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Yin Sin LIM[1], Bo XIA[2], Martin Skitmore[3], Jason Gray[4], Adrian Bridge[5]

[1]Undergraduate student, School of Civil Engineering and Built Environment, Queensland University of Technology, limyinsin2010@gmail.com

[2]Senior Lecturer, School of Civil Engineering and Built Environment, Queensland University ofTechnology. Email: paul.xia@qut.edu.au.

[3]Prof, School of Civil Engineering and Built Environment, Queensland University ofTechnology. Email rm.skitmore@qut.edu.au.

[4]Lecturer, School of Civil Engineering and Built Environment, Queensland University ofTechnology. Emial:jm.gray@qut.edu.au.

[5]Associate Professor, School of Civil Engineering and Built Environment, Queensland University ofTechnology. Email: a.bridge@qut.edu.au.

ABSTRACT

In response to the call for sustainability education in construction courses, higher education institutions have started to incorporate sustainability components into their construction course to some extent. This research aims to investigate sustainability embedded in construction management (CM) courses using the Queensland University of Technology as a case study. A content analysis of its CM course structure, unit aims, learning objectives and lecture materials is conducted to examine the sustainability elements incorporated into the CM curriculum. The results show the course incorporates sustainability components into the existing course structure mainly through horizontal integration, embedding sustainability into general units rather than an add-on subject. Additionally, the sustainability topics embedded in the course cover a comparatively broad and balanced range of sustainability categories, i.e. background knowledge, policies and regulations, environmental issues, social issues and economic issues as well as technology and innovation, although social sustainability aspects need to be further strengthened. This research addresses the need for urgency in the development of an effective sustainability education framework for construction courses. It is expected that the findings from this study will facilitate the improvement of sustainability education in construction courses generally.

Keywords: Education for sustainability, content analysis, construction management, construction industry, Australia

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Introduction

The world's population is increasing rapidly. To accommodate the growing population, there is huge demand for the construction of buildings and infrastructures. It is estimated that the construction industry contributes 10% of global GDP and creates employment for around 111 million workers worldwide (Economy Watch, 2010). Meanwhile, the construction industry accounts for approximately 60% of raw material extractions (Bribian et al., 2011). It is responsible for approximately 25% of the world's logging activities, 40% of raw materials extractions, 49% of sulphur dioxide emissions, 39% of carbon dioxide emissions, 25% of nitrous oxide emissions and 10% of particulate matter emissions (Ahn et al., 2009). Construction activities create extensive environmental issues such as greenhouse effects, biodiversity destruction, pollution, energy depletion and climate change and generate extensive wastage due to its fragmented project-based management (Bhattacharjee et al., 2012).

Along with its huge impact on the environment, the construction industry can also contribute significantly to the sustainability agenda by means of sustainable construction. Sustainable construction is defined as the efficient use of resources and ecological principles in managing and creating a healthy built environment to improve life quality while minimising environmental effects (Hui, 2002). There are an increasing number of construction firms embracing sustainable construction methodologies in line with a stronger momentum of the sustainability agenda among the stakeholders (Valdes-vasquez et al., 2012).

The most effective way to achieve sustainable construction is to intensify sustainability knowledge and expertise within the industry (Shelbourn et al., 2005). According to the Higher Education Academy (HEA) (2008), the emergence of sustainable construction places

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new demand on sustainability literate construction professionals to meet the new challenge. Nevertheless, the limited sustainability knowledge of the construction workers has become one of the key barriers hindering sustainable construction development (Ahn et al., 2013; Cotgrave & Kokkarinen, 2011; Chong et al., 2009). As a result, construction firms are placing high hopes on higher education to provide sustainability literate construction professionals (Murray & Cotgrave, 2007). Sustainability literate graduates are in increasing demand (Bhattacharjee et al., 2011), with around 65% of U.S. construction firms expecting a certain level of sustainable construction knowledge from graduates (Ahn et al., 2009). Additionally, a number of professional organizations, e.g. American Society of Civil Engineers (ASCE), also recognize the necessity of incorporating sustainability-related knowledge into engineering education to improve the sustainability literacy of future construction professionals (Brown et al. 2015; Weatherton et al. 2015).

