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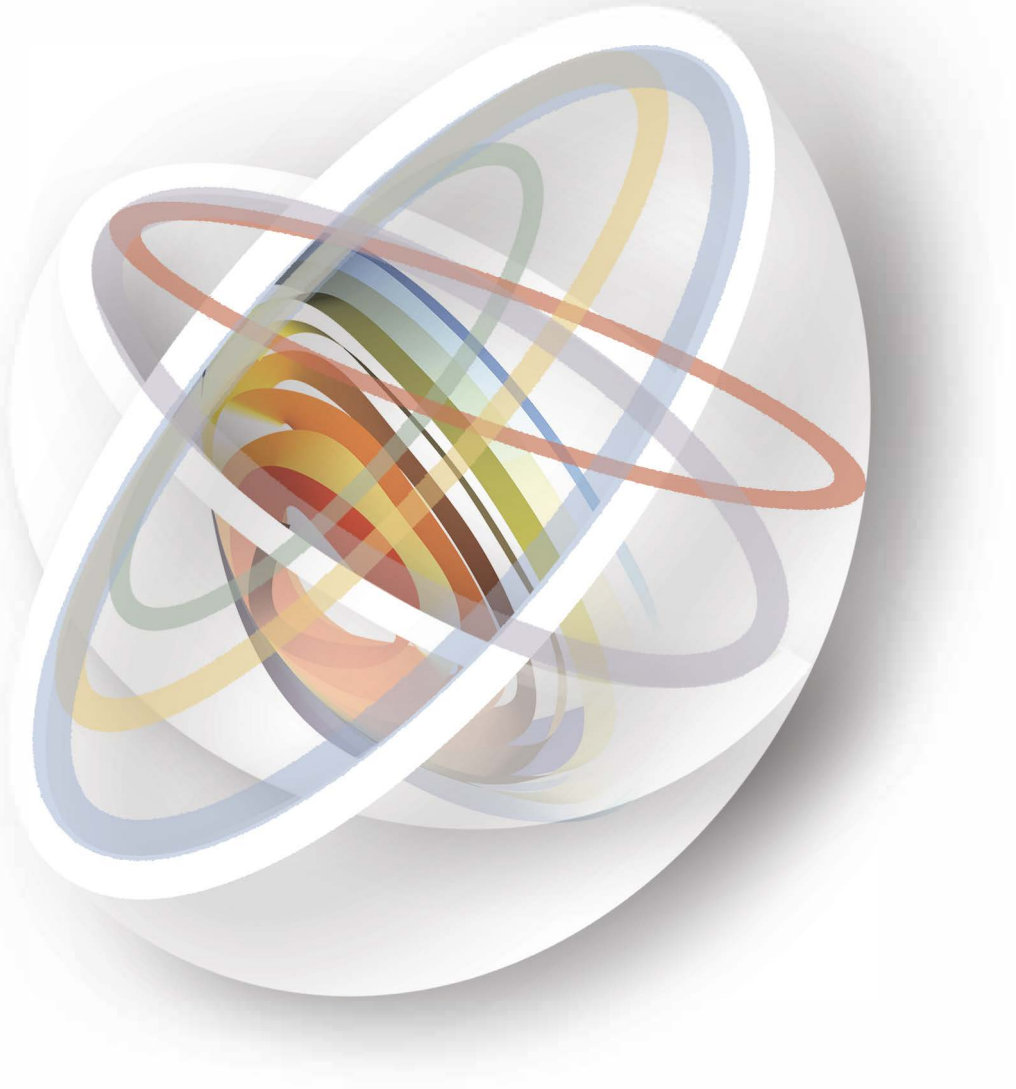
International Conference for

# Sustainable Design of the Built Environment SDBE 2018

*Proceedings*



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SDBE Sustainable Development of the Built Environment | UEL University of East London | Ain Shams University | University of Strathclyde Glasgow

## Foreword

The International Conference for Sustainable Design of the Built Environment SDBE 2018 forms one of the key deliverables of the British Council Newton Institutional Links Fund project: Building Capacity for Sustainable Development of the Built Environment (BC-SDBE) launched in April 2016. The aim of the BC-SDBE institutional link project is to bridge the gap between the rapidly developing advancements in research and training in sustainable development of the built environment globally, and the demanding professional development required in the construction labour market. The main objective of BC-SDBE project is to build capacity in education, research, innovation, and exploitation of state-of-the art sustainable development strategies to help promote and sustain socio-economic growth in Egypt.

