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Analysis of Knowledge domain credit requirement in the Sri Lankan four-year civil Engineering Undergraduate Degree programs

Samarasekara GN[a*], Munasinghe B[b], Kobika M[a], Ishara KMGM[a], Konthesingha KMC[a], Fernando GL[c]

[a]University of Sri Jayewardenepura, [b] Wayamba University of Sri Lanka, [c] Sri Lanka Institute of Information Technology
**Corresponding Author Email: gangas@sjp.ac.lk*

ABSTRACT

CONTEXT

In order to remain competitive in the global education landscape, universities offering engineering degree programs attempt to follow a common structure within the curriculum. As an example, most follow the minimum credit requirements of the Washington Accord (WA) stipulated through accreditation manuals of local professional bodies (which are signatories of the Washington Accord). Thus, universities attempt to design their curricula to include courses from different knowledge domains (e.g., Mathematics, Basic Science, and Computing; Engineering Science and Engineering Design and complementary studies). The emphasis given to different knowledge domains is reflected by the total number of credits in each domain. This study attempts to understand how the credit allocation for each knowledge domain varies across different degree programs in Sri Lankan universities.

PURPOSE OR GOAL

This research attempts to investigate the research questions

1. What are the trends for allocating credits for different knowledge domains in Sri Lankan civil engineering degree programs, and where do they stand in the context of local benchmarks?
2. What are the worldwide trends for minimum credit requirements for these knowledge domains?

APPROACH OR METHODOLOGY/METHODS

This research employed the below methods

1. Review and analyse the civil engineering curricula of main universities/ institutes in Sri Lanka and the selected higher-ranking foreign universities/ institutes to identify the allocation of credit for each knowledge domain.

ACTUAL OR ANTICIPATED OUTCOMES

1. All the selected Sri Lankan civil engineering degree programs have satisfied the minimum required knowledge domains.
2. The study will be extended to identify the trends of Sri Lankan degree programs in comparison to international degree programs.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

This study contributes to a deeper understanding of the knowledge domain variations in civil engineering degree programs in Sri Lanka and worldwide. The study revealed that all the selected civil engineering degree programs in Sri Lanka met the minimum required knowledge domains.

KEYWORDS

WA requirements, Civil Engineering degree program, Knowledge domains.

Introduction

Civil engineering is a pivotal field that shapes the physical and infrastructural landscape of societies. As a country continues to grow and progress, the role of civil engineers becomes increasingly critical in addressing the challenges of urbanization, transportation, water resources, and environmental sustainability. To ensure that future civil engineering graduates are equipped to tackle these complex issues, it is imperative to analyse and assess the knowledge domain credit requirements within Sri Lankan civil engineering degree programs.

In Sri Lanka, a country that places great importance on educational advancement and technical expertise, universities offering civil engineering degree programs have embraced the principles of the Washington Accord (WA). This international agreement, signed by reputable professional bodies, sets forth guidelines for engineering education, emphasizing the inclusion of essential knowledge domains. Consequently, Sri Lankan universities with engineering degree programs have sought to align their curricula with the WA's minimum credit requirements to ensure the standardization and recognition of their engineering degrees on a global scale.

The distribution of credits among different knowledge domains plays a pivotal role in shaping the overall educational experience of civil engineering students. Typical knowledge domains include Mathematics, Basic Science, Computing, Engineering Science, Engineering Design, and complementary studies. Each domain contributes distinct skills and knowledge, nurturing engineers with diverse skill sets that can address complex real-world challenges effectively.

The primary goal of this research is to delve into the credit allocation for knowledge domains within civil engineering degree programs in Sri Lankan universities. By analysing and comparing these allocations with local benchmarks, the study aims to gain valuable insights into the trends and patterns prevalent in the Sri Lankan higher education system.