Nonetheless, Lozano (2013) affirms that the majority of universities emphasise traditional disciplinary specialisation with little incorporation of sustainability. In response to the call for sustainability education in construction courses, some higher education institutions have started to incorporate sustainability components to some extent. However, studies show that sustainability literacy deficiency among construction students are still prevalent (HEA, 2008; Cotgrave and Kokkarinen, 2011; Iyer-Raniga and Andamon, 2012). This indicates a need for urgency in the development of an effective sustainability education framework for construction courses.

This paper focuses on the analysis of sustainability embeddedness in a construction management course provided by the Queensland University of Technology (QUT). The unit outlines, learning objectives and lecture content of each CM unit are analysed to reveal the

embedded sustainability knowledge. It is expected that the findings from this study will facilitate the improvement of sustainability education in construction courses generally.

Education for sustainability (EfS)

The concept of sustainable development has emerged as the recipe for unsustainable development (Watson, Noyes, & Rodgers, 2013). Many researchers stress that imminent actions are required to change the attitudes of young people towards the environment as they will be the future policymakers and leaders dealing the environmental costs involved (Cotgrave & Kokkarinen, 2010).

Universities are believed to have the greatest influence on sustainability development as they shape the future leaders at the end of their education (Cotgrave & Kokkarinen, 2011). The Stockholm Declaration 1972 is believed to have originated the push for education for sustainable development (EfS) in higher education internationally (Wright, 2004). The urgency for sustainable education was formally increased when the United Nations took the initiative to launch the UN Decade of Education for Sustainable Development (DESD) 2005-2014. These various declarations and treaties urge universities to realise the criticality of embedding sustainability into their curricula. They not only emphasise the need to impart sustainability knowledge but also promote skills and ability development so that future workforces are trained and prepared to manage sustainability reforms within an organisation, industry, society or country (Tilbury, 2004).

However, approaches for effective and meaningful EfS delivery remain a challenge for the institutions involved (Lozano et al., 2010). Most universities are still adopting conventional "Newtonian and Cartesian mental models", restraining the thorough diffusion of EfS (Lozano,

Lukman, Lozano, Huisingh, and Lambrechts, 2013). Even though some universities do show their commitment to EfS, very few, if any, manage to bring about a positive and lasting implementation (Holdsworth, 2010).

Furthermore, many studies state that most of the EfS modules over-emphasise the environmental issues, neglecting social and economic aspects (Kagawa, 2007, p.320; Murray & Cotgrave, 2007; Pappas, 2012). Pappas (2012) claims that environmental sustainability can no longer solve the complexities of the world issues involved. The social and economic contexts should also be emphasised by connecting theoretical education with real world sustainability problems so that practical solutions can be devised (Brundiers & Wiek, 2010). This can instil a greater sustainability appreciation and accountability among future professionals.

Development of EfS in Australia

According to Chambers (2011), the EfS in Australia has grown out of environmental education. For EfS at a higher education level, the Australian Research Institute in Education for Sustainability (ARIES) was established at Macquarie University in August 2004 to research, identify and inform higher education institutions on the national action plan for EfS (Tilbury, 2004). In addition, a vision was introduced by the Australian Vice Chancellors' Committee in 2006 (Chambers, 2011) of making universities the main medium for sustainability advancement through research and building capacity by 2020. At the same time, the Australasian Campuses Towards Sustainability Inc (ACTs) was established in 2006 to promote and support changes in sustainability curricula and research in universities across Australasia. There are 51 universities, TAFEs and polytechnics across Australia and New

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Zealand participating in their 2013 membership program to advocate EfS in the Asia Pacific region (ACTS, 2013). Notwithstanding the number of universities that join the ACTS program, ACTS reveals that it is hard to obtain full commitment from its members. Although resisted by the academic community, engaging curriculum renewal activities with greening campus initiatives is believed to be a synergistic way of promoting effective EfS (Desha & Hargroves, 2011).

Sustainability education in construction programs

Construction professionals can only make informed, safe decisions through education and an in-depth understanding of the concepts involved (Kevern, 2011). Realising the importance of the EfS in the construction industry, construction education plays a vital role in adapting sustainability into educational goals to cultivate competent students that fit the industry's needs. Sustainability learning should become an integral part of the curriculum of construction courses. Thus, higher education for sustainable construction should not only provide high level of qualification that leads to proactive actions, but also promotes self-motivation and identification among future professionals in order to generate positive sustainable development outcomes within the construction industry (Hartenburger, Lorenzo, & Lutzkendorf, 2013). Hayles and Holdsworth (2008) assert that sustainability needs to be embedded across the board so that students can realise the importance of sustainability as the key direction for the future building and construction industry.