Following the great success of SDBE 2017 conference where 112 papers were published in the proceedings, SDBE 2018 conference offers yet, another unique opportunity for academics, researchers, architects, urban designers, engineers, and professionals to meet and share the latest knowledge, research and innovations on low carbon building design, building performance, simulation tools and energy efficient building-related technologies. The conference theme is 'Research in Practice' where the focus is on showcasing sustainable design, building energy performance, sustainable planning of neighbourhoods and cities, emphasising a balanced approach to environmental, socio-economic and technical aspects of sustainability in practice based on research.

The book of abstracts includes all 110 accepted papers under 12 themes clustered into 6 thematic groupings. The full conference proceedings are available to download at http://newton-sdbe.uk/conferences/sdbe-2018/

On behalf of the SDBE 2018 Organising Committee, I hope the research papers hereby presented help stimulate further ideas for research in the near future.

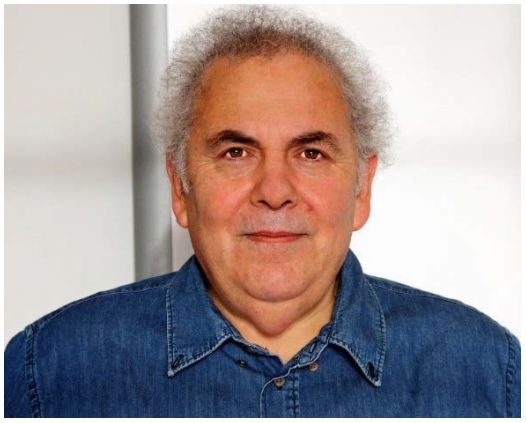
Yours sincerely,

Heba Elsharkawy

BC-SDBE Principal Investigator

## Keynote Speakers

### Philip Jones, Professor, Welsh School of Architecture, Cardiff University



Phil Jones is Professor of Architectural Science at the Welsh School of Architecture, Cardiff University, where he currently co-directs the University's Energy Systems Research Institute. His research area is in low energy, low carbon, and sustainable design in the built environment. He currently directs the Low Carbon Built Environment Project, including ten demonstrations of energy positive buildings and low carbon retrofits. He chairs the Welsh Government's Building Regulation Advisory Committee. He chairs the Board of Directors of Warm Wales, a community interest company which helps to mitigate fuel poverty in Wales. He has chaired two European COST Action networks, *Low Carbon Urban Built Environments* (2005-2009), and *Smart Energy Regions* (2012-2016). He is *Master Academic Adviser* on Tianjin University's Low Carbon Buildings '111' project (2014-2018). From 2015 to 2017 he was Distinguished Visiting Research Professor at University of Hong Kong and continues to collaborate with their Sustainable High-Density Cities Laboratory.

### Ashraf Salama, Professor, Head of Department of Architecture, University of Strathclyde

Ashraf M. Salama is Chair in Architecture and Head of the Department of Architecture at the University of Strathclyde Glasgow, UK. He has led three schools of architecture over the past 25 years in Egypt, Qatar, and the United Kingdom. He is a licensed architect in Egypt and was the Director of Research and Consulting at Adams Group Architects, Charlotte, North Carolina. Prof. Salama is the Chief Editor of ArchNet-IJAR, collaborating editor of Open House International, and editorial board member for numerous international journals. He also serves on the scientific and review boards of several international organizations in North America, Europe, and South East Asia. Professor Salama is the recipient of the 2017 UIA Jean Tschumi Prize for Excellence in the Architectural Education and Criticism. Professor Salama has published 9 books and over 170 articles and book chapters. His research interests and involve theories and methodologies of design studio teaching in architecture and urbanism; learning environments and workplaces; users-centred assessment of designed environments; adaptive urbanism and the spatial practice of migrant communities; liveability and diversity in rapidly growing contexts. He established and is currently leading the efforts CRAUCGS-Cluster for Research on Architecture and Urbanism of Cities in the Global South.

