others. There is only a slight difference between them. Despite that, the delivery methods as well as the course content could be different, even though the course name is the same.

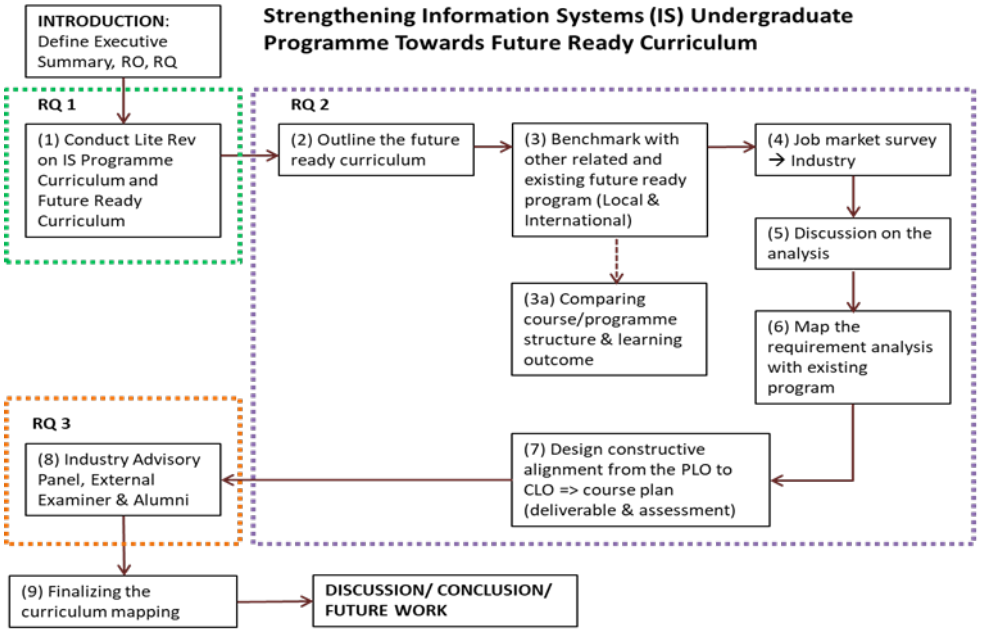

Fig. 2. Conceptual Framework on Strengthening IS Undergraduate Programme

Nevertheless, the curriculum must be in line with what the market needs, as this will lead to graduate employability. Looking at the industry requirements will enable us to underline the main courses to be conducted in the syllabus. In designing the curriculum, the students, as the programme's product, need to have the capability of transformative teaching and learning. Transformative teaching and learning will encompass the application of the technology, not only in using it but also in improving the existing technology. Moreover, understanding the importance of the requirements from the stakeholders could determine the success of the curriculum. Stakeholders, among them the alumnus, students, and academicians, play a vital role in ensuring the curriculum meets the objectives. They need to work hand in hand, as the products that will be

delivered in the programme will affect the outcome of the product. In this research, we have conducted surveys with our stakeholders.

4.4.1 Preliminary study

The literature review enables us to obtain more information regarding the course of future-ready curriculum as well as the current practise in information systems programmes. We would consider this phase to be the analysis phase. In other words, we conducted a preliminary study on the design of a future-ready curriculum based on articles and reviews of other universities' curricula. In conducting the literature review, the source of information was obtained from journal articles, conference papers, reports, and through focus group interviews. The interview session was conducted through online discussions and face-to-face meetings with the focus groups. During the session, we observed the archival data, such as existing course plan documents, and performed some analysis on the key issues. Some of the articles showed best practises, case studies, and comparative studies on the current state of academic programmes.

4.4.2 Benchmarking and market survey

For the University Curriculum Benchmark Report, several local universities were compared based on the duration of the study, industrial training semester, final year project semester, and total programme credits. From this report, the duration of study is between 3.5 and 4 years, and the earliest students to do their industrial training are in semesters 6 to 8. There is a university that allows students to do their industrial training before doing final-year projects. The benefit of students doing their industrial training in the final semester is that they can continue employment after their industrial training at the same company. This is based on an offer by the company. For final-year projects, students begin their projects as early as semester 7. The total average of credits for this programme is 128. Figure 3 shows a benchmarking among the selected universities on the current state of the academic programmes at some universities abroad and at local universities. Somehow, the practises of these universities could differ from one another.