Ekundayo et al. (2011) found that construction professionals need to have six main types of sustainability-related knowledge in order to deliver the sustainability agenda. These are background knowledge, policies and regulations, environmental issues, social issues, economic issues as well as the technology and innovation. In addition to cost, quality and

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time issues, construction students need to see their future professional role as one of informing clients on sustainable construction (Cotgrave and Kokkarinen, 2011). With their professional sustainability knowledge, they need to be able to suggest sustainability strategies for organisation reform

In Australia, researchers have developed case studies in several universities to investigate EfS for construction programs. For instance, Hayles et al. (2006) investigate the curriculum changes for sustainability in the RMIT construction program that expose their undergraduate students to housing sustainability and affordability. In Queensland, Griffith University has advanced sustainability commitment in its courses since its establishment forty years ago (Griffith University, 2012). The construction course in Griffith University is within the environment, planning and architecture faculty to specifically embody sustainability principles. The Mirvac School of Sustainable Development at Bond University set a good example of how green education buildings can not only contribute to minimising environmental impact but also become a source of inspiration in curriculum development (Tilbury 2011). Nonetheless, a study at RMIT shows that while students may consider sustainability as an important consideration for the future, they do not really understand the tools currently available to assist their sustainability goals (Iyer-Raniga et al. 2010)

Hayles and Holdsworth (2008) suggest that sustainability integration into existing curricula should be the ultimate outcome. A stand-alone sustainability module should serves as a starting point for further integration into existing modules. However, sustainability integration into existing curricula is hard to be identified and assessed as different institutions develop their own sustainability modules according to their organisational structure and culture. There is no consensus among universities and teaching teams on the content and

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delivery approaches to sustainability education in construction curricula (Bhattacharjee et al., 2011; Coral 2009; Wang 2009).

Research Methodology

Sustainability education is considerably new and its embeddedness varies between institutions. This research used an exploratory case study as the sustainability components embedded in CM courses have not yet been clearly defined (Mills, 2010). The exploratory case study aims to gain insights into sustainability embedding in the CM course of the Queensland University of Technology (QUT). The CM course at QUT is "considered one of the best in Australia and is highly ranked internationally" (Hotcourses 2015). Furthermore, QUT commits actively to the sustainability agenda through teaching, research, buildings, planning and behaviour.

The exploratory case study investigates phenomena that lacks detailed preliminary research and helps to provide a comprehensive evaluation and appropriate recommendations on the specific situation involved (Streb 2010). It does not provide grounds for the generalisation of effective sustainability education to other institutions due to the incongruent education delivery between different institutions. It does, however, serves as a useful tool for investigating the sustainability embeddedness in various educational institutions.

Content analysis is used to identify the sustainability embeddedness in the core units of the CM course. Content analysis helps to narrow down a large amount data into fewer selected categories (Bhattacharjee et al., 2012). The course structure, unit aims, learning objectives and lecture materials were collected and analysed. As QUT is currently operating a new course structure starting from 2014, this research examines the existing CM course

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commencing in 2006. To develop the new course structure, a strategic curriculum review of the existing CM course based upon consideration of internal and external factors including the QUT strategic development plan, changes to the regulatory environment in Higher education in Australia, including the strengthened Australian Qualifications Framework (AQF), the emergence of the Tertiary Education Quality and Standards Agency (TEQSA), international trends and employment industry and community needs, both now and into the future, was conducted. The recommendations arising from the review were designed to articulate broad principles and specific actions intended to position the new course to meet its curricular challenges and forge sustainable practices over the next decade or more. In the new CM course, sustainability continues to be one important aspect of the course redesign incorporating sustainable knowledge and practice within the various course unit structures. Therefore, the content analysis of the sustainability embedment in the existing CM course will provide useful recommendations for the new course design.