## Patrik Schumacher, Director, Zaha Hadid Architects

**Patrik Schumacher** is principal of Zaha Hadid Architects and is leading the firm since Zaha Hadid's passing in March 2016. He joined Zaha Hadid in 1988 and was seminal in developing Zaha Hadid Architects to become a 400 strong global architecture and design brand. He has been a partner since 2003 and a co-author on all projects. In 2010 Patrik Schumacher won the Royal Institute of British Architects' Stirling Prize for excellence in architecture together with Zaha Hadid, for MAXXI, the National Italian Museum for Art and Architecture of the 21st century in Rome. He is an academician of the Berlin Academy of Arts. In 1996 he founded the Design Research Laboratory at the Architectural Association in London where he continues to teach. Patrik Schumacher is lecturing worldwide and is currently a guest professor at Harvard's GSD. Over the last 20 years he has contributed over 100 articles to architectural journals and anthologies. In 2008 he coined the phrase Parametricism and has since published a series of manifestos promoting Parametricism as the new epochal style for the 21st century. In 2010/2012 he published his two-volume theoretical opus magnum "The Autopoiesis of Architecture". Patrik Schumacher is widely recognized as one of the most prominent thought leaders within the fields of architecture, urbanism and design.

## Sean Smith, Professor, Director of the Institute for Sustainable Construction, Edinburgh Napier University

Sean leads the Institute for Sustainable Construction, the CIAT Centre of Excellence in Architectural Technology and is Professor of Construction Innovation at Edinburgh Napier University. He has been an invited guest scientist in government construction research institutes in Canada, Italy and Germany. In 2009 and 2015 his research teams were awarded the Queen's Anniversary Prize for the positive impact of their work for industry, environment and society for the 'development of Robust Details' and 'Timber engineering and sustainable construction'. Over 1 million new homes across the UK have used his technical designs. He has supported over 80 low carbon innovative construction products to market, co-inventor of 17 patented products and led the formation of the Construction Scotland Innovation Centre. He currently chairs the Scottish Government working group for new housing construction skills.

Mina Hasman, Associate Director – Skidmore Owings & Merrill LLP (SOM)

Mina Hasman leads Skidmore Owings and Merrill's sustainability and wellness operations and long-term vision, for the London office. She challenges existing best-practices by developing new systematic and design-based approaches applied and tested in complex, international projects.
Mina embraces multi-disciplinary research and collaboration with others to deliver sustainable design solutions that yield long-term environmental, societal and cost benefits.

*Mark Jenkinson,* Head of AMO Cities & City Director London
Siemens Global Center of Competence Cities, Sustainability and Cities.


Based out of Siemens' Global Centre of Competence for Cities at one of the world's most sustainable buildings, the Crystal in the east of London, Mark oversees Siemens' account management approach to cities world-wide.
In March 2013, Mark also took on the role of City Director for London – a key focus of the role is to support London's sustainable development through the provision of smart, efficient technological solutions and services for building, energy and transport infrastructure.
Mark joined Siemens in 1993 and since then has taken on a variety of roles and responsibilities across Siemens in a wide range of industries and markets in the UK, across mainland Europe, the Middle East and Asia.
Mark has participates in a number of committees including the Royal Docks Advisory Board and sits on UEL Industry Advisory Board for Civil Engineering.

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# Developing a framework for embedding Education for Sustainability (EfS) within the built environment sector in Egypt

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**Abstract:** Education for Sustainability (EfS) is a growing movement that seeks to prepare researchers, educators and practitioners for a career that embraces sustainable values and principles. Historically, this approach has been integrated to varying degrees across the globe, with developed countries typically applying this approach more widely than developing countries. Building Capacity for Sustainable Development of the Built Environment (BC-SDBE) project, has been set up to improve EfS within the Architecture and Engineering disciplines within Egypt. The aim of the project is to develop a viable framework for embedding sustainability principles, theories and applications into education and training. Achieving sustainable development in Egypt requires proactive engagement of stakeholders from educators, practitioners, developers, and policy makers. The first stage of the research undertaken in this project has gathered data surrounding the opinions on the current curricula through a stakeholder survey, themed workshops and open-ended questionnaires. In the second stage of the research, results from a workshops held in Cairo surrounding the required skills for achieving holistic sustainability within the built environment sector are presented. This is followed by an open-ended questionnaire aimed at engaging academic groups involved in education in the built environment, which was undertaken during the second stakeholders' workshop. The aim of this questionnaire is to reveal concepts and generate in-depth discussion surrounding curricula issues in Egypt and achieve consensus for the development of a proposed strategic framework which EfS at the heart of the education policy agenda in Egypt, progressively at all levels of education and professional training of graduates and practitioners in the built environment. This paper presents and discusses results from the second stage of the project methodology.