To achieve these research objectives, the study adopts a comprehensive approach. Firstly, the curricula of prominent civil engineering degree programs in Sri Lanka are reviewed and analysed. Additionally, to gain an international perspective, select civil engineering programs from higher-ranking foreign universities and universities with similar rankings were also considered for comparison. By doing so, the research seeks to identify any gaps or similarities between local and international credit allocation trends, for different knowledge domains thus offering a broader context for understanding the Sri Lankan engineering education landscape.

Background

STEM education refers to an educational approach that focuses on the four academic disciplines: Science, Technology, Engineering, and Mathematics. It is aimed to provide students with a comprehensive and interdisciplinary understanding of these subjects, emphasizing problem-solving, critical thinking, creativity, and real-world application. Standardization in order to ensure a consistent level of quality and rigor across different engineering programs.

An engineer with a background in humanities and social sciences is likely to appreciate the broader implications of engineering decisions beyond just technical aspects. Humanities and social sciences contribute to understanding the context of problems and foster critical thinking skills. Therefore, engineering education should include a comprehensive foundation in mathematics, natural sciences, humanities, and social sciences to effectively address global and societal challenges. By embracing this well-rounded education, engineers can better serve society and make informed decisions that consider the broader implications of their solutions. (Robert & Brown, 2004)

According to Ghosn, the traditional first-year curriculum in civil engineering comprises basic science and liberal arts courses, lacking engineering content, which may lead freshmen to lose interest in the field. To address this issue, a new module on structural engineering has been introduced within the Freshman Design course. The module aims to achieve various objectives, including introducing students to structural analysis and engineering materials, emphasizing the significance of math and science in civil engineering, stressing the importance of understanding physical phenomena in problem-solving, highlighting the role of computers in complementing analytical skills, and showcasing the multi-disciplinary nature of civil engineering. The modified course now includes topics such as Testing of Materials, Computer Usage, Design Process, and Engineering Communications, providing a more engaging and relevant learning experience to foster freshmen's interest and understanding of civil engineering from the outset of their academic journey. (Ghosn, 2016).

The degree awarding institutes are expected to structure their curriculum consisting of courses from different knowledge domains. In the case of Sri Lanka, the Institution of Engineers Sri Lanka (IESL) which is the local signatory to the Washington Accord has specified accreditation requirements through its accreditation manual (The Institution of Engineers Sri Lanka, 2023) and recognitional manual (The Institution of Engineers Sri Lanka, 2019). IESL Manual of Accreditation (The Institution of Engineers Sri Lanka, 2023) and Manual of Recognition (The Institution of Engineers Sri Lanka, 2019). At present, the Sri Lankan civil engineering degree programs are aligned with the 2014 IESL Accreditation Manual (The Institution of Engineers Sri Lanka, 2014). The programs who seek for provisional accreditation are designed according to the Manual of Recognition (The Institution of Engineers Sri Lanka, 2019) which has specified curriculum design conditions that are similar to those specified in the IESL Accreditation Manual.

According to the IESL Accreditation Manual, a degree program is expected to consist of courses covering three different knowledge domains namely Category (A) Mathematics, Basic Science, Computing; Category (B) Engineering Science, and Engineering Design; and Category (C) Complementary Studies (Figures 1). The categories B and C were further categorised into subcategories namely; B1- Engineering Science, B2- Engineering Designs, C1- Management & Economic communication professional ethics, C2- Humanities, Social Sciences, and Arts, as shown in Figure 1. The minimum credit requirement for each categorisation specified by IESL are also given in Figure 1 under each category and subcategory. A summary of similar requirements specified by selected accreditation is given in Table 1.