After the content analysis, a questionnaire survey was conducted with senior undergraduate CM students to evaluate the effectiveness and usefulness of the sustainability embedment in the CM course. A questionnaire was sent to approximately 200 Year 3 and Year 4 CM students and 51 were returned completed, representing a response rate of 26%.

Results and analysis

QUT CM course

CM plays a dominant role in administering and coordinating various construction projects ranging from residential to commercial, retail, infrastructure as well as civil works. The QUT CM course aims to equip students with building construction techniques that develops

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progressively from elementary knowledge through to complex and in-depth CM knowledge. The course is concerned with the management of the whole construction process with a detailed understanding from conception to planning, construction, commissioning and maintenance.

The course consists of 4-year academic study that is designed to develop a foundational knowledge of construction. There are 28 core units for the CM major, which comprise 8 core urban development units, 16 core CM discipline units and 4 complementary CM units. CM students are required to take a second major or optional minor for the full completion of the course. The second major and minor options are designed to provide diverse professional skills and knowledge beyond the CM field as well as non-discipline skills. The QUT CM course is accredited by the Australian Institute of Building (AIB).

The QUT CM course provides students with the skills of resource management, measurement and estimating, site management, scheduling and programming as well as technical communication. The course educates students to acquire comprehensive technological knowledge, management and communication skills to handle a project by meeting cost, time, quality, safety and environment objectives. Graduates are expected to be able to perform construction supervision, subcontractor resource management, estimating and construction planning in accordance with the standards, regulations and contract documents.

Findings of the content analysis

Analysis of the CM course structure reveals that only one unit (UDB100 Urban Development and Sustainability) is introduced as an add-on subject. The remainder of the units adopt horizontal integration for sustainability embedment. Horizontal integration is an approach of incorporating selected sustainability concepts into the units of a course (Watson, et al., 2013).

This shows that QUT mainly integrates sustainability into its general units rather than an add-on subject. Ceulemans & Prins (2010) also believe that horizontal integration can helps students to appreciate and apply the sustainability knowledge into technical content in a more systemic way.

Vertical integration is also adopted by the QUT CM course. Vertical integration involves the addition of new sustainability courses into the existing course as an isolation option (Watson, et al., 2013, p. 236). QUT offers a sustainability minor that forms part of the vertical integration. This was designed for those who wish to explore sustainability topics in depth. However, the sustainability minor option was discontinued from December 2012, to be replaced by horizontal integration.

After examination of the overall CM course structure, the research focused on the analysis of the CM core units. The unit outlines of each core unit were first investigated. These consist of rationale, aim, learning outcomes, content, teaching and learning approaches, assessment, academic integrity, resource materials and risk assessment statement. In the unit outline analysis, the unit aims and learning outcomes were analysed as they establish the purpose and expectations of a unit. The analysis indicates that 2 out of 28 (7%) core CM units include sustainability in their unit aims. On the other hand, 6 out of 28 (21%) core units incorporate sustainability as part of their learning outcomes. Table 1 shows the unit aims and learning outcomes of the units that contain sustainability related aims or learning outcomes.

Please insert Table <1> here

From the analysis of unit outlines, it was found that sustainability is normally included as part of the unit aims and learning outcomes. In the unit aims, sustainability knowledge is provided

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to the students at the introductory level. For the learning outcomes, students are expected to be able to identify, analyse, discuss, apply and think critically on the incorporated sustainability topics after completing the units.

After the unit outline analysis, the weekly lecture materials of all the CM core units were further examined for their sustainability embeddedness within the CM course. It was found that in addition to the above-mentioned 6 units, 4 units also cover sustainability topics in their lecture content although their unit outlines do not include sustainability related aims or learning outcomes. The analysis of sustainability topics covered in the weekly lecture materials helps to reveal their sustainability embeddedness more holistically. This shows that a total of 10 out of 28 (35.7%) core units cover sustainability knowledge in their lecture content.

In the CM course, 50% of the Year 1 units cover sustainability topics; 29% of the Year 2 and Year 4 units contain sustainability components respectively and 33% of the Year 3 units contain sustainability embedment. The distribution of sustainability related units in the CM course is shown in Figure 1.

Please insert Fig <1> here

40% of the 10 sustainability related units are taught in year 1, which are mainly related to introductory and background knowledge of sustainability. More in-depth and specialised sustainability knowledge are introduced progressively from Year 2 onwards.