**Keywords:** *Curricula Development, Educational Framework, Sustainable Built Environment, Questionnaire, Interviews, Workshops*

## Introduction and Context

Architecture discipline plays a key role in implementing sustainability within the built environment, as it has the benefit of blending creativity and scientific innovation, which impact upon all of society who interact with the built environment. If the discipline can truly develop and embed sustainability within the design, construction and use of the built environment, sustainability goals will be enhanced greatly (Taleghani, Ansari and Jennings, 2011). In terms of education, a broad knowledge set and ability to apply aspects from the three pillars of sustainability is essential at an early stage in the architects' career. The major role of the education sector is to develop and build capacity for this action (UNESCO, 2003), as it has been shown that at Higher Education Level (HE), training and research activities have a considerable impact on implementing sustainability-related knowledge and innovations into practice (Bettencourt and Kaur, 2011; Frimana *et al.*, 2018).

In the past, sustainability education has typically been 'about' sustainability, with content being delivered through courses in the form of transmissive surface learning (Altomonte *et al.*, 2013). The current consensus around the topic suggests that it is essential that EfS is not just focused on the content of the curricula taught, but introduces the approach of integrating sustainability within the entire curricula design process (Altomonte *et al.*, 2014). Despite the benefits of embedding sustainability within curricula, the process of curricula

development often poses a number of challenges. The need for balance across curricula is also a key problem. In general, for Architecture and Engineering type courses; there are imbalances in curricula, most often with more technology-focussed courses or general theory found over sustainable design courses (Porras Álvarez *et al.*, 2016).

The United Nations Decade for Education for Sustainable Development (DESD) that started initially in 2005-2014 gave an appropriate motivation to the educators to integrate sustainability into all aspects of education and training ; through updated curricula, research and sustainability related activities (Thürer *et al.*, 2018). However, the literature suggests that there has been a lack of integrated education and innovative teaching methods, which has led to educational failings and knowledge gaps surrounding sustainability (Tzonis, 2014). Education in both developed and developing countries needs to shift toward 'Education for Sustainability' or EfS, which encourages a greater understanding and ability to critically appraise and apply the sustainability concepts in a range of contexts (Tilbury, 2004; Iyer-Raniga and Andamon, 2016). Sustainable development (SD) is a key pillar for the socio–economic welfare of Egypt. The country is growing rapidly, and the demand for building in the civil and residential sectors has left a clear gap in terms of the skills available to deliver sustainable development in the built environment. The HE sector is encouraged to modernise to ensure that sustainability principles and theories are solidly embedded in their curricula, which in turn will reflect on more sustainable design in practice. Education for Sustainable Development (ESD) is a series of learning actions taken towards decision making on the long-term future of the three pillars of sustainability (Environment, Social and Economic). One of the core principles underpinning Education for Sustainable Development (ESD) is the development of "critical thinking skills, analytical skills, empathetic capacity and the ability to be an effective person who can take action to achieve desired development introducing education for sustainable development outcomes" (Tormey 2003, p. 2).

In Egypt specifically, education for sustainable development and environmental design is very limited and there is a considerable gap between the country's current regulations, the market's requirements and what ought to be taught in the departments of architecture (Dabaieh, Lashin and Elbably, 2017). In general, studies show that there is a significant difference between the architectural practice and education and integration of sustainability and environmental design requirements within them both (Farahat, 2011; Dessouky, 2016). These differences offer educators many challenges in putting the knowledge obtained at university into practice (Farahat, 2011; Dabaieh, Lashin and Elbably, 2017). Currently there is obvious desire to raise the sustainability knowledge and skills within architectural education at the HE levels (Dabaieh *et al.*, 2018). Above all, it appears that sustainability in the built environment requires integration within the architectural education in Egypt. There is a belief that this can be delivered with new teaching systems that focus on the practical education rather than solely the theory only (Salama, 2015; Dessouky, 2016). Learners should be engaged in real life case studies to support and develop critical evaluation of available and innovative solutions, and reflection as learning approaches. Learners should also be encouraged to confidently disseminate their learning experience and knowledge in their profession through partnership with their peers in their communities and practices. They are introduced to new ways of working collaboratively with other stakeholders in the construction industry, including clients, contractors and suppliers (Elsharkawy and Zahiri,

2017). Hence, the outcomes of sustainability-focused education and the training programmes are crucial to support the government strategic plans and goals in achieving the overall sustainability of the BE, on the macro and micro levels.