Features	Singidunum University	Jan Kochanowski University of Kielce	UTM
Program Name	Bachelor in Software and Data Engineering	Bachelor in Data Engineering	Bachelor of Computer Science (Data Engineering)
Duration of Study	4 years	3.5 years	4 years
Industrial Training	Year 4	Not stated	Semester 6
Final Year Project	Year 4	Not stated	Semester 7 & 8
Total Credits	Not stated	Not stated	128

Fig. 3. Benchmarking among the universities

Studies from the industry were conducted to obtain feedback on the new curriculum structure of information system courses. A market survey was conducted to get a response from the industry on the new programme. An online questionnaire was shared with the industry. Figure 4 shows that 102 respondents responded to the online questionnaire, of which 84.3% were from locally owned organisations and 15.7% were from foreign-owned industries.

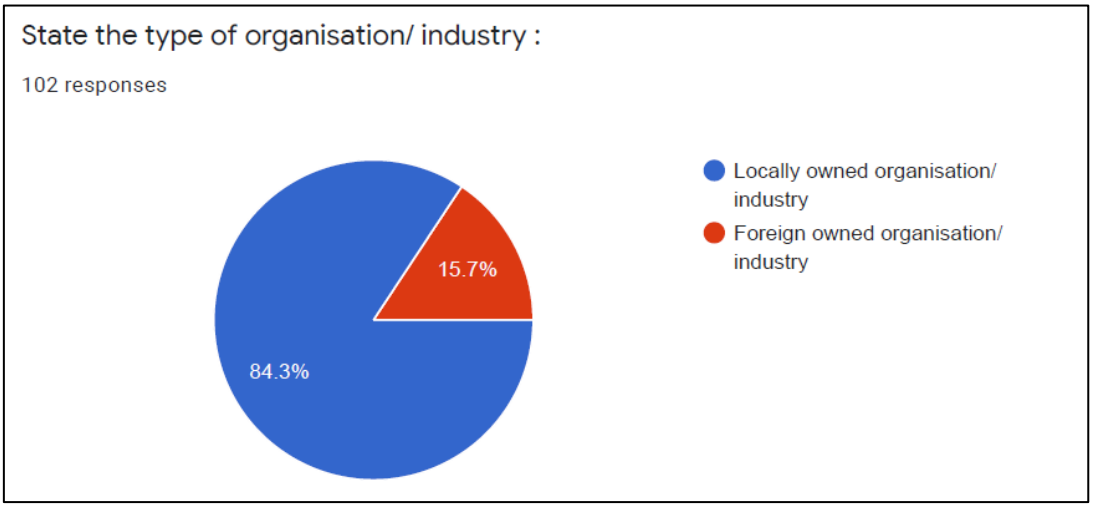

Fig. 4. Responses from the organizations/industries

4.4.3 Meeting

The Information Systems programme held several meetings and online discussions to discuss the changes needed for the new programme. Apart from programme and faculty-level meetings, industry meetings were also held by the faculty to get feedback from the industry on the new programme of Bachelor in Computer Science (Data Engineering).

The Board of Studies (BoS) of the Faculty of Computer Science and Information Technology (FCSIT) has primary responsibility for student teaching and learning and quality improvement in all faculty programmes. The BoS ensures the successful implementation of the university's teaching objectives and is fully responsible for the content, structure, delivery, quality assurance, and result recommendations. Programme consistency is maintained by measuring and reviewing faculty teaching programmes with external and internal processes, including student feedback and individual student performance and progress. The Board of Studies meets once a term. The committee includes staff who contribute to undergraduate programmes in the faculty, student representatives, alumni, and industry. In addition, the programme has appointed an external examiner from local universities and industry advisory panels to review and provide feedback on the current programme structure.

4.4.4 Curriculum review workshop

The faculty held a discussion session to present the findings from the review of the programme structure and finalise the structure of the programme. Inputs from various stakeholders were summarised and presented during the session to improve the current curriculum. This review will be conducted once every four years to ensure the relevance of the present curriculum and the demand from the industry, thus ensuring that the graduates will have sufficient skills upon entering the workforce.