As shown in Table 2, a total of 25 sustainability topics are delivered in these 10 units. These topics cover a wide spectrum of sustainability areas, ranging from generic climate change and environment protection to specific sustainable energy technologies and innovations.

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Following Ekundayo et al.'s (2011) six main categories of sustainability-related knowledge areas for the sustainability agenda delivery, these 25 topics can thus be grouped into background knowledge, policies and regulations, environmental issues, social issues, economic issues as well as the technology and innovation (see Table 2).

Please insert Table <2> here

Table 2 indicates the environmental category to be the most extensively covered area. There are 5 units covering 9 environmental topics. Furthermore, the policies and regulations topics place more emphasis on environmental legislation than social and economic issues. This corresponds with the findings of many previous studies in that much emphasis of the EfS is placed on the environmental sustainability development.

Apart from environmental sustainability, the QUT CM course also covers other sustainability categories quite extensively, including sustainability policies and regulations, sustainable technology and innovation, as well as economical sustainability. Figure 2 shows the unit distribution between different sustainability categories. Both environmental and regulation related sustainability topics are covered in five units, followed by economic sustainability and technology and innovation in four units each. Social sustainability is the least covered, with two units incorporating social sustainability topics into the lecture materials. Based on the number of topics and units for each sustainability category, it can be concluded that the CM course provides a comparatively balanced structure of sustainability knowledge although the social aspect is in need of being strengthened.

Please insert Fig <2> here

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Findings of questionnaire survey - student assessment results

Table 3 shows the profiles of the respondents. The target respondents are year 3 and year 4 CM students as they have already been exposed to most of sustainability related units. As shown in Table 3, the majority of the respondents are male students and study in full-time mode, which are quite representative of the whole CM student population at QUT. The majority of students (67%) also have working experience in the industry, which is not surprising as the CM course at QUT is very popular among construction professionals.

Please insert Table <3> here

The students were required to assess the effectiveness and comprehensiveness of sustainability embedment in the CM course and evaluate the usefulness of such embedment for their future career development based on a 5-point Likert rating scale from 1(least significant level) to 5 (most significant level).

Please insert Table <4> here

As shown in Table 4, the students show high level of interest (3.67/5) in sustainability knowledge and recognize its importance for construction professionals (3.81/5) - underlining the importance and necessity of embedding sustainability knowledge in the CM course.

For the comprehensiveness of the embedment, students perceive that sustainability knowledge has been reasonably welly embedded (3.25/5), with year 3 students rating it higher (3.46/5) than year 4 students (3.04/5), probably due to the continuous improvement of

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sustainability knowledge delivery and the increased awareness of sustainability development on the course. For the usefulness of sustainability embedment, students also believe that topics embedded into the CM course increase their sustainable construction knowledge reasonably well (3.29/5) and reasonably useful for their future career development (3.47/5).

Finally, the questionnaire survey also revealed that almost two thirds of the students prefer the incorporation of sustainability topics into weekly lectures where applicable, instead of the weekly delivery of individual sustainability topics – indicating that linking sustainability knowledge to existing construction theoretical knowledge is a more popular and therefore effective way of learning in this context.

Discussion

The background knowledge and concepts appear to give students an understanding of the broad picture of sustainability. Thus all the topics covered in this category are lectured on an introductory level and embedded in year 1 units. These aim to improve the general sustainability literacy of CM students, which enables them to understand issues relating to sustainability and make choices conducive to sustainable development.

As mentioned in the literature review, construction activities contribute to relatively extreme environmental deterioration. It is therefore understandable that education institutions mainly focus on the environmental aspects for their CM courses. The environmental topics covered in the QUT CM course can be divided into general and construction related environmental topics. The general environmental issues cover pollution, road transport emissions, greenhouse gases, resource depletion, ecological footprint, ecosystem quality, flora and fauna and renewable energy. On the other hand, sustainable-construction-related topics include

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environmental evaluation of construction materials, green building rating systems and environmental assessment. For the environmental evaluation of various construction materials, knowledge of their availability, environmental impact, embodied energy efficiency product lifespan, reusability as well as recyclability are introduced to help students in understanding the contribution of various materials to sustainability development.