The Accreditation Board for Engineering and Technology (ABET) has also given guidance on knowledge domain composition in terms of the subject areas appropriate to engineering which are referred to worldwide in curriculum planning for engineering programs. Accordingly, the programs are expected to have a minimum of 30 semester credit hours for mathematics and basic sciences, 45 semester credit hours of engineering topics, consisting of engineering and computer sciences and engineering design, and utilizing modern engineering tools. (Engineering Accreditation Commission, 2022). Other accreditation bodies have also given some specifications about including courses from different knowledge domains. The Hong Kong Institution of Engineers (HKIE) expects that a degree program would normally include one year of mathematics and basic sciences, at least two years of engineering topics, including engineering sciences and engineering design, and complementary studies that support the professional nature of the curriculum (Board Accreditation, 2013)

Engineers Australia has also given guidance on learning content from different knowledge domains. Learning content from courses from Mathematics, science, engineering principles, skills, and tools appropriate to the discipline of study and qualification to be 40% or more of the total content. Further approximately 20 % of learning content is to be covered from the courses in Engineering design and projects. The same level of learning is expected for the courses from the Engineering discipline specialization. Approximately 10% of learning content is expected to be covered from Integrated exposure to professional engineering practice, including management and professional ethics. The remaining 10% has been allocated for other elective courses. (Engineers Australia, 2019)

Table 1: Summary of Minimum Credit requirements specified by different accreditation bodies

Category	IESL (Credits)	ABET (Credits)	Engineers Australia (EA)		Hong Kong Engineers (HK)	
			EA Specified	EA Equivalent * (Credits)	HK specified	HK Equivalent * (Credits)
Category A	25	30	40%	52	1 year	32
Category B	75	45			2 years	65
Category B1	25		20%	26		
Category B2	25		20%	26		
Category C	20		10%	13		
Category C1	15					
Category C2	5					
* Equivalent calculated assuming 130 total credits for the four-year program						