5. Analysis of Data

This section focuses mainly on the results of the market survey and feedback from the Industry Panel. The market survey is divided into three parts as follows:

5.1 Market Survey

5.1.1 Part 1: Content of programme and its relevance to the needs of the organisation

In this part, the market survey report indicates that the programme meets the basic theories required in the related discipline. A statistic of respondents is shown in Figure 5, where 60.8% of respondents fully agree and 39.2% partially agree. 90.2% agreed the theories used in this programme are relevant to the current situation. Then 96.1% of respondents agreed that the subjects contributed to the strength of the programme. 82.4% of respondents agreed that this programme covers all relevant subjects. From the six criteria stated in the market survey, the use of ICT is the most fulfilled (78%) criteria, followed by the fundamental theory (75%), the use of quantitative methods (62%), the current concept (56%), and the least fulfilled legal criteria (54%). In addition, 94.1% of respondents agreed that a four-year study duration was sufficient for students, and 96.1% agreed that a six-month period of practical training was sufficient for students.

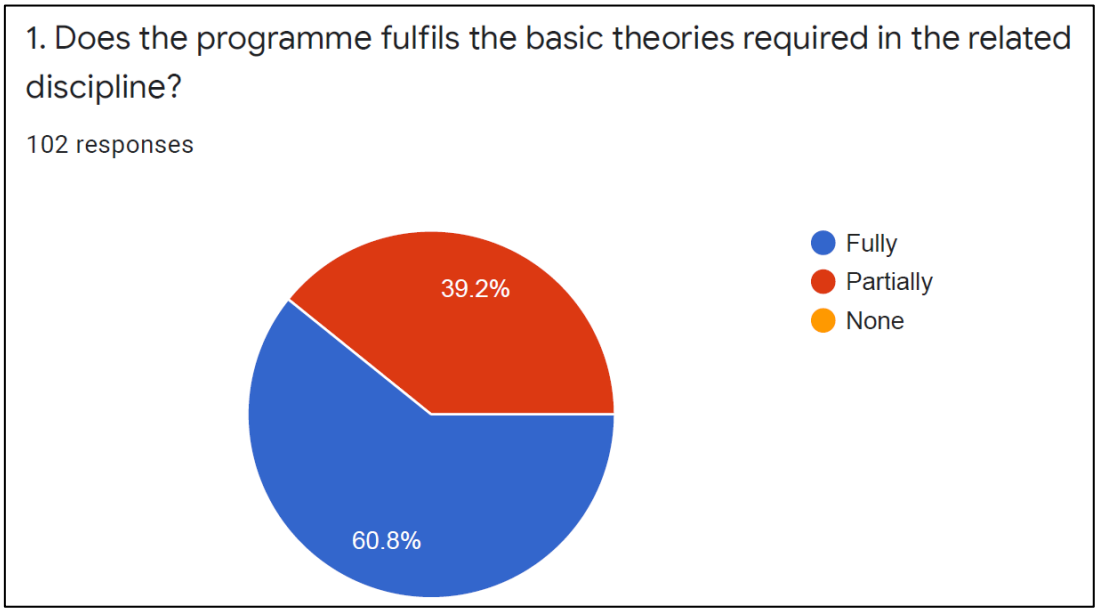

Fig. 5. Programme fulfils the basic theories

5.1.2 Part 2: Career opportunities

In this part, 60.8% of respondents stated that between 1 and 3 posts in their organisation can be filled by graduates of this programme. 48% of respondents agreed that the appropriate income for graduates of this programme is between RM2000 and RM2,500 per month, and 92.2% agreed that this programme is suitable to be upgraded to a higher level of master's degree.

5.1.3 Part 3: Others

Respondents have sponsored the students in this field (70.6%). 88.2% agreed that the programme could produce knowledgeable and competent graduates for the labour market. According to [22],

cloud computing, big data, and e-commerce remain high priorities, following a trend established in previous years. The adoption of these technologies has transformed the way we teach and learn in education, which led to the rise of Education 4.0. Therefore, we need to update our curriculum (to be future-ready) to ensure that our future graduates can fulfil the demand.