Although environmental aspects should be the main issues to be addressed within the construction industry worldwide, Pappas (2012) claims that environmental sustainability can no longer solve the complexity of world issues. Murray and Cotgrave (2007) also focus on the significance of social-economic aspects in the global context, while overlooking the gross national product (GNP) generated for each country. Therefore, more holistic sustainability coverage should be developed by incorporating more economic, social and other related topics into course modules. QUT realises the significance of the sustainability knowledge in other aspects and includes them in its curricula to better prepare students for the successful delivery of sustainable construction projects. The economic, technology and innovation, regulation and policies and social aspects appear to be adequately covered in the sustainability units.

For economic sustainability, life cycle costs are the most highly emphasised. Life cycle costs involve the costs of a building from its cradle to grave, which promotes long-term cost savings rather than the conventional short-term capital cost savings. This concept is highlighted, as costs are the main concern for most of developers and other owners in the real world. Natural capitalism has also been discussed. It is a new business model that advocates four interlinking principles, where business interests should consider the environment interests while satisfying the consumers' need and profit (Hawken et al. 1999). This whole-system-thinking-approach is briefed with examples in the lecture to inspire students for

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innovative solutions towards a sustainable built environment. The embedded knowledge of technology and innovation in sustainable construction comprises sustainable building practices, sustainable building materials, sustainable transport, sustainable energy technology and energy efficient buildings, which form the fundamental part of sustainable construction. Sustainable building practices focus on long-term affordability, quality, an efficient community, environment and economic development.

The various governing approaches (e.g. Acts, environmental legislations and sustainable building law) are also widely covered, so that the future professionals are aware of and able to apply the legislation related to sustainable development. Social sustainability topics include the population problem and sustainable living. The ever-increasing population problem is highlighted in multiple units as an issue to be dealt with when the earth resources are scarce. Sustainable living - comprising housing design, energy consumption, food, transportation, water and waste management - is integrated too. Nonetheless, other social sustainability topics such as community involvement, human rights and corporate social responsibility are lacking. Considering that the new course is replacing the existing CM course of this research, further study is required to examine whether the lack of social sustainability embedment, compared with environmental and economic ones, is remedied in the new course structure.

For the delivery of sustainability topics, the traditional lecturing method is the main approach adopted in the current CM course. However, as Hayles and Holdsworth (2008) point out, traditional lecturing method is an inefficient means of helping the students recognise the real issues. Therefore, more hands-on approaches, such as study tours, seminars and site visits can be organised to challenge the way of thinking and deepen understanding of the complexity of sustainability. Additionally, practical examples and real world projects that involve

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sustainable development can be used to improve the delivery of sustainable construction education. Moreover, related assessments need to be used more often to increase students' awareness of sustainability knowledge requirements.

Conclusions

The rationale for embedding sustainability in construction degree programmes emanates mainly from the growing impetus to improve the environmental performance of the construction industry. Furthermore, research from Australia and elsewhere records the increasing perception of the industry of the higher education sector as the major provider of sustainability-focused construction education. From the content analysis of QUT CM course, it can be concluded that the course incorporates a reasonable amount of sustainability components into the existing course structure through horizontal integration, which helps students to better relate sustainability with other construction knowledge. Additionally, with the exception of social sustainability, the sustainability topics embedded in the CM course appear to cover a comparatively broad and balanced structure of sustainability categories. The assessment of students' perceptions of sustainability embedment also shows that this not only increases their sustainability knowledge but also helps in their future professional career.

A curriculum emphasizing sustainability knowledge will provide students, universities and community partners with multiple opportunities to engage in meaningful and relevant exchanges. To further improve the sustainability education in CM curricula, it is of great significance to understand the industrial requirements for sustainability knowledge, as there are no standards or guidelines to determine the sustainability topics that should be covered. Furthermore, given the importance of professional development, it is critical for universities to train and provide an interactive platform for the academic staff to have more

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comprehensive sustainability knowledge. Additionally, as the students prefer the incorporation of sustainability topics into weekly lectures instead of the separate delivery of individual sustainability topics, the way in which sustainability is incorporated into traditional construction knowledge should be taken into careful consideration in the development of future sustainability education frameworks.