This paper presents and discusses research outcomes that will aid the development of an educational framework for embedding sustainability in the built environment in Egypt. Research has been carried out to assess and improve upon the educational and training levels in the country. The study presented includes a questionnaire- based survey with academics and presents results from stakeholder workshops involving academics, practitioners and students from the built environment sector.

## Research methodology

The BC-SDBE project, as a capacity-building initiative, aims to provide learners with a concrete base of knowledge and understanding of the principles of sustainable development, both in theory and practice, focusing on critical and reflective application of theory and principles of sustainable development in practice. The education research side of the project aims to investigate the current state of sustainability education in Egypt in the built environment sector. To achieve this, a sequential mixed methods approach has been designed blending qualitative and quantitative research methods over the course of the project. This approach provided insight into the sustainability education aspect of the Architectural Engineering department at Ain Shams University, Cairo, which the project is using to serve as a microcosm for Egypt's built environment education sector. The research methods are summarised below to set the context for the results discussed in this paper.

### *Skills gap online survey*

A skills-gap survey was carried out for academic staff and students across a broad range of Higher Education Institutions (HEI's) in Egypt. The aim of this survey was to develop an impression of the current built environment sector across Egypt and highlight the current skills gap in education, training and practice. The results from this survey have been recently discussed (Elsharkawy, 2017; and Elsharkawy and Zahiri, 2017).

### *Stakeholders' workshops*

Stakeholder workshops were carried out in Cairo during the project. These followed a moderated 'round table' discussion format. This allowed the results to be investigated for common themes and reveal areas for further research. The first Workshop (August 2017), discussed how the current system of education in the built environment area could be improved in Egypt. The discussions focused on three themes: 'Curricula development', 'Continuing Professional Development' and 'Practice and Training'. The second workshop (March 2018) generated discussion surrounding the potential for interdisciplinary projects and the ways of embedding them within the current curricula to improve the employability of graduates in Egypt.

### *Stakeholders' questionnaire*

An open-ended questionnaire focusing on the recurring themes identified from the previous research work was distributed at the third stakeholder workshop in Cairo, held during March

2018. The aim of the questionnaire was to elicit detailed responses surrounding the common themes identified in the workshops. The questionnaire was designed to generate further understanding related to the key skills requirements of students, the methods to develop these skills, the potential for curricula change, the perception of practical projects, and the perceived benefits and barriers of Academic – Industry collaboration for successful EfS. The answers to these responses were coded thematically for analysis by grouping responses according to the common themes presented in the responses.

## Results and discussion

### *Skills gaps online survey*

The survey results provided an insight into current education and practice of sustainable design in Egypt, with a sample of academics, practitioners, and students responding to a variety of questions. HEI's involved Included Ain Shams University, The British University in Egypt, Helwan University, Alexandria University and others. The results of this survey have been published in (Elsharkawy, 2017). However, the key result from this work shows that Education for sustainability needs improvement as only 20% of respondents acquired their sustainability knowledge at Undergraduate (UG) level. To build capacity for sustainable development in Egypt it is clear that a new strategic framework to embed sustainability at the start of a student's career is necessary. Additional results show that there is often low participation in research due to limited resources both financial and physical, highlighting resource constraints as a barrier to overcome.

### *Stakeholder workshops*

Following stakeholders' workshops key recurring themes have been identified as key target areas to improve EfS at HEIs in Egypt. Students Skills were a key theme – these largely could be grouped into Technical skills that can be taught directly, such as research skills, lifecycle calculations, software use and choosing between electrical systems, building finishes etc. and soft skills which can be taught indirectly or developed by a student through the course of their study. These soft skills include aspects such as independent learning, creative thinking, teamwork and an appreciation for different disciplines agenda's. A variety of teaching methods will need to be utilised to develop these broad range of skills. Teaching methods were discussed and received numerous suggestions during the workshops. Conventional teaching methods such as site visits, lectures and joint project work were suggested. However, more innovative techniques such as learning by teaching, problem based learning, capstone projects and peer based learning were mentioned. These suggestions show that there is an awareness of the need for varied teaching methods, and that implementing them will be the next step. Adopting innovative teaching methods is something on the HEI's radar as these may develop interdisciplinary, technical and real world experience for students.