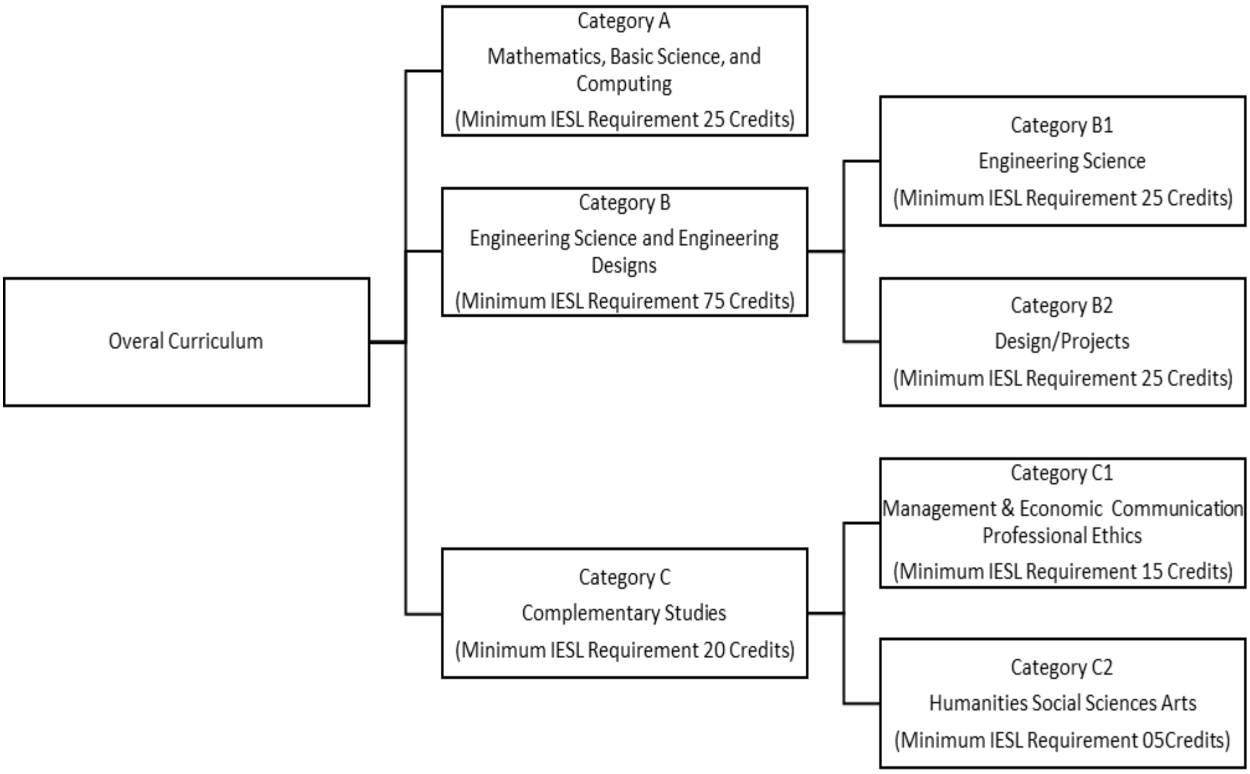

Figure 1: Knowledge domains and respective minimum credit thresholds as per IESL requirements.

Methodology

The data for this study was obtained from the civil engineering undergraduate curriculum (four years) documents publicly available from eight (08) main Sri Lankan universities/institutes (i.e., from program handbooks and course curricula available online from university websites). These data were thoroughly reviewed to extract information on credit allocation as per the IESL categorisation mentioned in Figure 1 by considering the nature of each course and its content (wherever the content is available).

A sample of eight (08) similar or higher-ranking international universities/institutes with reputed civil engineering programs were chosen for this comparison. The credit allocation data for the selected international universities/institutes were gathered from publicly available sources (e.g., official websites, academic program documentation, etc.). The information will focus on the same knowledge domains as the Sri Lankan programs, allowing for direct comparisons.

The local universities/institutes considered are designated as LU1, LU2, LU3, LU4, LU5, LU6, LU7, LU8 and the international universities/institutes are designated as IU1, IU2, IU3, IU4, IU5, IU6, IU7, IU8. The credit allocation of the curriculum was taken into consideration for categorisation.

These data were thoroughly reviewed to extract information on credit allocation as per the IESL categorisation mentioned in Figure 1 by considering the nature of each course and its content (wherever the content is available). Then the comparison between each category was done.

Curriculum documents, including course syllabus, and program handbooks obtained from university websites were thoroughly reviewed to extract information on credit allocation under three categories namely: Category A) Mathematics, Basic Science, Computing; Category B) Engineering Science, and Engineering Design; and Category C) Complementary Studies. Category B is further divided to subcategory B1 representing the credit allocation for Engineering Science, and subcategory B2 representing Engineering Designs. Further, Category C is divided into C1 representing the credit allocation for Management and economics... and C2 representing Humanities, Social Sciences, and Arts.

Finally, the results of Sri Lankan universities/institutes were compared with similar data obtained from the selected international universities/ institutes to investigate where the trends of Sri Lankan degree programs differ from those in international degree programs.

Limitations and Threats to Validity

The sources of curricula used in this research were obtained from the information published in the websites of the individual institutes during the period from 2019 -2023. It was observed that that information may not be up-to-date and/or not comply with the latest curriculum in use. Although the categories identified are in accordance with the Washington Accord (and the subsequent local accreditation criteria), the categorisation of courses is particular to this research. It was observed that the contents of courses and curriculum layouts of individual institutes have fulfilled these requirements in overlapping accreditation criteria among and/or within courses.

Wherever the different credit systems were used by international universities/institutes, such were converted into the Sri Lankan credit system (IESL credit system) based on student contact hours.

Results and Discussion

First the credit requirement mentioned in each Sri Lankan and international universities/institutes are analysed with different categories.

Figures 2 and 3 show how the universities/institutes have allocated the credits for each of the three categories and whether they have met the minimum credit thresholds as given in the IESL manual. Accordingly, all Sri Lankan universities/institutes have exceeded the minimum requirement indicated by the IESL accreditation manual. While all universities/institutes have exceeded the minimum credit requirement of Category A by 0-12% and Category C by 0-35%, they have maintained a surplus of 6-29% credits in Category B.