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Figure Captions:

Figure 1: Sustainability units delivered in the various years of study

Figure 2: Unit distribution in sustainability categories

Course\Units	Year	Aims related to sustainability	Learning outcomes relating to sustainability
UDB100 Urban Development and Sustainability	Year 1	This unit aims to develop your professional skills, knowledge and capabilities at an introductory level within the context of environmental sustainability.	• Demonstrate critical thinking and reflection in reference to sustainability and the implications of the concept for society and your profession • Explain how ethics, values and a person's sense of social responsibility shape the processes they use and the products they create
UDB101 Stewardship of Land	Year 1	The aim of this unit is to introduce you to the fundamental concepts associated with land and land use with respect to the ecological, legal, social, political and cultural influences and consequences.	• Distinguish the various legal, environmental, geophysical, cultural, ethical and political influences related to land use and development.
UDB104 Urban Development Economics	Year 1	Nil	• Identify, analyse and understand the relevance of price theory, location theory, land use economics and environmental economics in determining urban and regional development
UDB214 Professional Studies 2	Year 2	Nil	• Apply the principles of sustainable design and decision making in all stages of a project.
UDB314 Statutory Construction Law	Year 3	Nil	• Identify the increasing social responsibility elements of building construction that are now being regulated (as opposed to minimum safety standards), accessibility and sustainability, etc.
UDB316 Cost Planning and Control	Year 4	Nil	• 1. Compare the relative importance of sketch design in terms of capital cost and building design in terms of life cycle costs and building maintenance generally, as well as the relative importance of building elements in relation to capital versus life cycle costs

Table 1: Units that contain sustainability related aims or learning objective in unit outline

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Table 2: Topics covered in the sustainability units by category

Category	Topics	Units
Background knowledge and concept	Overview of sustainable urban development	UDB100
	Climate change	UDB104, UDB111
Policies and regulations	Environment Protection and Biodiversity Conservation Act	UDB101
	Environment legislation	UDB104, UDB214, UDB302
	Sustainable building law	UDB314
Environmental	Environmental issues	UDB104
	Materials environmental evaluation	UDB111
	Ecological footprint	UDB100
	Ecosystem quality	UDB104
	Flora and fauna (Priority species)	UDB214
	Renewable and non-renewable energy	UDB100
	Greenhouse gas reduction	UDB215
	Green building rating system	UDB100
	Environmental assessment (sustainability issues)	UDB214
Social	Population problem	UDB100, UDB111
	Sustainable living	UDB100
Economic	Life cycle cost	UDB100, UDB215, UDB316
	Natural capitalism	UDB100
	Value management	UDB316
	Economic solution to address environmental issue	UDB104
Technology and innovation	Sustainable energy technology (Photovoltaic, wind turbine, energy supply reduction)	UDB100, UDB 215
	Sustainable building practice	UDB100
	Sustainable building materials	UDB100, UDB111
	Sustainable transport	UDB100
	Energy efficient building	UDB310

Table 3 Profile of respondents

Profile	**Categories**	**Frequency**
Gender	Male	80%
	Female	20%
Study year	Year 3	51%
	Year 4	49%
Study mode	Part time	8%
	Full time	92%
Working experience	No	33%
	Yes	67%

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Table 4 Students perception of sustainability embedment in the CM course

Perception of sustainability embedment in CM course	**Mean**	**Std. dev.**
1. Overall interest towards sustainability knowledge	3.67	0.74
2.Importance to sustainability knowledge for construction professionals	3.81	0.90
3.Comprehensiveness of sustainability incorporation into the course	3.25	0.80
4.Use of sustainability embedment to improve sustainability knowledge	3.29	0.70
5.Use of sustainability embedment to help their future career	3.47	0.83