In addition, workshops have revealed key knowledge areas. These included standard areas of architectural education such as fundamentals of structure, fluid dynamics, heat transfer, lighting, acoustics, and building regulations. However, holistic approaches such as cultivating a specific mind-set were proposed. These included aspects such as appreciating independent learning, acquiring a wide range of sustainability-related knowledge, understanding building concepts not just calculations, and understanding buildings

requirements. These mind-set topics go beyond course content alone, and suggest areas that HEIs can develop in future to produce well-rounded graduates. Additionally, workshop participants recognised that specific topics such as cost, waste management and site management need improving. The need for capacity-building was also discussed and can largely be improved by addressing 4 categories:

Training (CPD), skills improvement (critical thinking, team management and leadership), resource constraints (lack of research facilities and testing labs) and collaborative opportunities (new staff and industry networks, build interdisciplinary staff networks and encourage shared projects). Interdisciplinarity was also discussed and an overall action plan for embedding this within HEI's was suggested and the suggestions fell into the following themes: Regulatory improvement (Agreeing university bylaws, developing collaboration with industry/practice (KTP's, internships), curricula change (interdisciplinary projects, more peer interaction, graduation projects must follow real world scenarios) incentivising interdisciplinary integration (incentive/punishment plans) and evaluation (evaluate current resources, follow up plans and evaluate future outcomes).

Furthermore, employability was discussed as well. The workshops recognised that there are current strengths to build upon. Current strengths in terms of employability are the reputation of graduates (Highly aware, creative and technically literate) the position of architecture as a sector (rapidly modernising, large number of specialist tracks, ability to coordinate tools, ideas and technology) and current collaborative strengths (innovation hubs, professional studies and extracurricular provision). Employability weaknesses were identified as a lack of data (limited information on building codes, market needs, building economics and access to market data), resource issues (lack of them), need for innovation (real context often missing in teaching, largely one-way teaching methods, lack of new technologies, student factors (poor project management, not aware of other disciplines) and missing knowledge (lack of staff training and poor awareness of new materials and methods). Opportunities to embed employability were also highlighted as follow:

Curricula and student development (more collaboration with students, embed professional skills, teach new technologies, social media training) reputational opportunities (emphasise the quality of teaching staff, use Cairo location to advantage and large number of specialisation) collaborative opportunities (more internships, new markets and jobs). Threats to employability integration were identified as curricula related (need for international accreditation, need for technical training and high competition from the private education sector), regulatory threats (building codes are not mandatory, student numbers are controlled by government, economic (codes can be expensive to implement in terms of building technology or materials), collaborative barriers (the need for more coordination and communication between academic and industry) and external threats (population increase, rapid technological advances, new build cities not focusing on sustainability).

Finally, the suggested actions included improving collaboration (joint Academic-Industry supervision of student projects, Link research plans to market needs, Private-Public participation) developing more training (diversify curricula, applied interdisciplinary projects, develop staff training, project management and economy, maintenance systems, etc.) and encouraging attitude change (enhance the culture of interdisciplinarity).

***Stakeholders' questionnaire***

Overall, eighteen respondents identified as academics responded to the survey. With a broad range of seniority levels represented (junior staff n = 9) (senior staff n = 9). Most respondents were from Ain Shams University, which is to be expected as they are the BC- SDBE project partner institution, but it is important to remember that this may bias the results and not be entirely representative of the HEI sector for the Built Environment in Egypt.

Concerning the first question, ***'What do you think the key skills an engineering or architect student needs to develop to successfully apply sustainability themes in their career?';*** most respondents answered this question with many answers generated. Some 21 skills were suggested as being key for graduates to apply sustainability themes throughout their careers. The most commonly reported theme (9 respondents) was software and technology related skills. Other skills suggested included communication, teamwork skills, critical thinking and independent learning. These are all skills seen as desirable within the built environment literature (Iyer-Raniga and Andamon, 2016). Interestingly awareness of sustainability themes such as environmental issues, economics and social impacts were all referred to, but much less frequently. These issues are perhaps more important than the more easily identifiable skills. A broad awareness and understanding of sustainability issues is a key learning outcome that HEI's must address (Murray and Cotgrave, 2007).