The surplus of credit requirements for Category B (i.e., Engineering Science and Design) indicates the desire to achieve a certain level of standard and quality in their educational offerings. However, the same attention is not given to the other two knowledge areas. Out of the 8 international universities/institutes assessed, seemingly only three fulfill the minimum requirement, while some universities/institutes seem to have paid very little attention to Category C. Moreover, the variation of credit distribution among the categories appears to be high.

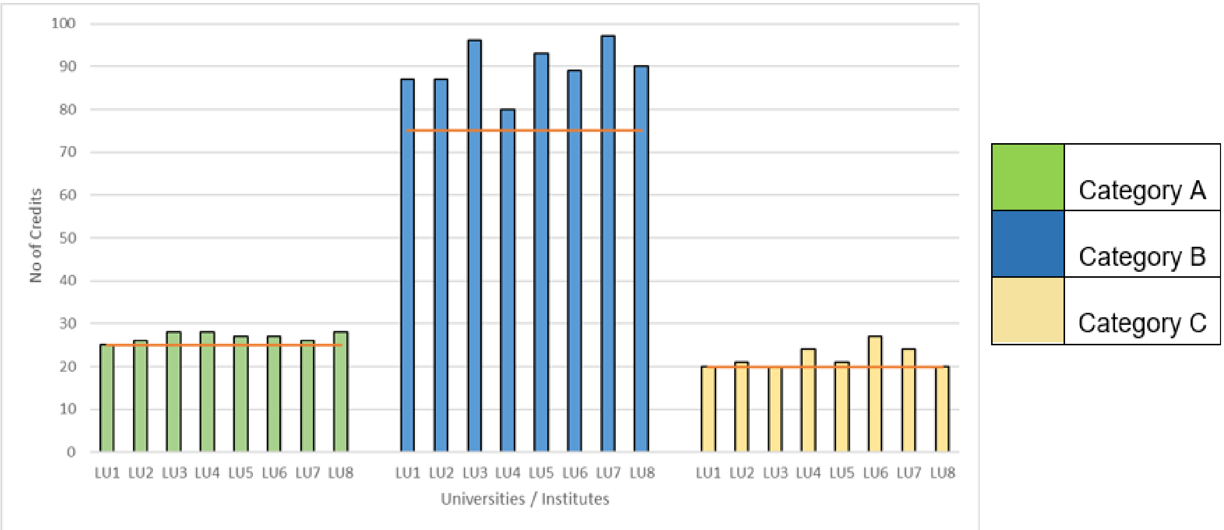

Figure 2: Credit allocation of Sri Lankan Universities/ Institute for Category A, B & C