5.2 Industrial Panel Evaluation Feedback

The Industry Advisory Panels (IAPs) had conducted a visit and meeting with programme members to review and comment on the programme objectives and curriculum implemented for the department in relation to the current and future needs of the industries. The role of IAP is to provide an industry perspective on the functions and operations of the various academic programmes. Based on the IAP report, the programme must provide students with exposure to recent computer science and information technology knowledge. For instance, the area of artificial intelligence in addition, soft skills (communication, interpersonal, leadership, professionalism, teamwork, and so on) are also important to produce a competent and knowledgeable student. Table 1 presents some of the additional components and technologies incorporated into the courses offered.

Table 1
Additional components and technologies

Component and Technology	**Course**
Artificial Intelligence • Fundamental AI knowledge and AI programming language tool	Artificial Intelligence
The 6 Thinking Hats Principles • Improve communication skills and be more effective in teamwork	Soft skill and volunteerism System Analysis and Design Project Management
Python • Fundamental concept enhanced with hand-on in solving a broad set of data analysis problem	Data Analytics Natural Language Processing Machine Learning

6. Result

Through engagements and surveys with various stakeholders in redesigning the curriculum, five new courses have been identified and added to the new programme structure. These courses are relevant to current trends and evolving technological changes, as well as in line with present demands and interest from the industry and government sectors. Moreover, these courses are also reflected in the latest Addendum for Computing, a supporting document to the present MQA Programme Standard for Computing.

6.1 Artificial Intelligence

IR 4.0 focuses on the technological advancement of data exchange and automation. In recent years, there has been an increase in demand for Artificial Intelligence (AI) courses to be included as part of the curriculum to address the needs of IR4.0 and create new and exciting career opportunities. AI is a fast-moving technology that has a meaningful impact on society. Students will explore the concepts behind AI, such as algorithms, machine learning, and neural networks, as well as the fundamentals, such as building blocks and AI components, and how technology can be applied to solve real-world problems. For instance, Roslan *et al*., [23] mentioned that the use of AI in video

games may be a helpful example for students, as it is one of the examples that they can relate to. From there, educators can incorporate other types of AI technology into their lesson plans.

6.2 Machine Learning

Machine learning is a pervasive technology that enables computers to perform actions similarly to human actions without being explicitly programmed. Through this course, students will learn the theoretical aspects of machine learning techniques, their practical implementation by applying these techniques to new problems, and best practises in innovation pertaining to machine learning and AI. This also serves as one of the basic courses in data engineering to be offered prior to the Data Analytics and Natural Language Processing courses.

6.3 Natural Language Processing

This course focuses on the fundamentals and techniques of natural language processing, particularly text analysis. The statistical nature of these methods is crucial in many domains, including computer science. Data is generated in huge volumes and at high speeds; hence, there is a need to perform statistical textual content analysis to find insightful patterns using computational tools. Students will be able to analyse large volumes of data using descriptions, visualisations, and statistics, mapping the appropriate processing technique to a problem, implementing the suitable method, and demonstrating the necessary skills to solve real-world problems.

6.4 Probability and Statistics

Probability and statistics are essential skills that involve collecting, organising, describing, predicting, and analysing numerical data. In the field of data engineering, these skills provide a strong basis for courses such as data analytics, artificial intelligence, machine learning, and natural language processing. The goal of this course is to enable the students to interpret and apply these principles based on statistical information to solve real-world problems in a meaningful and appropriate way.

6.5 Data Analytics

The data analytics course provides an introduction to data analysis concepts, the role of a data analyst within the data ecosystem, exploring the fundamentals of data gathering, identifying data sources, and the tools used to perform daily functions. According to the survey, most of the alumni, industry professionals, and IT practitioners suggested including this course in the curriculum, taking into consideration the relevance of big data platforms and how these skills (cleaning and analysing data) are used to visualise and share data using various dashboard tools. This course will be offered together with data mining in the data science field.

7. Conclusion

This paper proposes a new curriculum structure for the Bachelor in Computer Science (Data Engineering) programme according to MQA requirements and compliance with CSBOK. The improvements involved feedback from industries. As a result, five new courses have been introduced to improve the programme curriculum structure, and the MQA has approved offering this programme in the 2024–2025 academic year.

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