The second question, ***'Could you suggest any ways that these skills can be developed? What approaches do you use currently?'*** received 13 responses**.** A wide range of responses were also submitted for Q2 – this question intended to provide more information surrounding current teaching methods, and whether any innovative solutions would be suggested. Critically looking at the methodology this question was posed poorly as respondent's answers did not make clear what are current approaches, and what are suggestions. However, an analysis can be made. Workshops were the most commonly reported method, and are a conventional method of education. Interesting alternative ideas included: interdisciplinary themes 'embedding requirements that influence students to interact with other disciplines', assessing practical issues such as 'simulating real lie situations or big construction problems for students to solve' and encouraging attitudinal change by developing 'a sense of responsibility towards his/her society and environment at large'.


Figure 1. Q2 Word cloud (Source: Authors)

A range of methods were proposed as teaching tools to develop the skills mentioned in Q2. As shown in Fig. 1, the most common suggested methods are introducing more workshops, developing interdisciplinary work, and encouraging project work. However, innovative suggestions such as solving real world problems, promoting a sense of responsibility and involving industry in the academic process were also made. This is promising as education for sustainability requires a shift from conventional teacher lead education to a more student led model (Sewilam *et al.*, 2015). There are many ways of teaching sustainability themes, ranging from traditional, technical and reflective methods (Christie *et al.*, 2013) and a range should be incorporated into teaching to account for different learning styles (Elbarkouky, Aboshady and Salem, 2013), (Li *et al.*, 2018).

As for the third question, ***'How easy is it to adjust the current curriculum, do you have the freedom to make changes and introduce new techniques?'*** 15 respondents answered. However, the response was unanimous in that the current curricula taught at respondent institutions can be changed. This question uncovered additional themes. Some responses (n=3) agreed that there is a current willingness to change curricula to embed sustainability themes, 2 respondents suggest that curriculum is easy to change, 2 agree that minor changes can be made, and 2 respondents mentioned that university byelaws are being developed that will presumably enhance curricula change.

Curricula change will be a key method in adapting and integrating sustainability themes, and we can see from the literature that there is no standard solution to encouraging it (Ferrer-Balas *et al.*, 2008) but it is widely accepted that the introduction of new course content, education delivery and assessment methods is essential. Curricula change should encourage a range of new Intended learning outcomes tailored to the required skills of Egypt's built environment students. The most positive aspect revealed through the questionnaire is that there is real willingness to enact curricula change for sustainability, as willingness to change is often highlighted as a barrier (Bedawy, 2014). There will be barriers to overcome such as organisational, pedagogical and financial limitations (O 'byrne, Dripps and Nicholas, 2014). These need to be investigated and understood to enact change within Egypt.

Thirteen respondents answered the fourth question, ***'Do you think that hands on practical projects are beneficial to students and why? Do these types of project happen often?'*** The majority agreed that hands on projects are beneficial to students but do not occur often. One respondent reported that 'The practice (of practical projects) enhances the perception of students about the profession and its challenges' however these occur 'not so often, more usually they are designed projects with conceptual requirements, that aren't aligned with reality'. This quote suggests that practical based live projects such as working with real life case studies are beneficial for students – but they do not happen often. The implementation of practical projects can be challenging, a participant mentioned that 'the students sometimes start participating in some practical projects through their workshops, but they do not get to the end'. Respondents broadly agree that practical projects do not occur enough. One respondent from a university outside of Egypt stated 'Nowadays, yes these projects happen often, even in residential' – which suggests that by making changes to the curricula, practical projects could become more popular. Dabaieh *et al.* (2018) present results from practical projects delivered through a 'living lab' for architectural students. They agree with our respondents that the approach 'prepares students for the reality of architecture

practice in Egypt' through practical application of theory. This practical learning also develops a student's understanding of the whole design process showing how their actions made their design into a real building