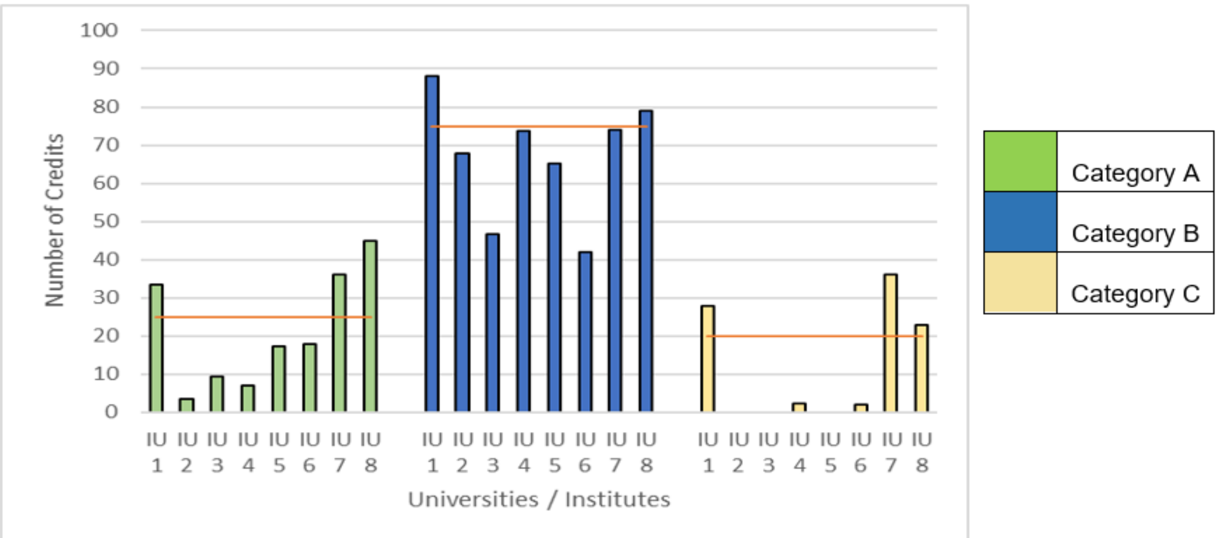

Figure 3: Credit allocation of International Universities/ Institute for Category A, B & C

Figures 4 and 5 show how the universities/institutes have allocated the credits for each of the subcategories and how the IESL-specified minimum thresholds have been satisfied. Similar to previous observations all Sri Lankan universities have exceeded the minimum requirement in each subcategory.

Furthermore, upon conducting an analysis under the specified subcategory, it becomes evident that the criteria under Category B can be met successfully by Category B1. However, it is notable that Category B2 fails to fulfill the requirements. Additionally, when comparing Category C1 with Category C2, it becomes apparent that Category C1 deviates significantly from the minimum requirement in question. This discrepancy suggests that Category C2 performs comparatively better in meeting the specified standards than Category C1 does. Category C1 exhibits a notable deviation from the minimum requirement when compared to Category C2.