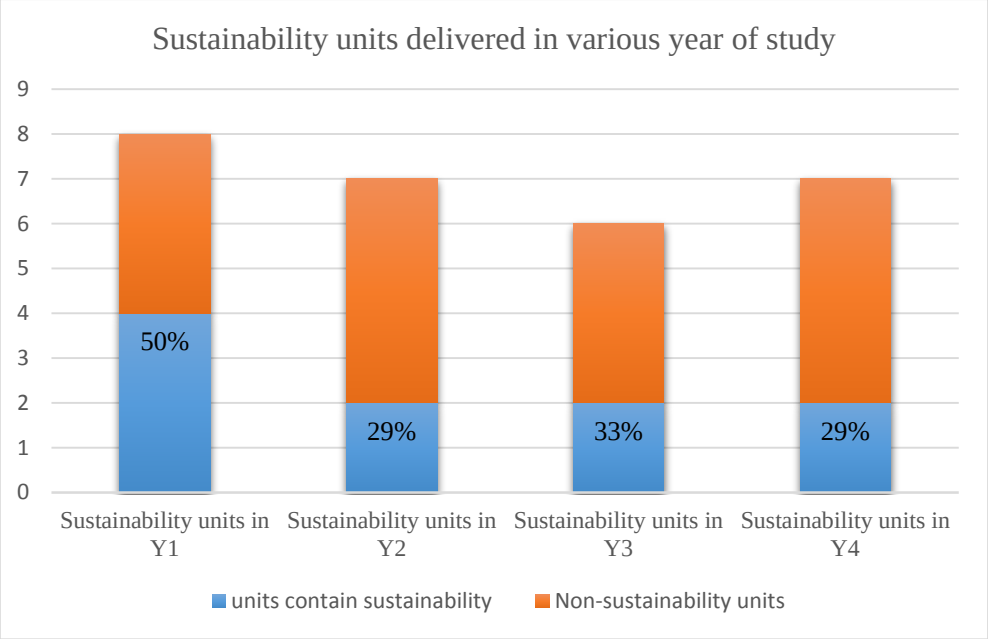

Figure 1: Sustainability units delivered in the various years of study

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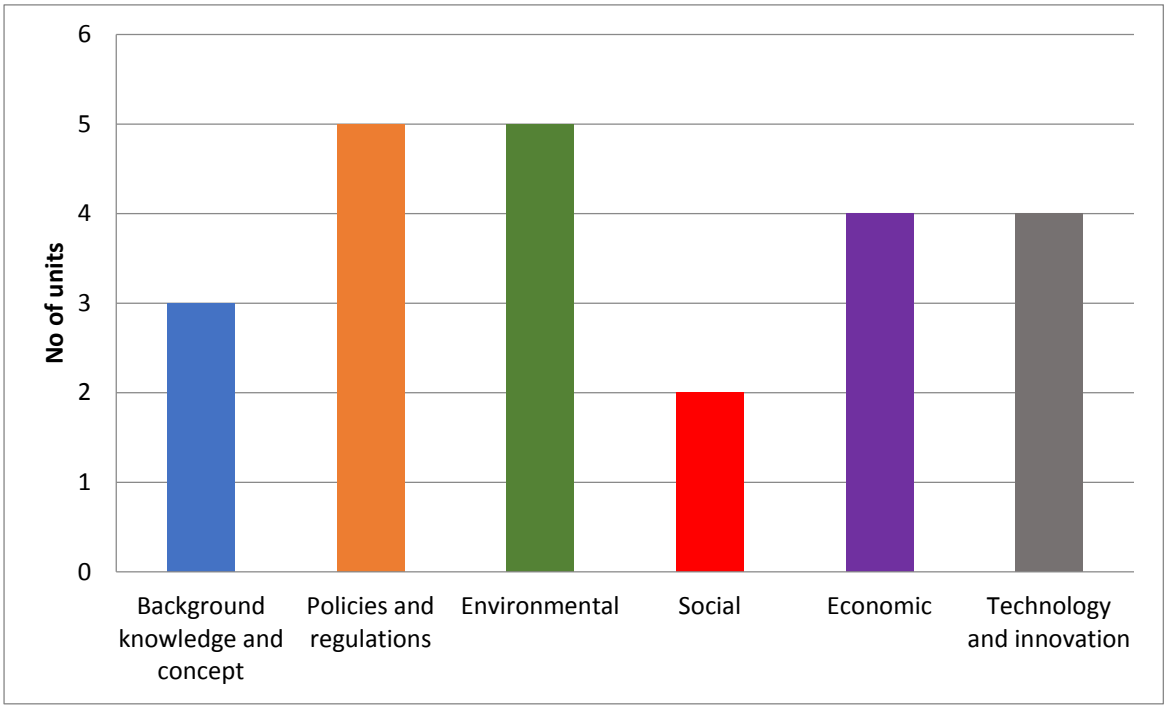

Figure 2: Unit distribution in sustainability categories

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