Finally, 14 responses were collected from the fifth and last question, ***'Do you think academics and practitioners could work together more to enhance student's education? If so what do you think the main barriers are to working with industry?'.*** Respondents agreed that academics and practitioners could work more closely together to enhance student learning. However, a range of perceived barriers to working together with industry were raised by the academic respondents (Fig. 2). As seen in Fig 2. The most numerous response was that of student time pressure – suggesting that academic-industry collaboration is regarded as an extracurricular activity that students do not have time for. Other barriers included trust and cooperation, poor awareness of the potential benefits by both Academics and Industry, a lack of clear incentives, resource and cost barriers, and differences in working practices. Collaboration between Industry and academia could be an essential method for enhancing UG student's education. Knowledge exchange, internships and demonstration projects provide an avenue for the practical application of skills and knowledge obtained through university courses. This academic – industry collaboration has long been an effective route to prepare students for the world of work (Samuel, Donovan and Lee, 2018). Through involvement with industry, students can develop 'personal added value' by demonstrating work experience, increased skill levels and enhanced employability (Brooks and Youngson, 2016) which provide long lasting effects on career progression.


Figure 2 Q5. Word cloud (Source: Authors)

The issue of time pressure for both students and industry appears is a key perceived barrier: One respondent stated 'students do not have much time for extracurricular activities' with another referring to 'tight time slots' for students. For industry, the issue of time is apparent with one respondent stating 'professional architects are often busy, and have busy schedules and can hardly accommodate time for students work' another respondent answered 'consultancy offices are very busy and are not willing to receive students or send their (own) officers to be present and cooperate with academia'. Therefore, opportunities to engage with industry should be incorporated into the curricula, not left as an add-on. Other potential barriers such as trust, resources, cooperation, and expectations of Industry and Academics will only be resolved by developing mutual collaborations and raising awareness of collaborative benefit. One respondent summarised the issue: the barriers are 'mainly the

lack of awareness on both sides for the importance of such exchanges, and the lack of awareness of the win-win situation that could be gained'.

**Conclusion – How to build a Strategic Framework**

The vision is that all HE built environment courses in Egypt contain a fully balanced, integrated and interdisciplinary approach to sustainability themes. These will produce graduates who are aware of the sustainability goals that they can contribute towards, and achieve them in a confident, efficient manner, which will benefit the environmental, social and economic prosperity of Egypt as it develops. From the literature and the results obtained through the BC-SDBE project to date, some key general suggestions for HEI's in Egypt can be made. By incorporating these suggestions into future curricula developments, HEI's can work towards developing a strategic framework to deliver the sustainability vision.

Any strategic framework for Egypt must take account of two sides, namely updating the pedagogy (curricula, skills, awareness and theory) to reflect upon new and innovative teaching styles which can be tailored to specific aims. The other key side for development is ensuring an increased real world application of the taught skills. This will most likely be achieved through problem based learning delivered through a variety of methods (such as hands on projects and industry collaboration) to encourage the application of theory. HEI's in Egypt must ensure a balanced approach to future curricula change. It is crucial that both soft and hard skills are developed evenly and that course content does not become biased towards the 'exciting' topics of software and technology. These topics must be covered, but not at the expense of a broad understanding of sustainability principles. New updated curricula must increase the awareness of social, economic and environmental problems and equip students with the skills to solve them.

A key focus for curricula change, should be the adoption of innovative teaching methods such as problem based learning and compulsory credit bearing work focused on the resolution of real world problems. In addition to this, all modules should involve both interdisciplinary work and independent learning aspects to develop well rounded students. Perhaps more importantly still, new curricula should ensure that theory and practical projects are combined within modules to complement each other and enhance student learning. Academic – Industry partnerships should be fostered by HEI's in Egypt. These are hugely beneficial for the development of a student's confidence and allow the real-world application of the theory taught at university in a professional setting. In addition, these will develop a student's employability – which will ensure sustainably aware graduates are employed where they can make a real-world impact.

Finally, there will be many barriers to updating and changing curricula such as Institutional, financial and regulatory issues, however there is a clear appetite for change, so HEI's within Egypt should investigate the barriers at their own institutions, and seek a variety of methods to overcome these barriers to make curricula change for sustainability a reality. It is important to note that the questionnaire data is by no means exhaustive or fully representative of the HEI sector in Egypt due to low responses (n = 18). The results appear to match the literature in terms of its findings, but more extensive research will be required. Future work around EfS in Egypt should attempt to delve deeper into the factors affecting the choice of teaching methods and curricula development. The work could also investigate any

pre-existing relationships HEI's have with industry at present, and determine methods to spread awareness of the benefits of academic-industry partnerships.


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