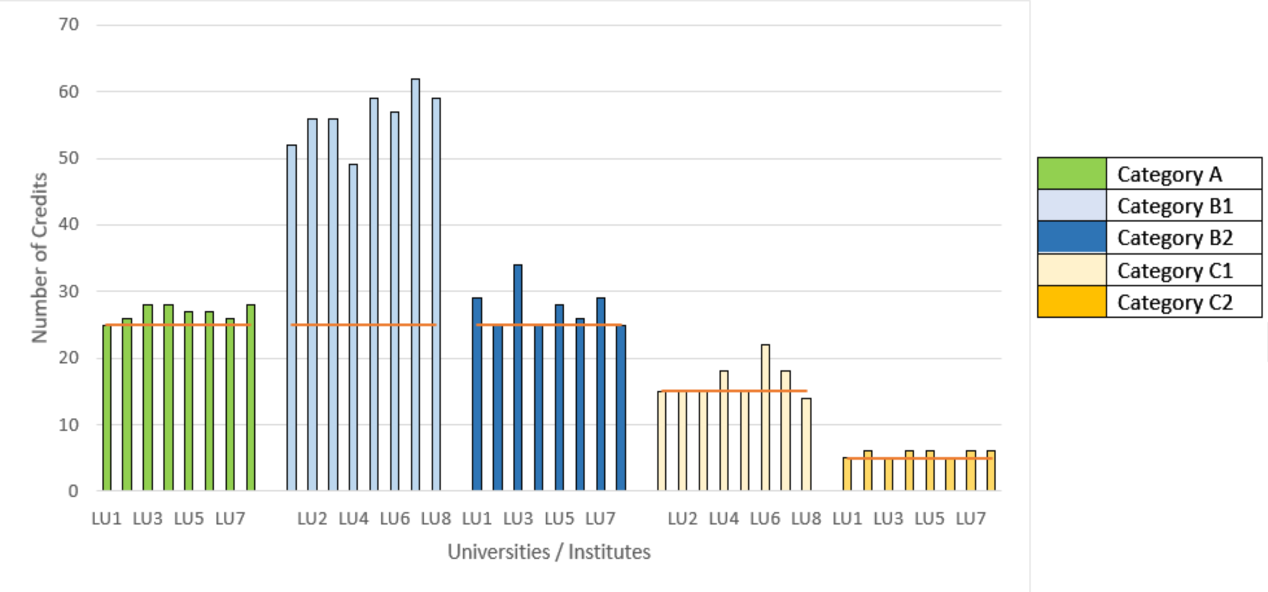

Figure 4: Credit allocation of Sri Lankan Universities/ Institute for Category A, B1, B2, C1 & C2

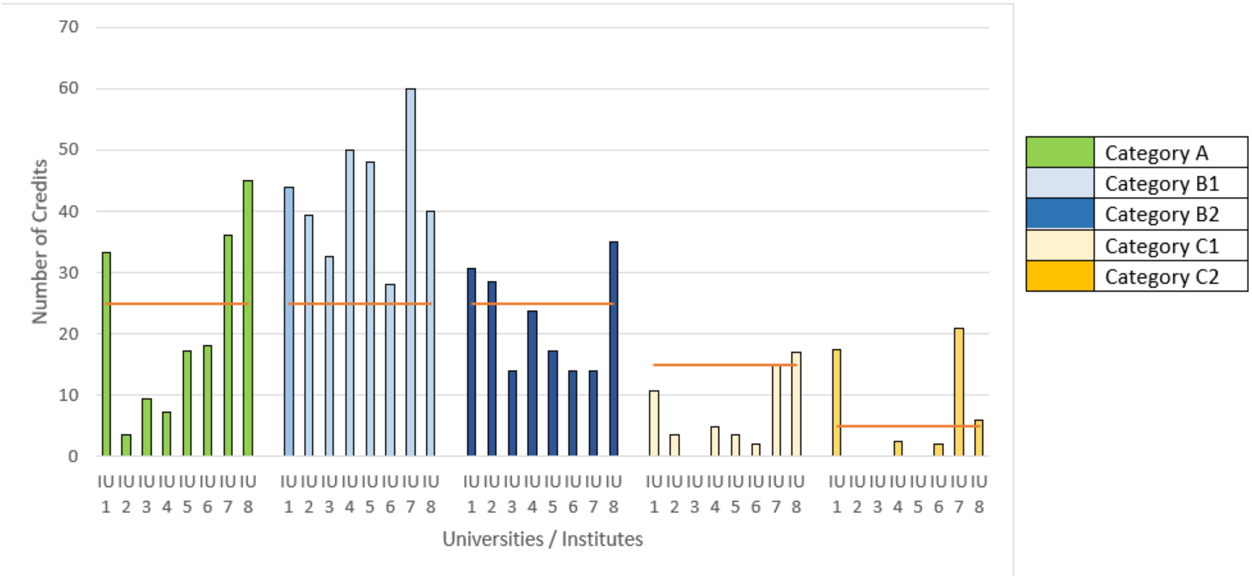

Figure 5: Credit allocation of International Universities/ Institute for Category A, B1, B2, C1 & C2

Conclusion

This research study has provided valuable insights into the knowledge domain credit requirements in civil engineering degree programs within Sri Lankan universities/institutes. The results indicate that all the selected civil engineering degree programs in Sri Lanka meet the minimum required knowledge domains in all Categories. This suggests a standard and quality in the educational offerings of these universities/institutes. We observed that there is a variation in different knowledge domains and each country has its unique curriculum requirements. This finding suggests the need for a more balanced allocation of credits to ensure a comprehensive education that nurtures engineers with diverse skill sets. The study also recommends that further research be conducted to identify the reasons for the variation in credit allocation across different universities.

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