

## UNIVERSITY LIVING LEARNING LABS: AN INTEGRATIVE AND TRANSFORMATIVE APPROACH

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**Abstract:** Having the global movement of the University's third mission of co-creation for sustainability, the living lab has mentioned as one of innovative and transformative approach for university response to the global environmental challenges of climate change. However, not much attention has been discussing in a more structured manner how the university function as living labs in the context of the societal learning process. The study analyses the extent of how the university can accommodate the living labs approach and educate the public in a larger agenda of the society learning process in the context education for sustainable development, ESD. What are suitable learning pedagogies that can accommodate the transformations process? What kind of approaches need to be adapted to generate more robust research output to translate sustainable development in the realm of sustainability science. By using broad definition of living labs, consider the UTM New Academia Learning Innovation, realizing the initiative from the Ministry of Education Malaysia to enhance the role of university to engage larger society in mainstreaming sustainable development and by referring to the Malaysia Educational Blueprint, the study came up with a more comprehensive and approach of university mobilizing sustainable development by fully utilizing his role and function in the context of Malaysia. Finally, this article outlines several important characteristics to determine the success of the university living labs by developing an integrative and transformative framework called the University living learning labs. The framework aims to strengthen the internal capacity in research, teaching and learning and campus operation and added the fourth element of university-industry community partnership as a linkage to the society outside the university.

Keywords: University, living labs, sustainability, education, research.

### Introduction

The global movement for the university's third missions of co-creation for sustainability demonstrates a concrete movement for sustainability implementation. It manifests into various projects, programs and initiatives which require the creation of collaboration work within and beyond their boundary and territory or we called it as living labs (Molnar *et al.*, 2011; Evans, 2012; Zen *et al.*, 2018). It is one of the tools for the transition of society toward sustainable society (Trencher *et al.*, 2012), such as urban living lab, university–community partnerships for sustainability (Trencher *et al.*, 2014), an urban sustainability extension service (Molnar

*et al.*, 2011), regional sustainability initiatives (Zilahy & Huisingh, 2009), the carbonization of urban governance, experimental governance and the transition to a low-carbon economy (Evans, 2012). This is one of the examples of the Living labs as an emerging open innovation approach developed based on the co-creation of knowledge shared with various stakeholders (Tanev *et al.*, 2011) where boundary setting is no more relevant.

Living Lab concept has been applied in a various context beyond the campus boundary by emphasizing hands-on experience through the pioneering 'Action Learning Labs'. Using this approach, the students received on-the-

ground opportunities to put classroom theory into practice which were more on the real-world experience. For example, involvement of students with the adjacent community of the University of Tokyo (Trencher *et al.*, 2012), the students of Oberlin Community as change agents in the Oberlin Project (Rosenberg Daniel *et al.*, 2015) and a chance for students to work side-by-side with corporate and non-profit partners to apply classroom lessons into a high-impact business challenge applied in business management student of MIT Sloan living lab (MIT Sloan, 2016).

The University living labs have been widely adopted in the Universities in Europe as a platform for creative ideas and optimize work capabilities with various stakeholders, such as the University, industries and small-medium enterprise, SMEs (Ståhlbröst, 2013). The living labs network around Europe called European Network of Living Labs (ENoLL) which was created in 2006 has approximately 190 active members of living labs worldwide. There are almost 400 members of organizations including IHE, industries and small medium enterprises, SMEs from countries such as Canada, South Africa, China, Brazil and other European countries such as Ireland, Belgium, Finland and Sweden and many others.

There is also focuses given to use the campus society as a demo site to showcase the real sustainability challenges demonstrated in a living lab setting (Cohen & Lovell, 2014; Evans *et al.*, 2015; Zen, 2017a; Zen *et al.*, 2016; 2018). This is where the inter and trans-disciplinary approaches for the adoption of an issues-based of sustainability science has a chance to be implemented (Cohen & Lovell, 2014; Zen *et al.*, 2016). Given the traditional set up of the university which is more towards a faculty-based of a single discipline approach that leads to the silo research and teaching and learning, the establishment of University living lab creates an opportunity to overcome that challenge by itself (Yarime *et al.*, 2012; Zen 2017a).

Living labs application in the University has been demonstrated in a transformation

of 25-acre campus into a sustainable 'living laboratory' in St Clair County Community College in Michigan since 2004 (Cohen & Lovell, 2014). The campus facilities provide a range of sustainability learning opportunities for students across academic and technical program e.g. food services, construction and land use, transportation, buildings, grounds and parking. Their experience is summarized in eight elements to building a living lab, which are i. engaging the right campus participants, ii. Identifying key collegiate program, iii. Building credibility through engagement and data, iv. Integrating into the curriculum, v. expanding beyond the individual program of study. vi. Building partnerships with industry, vii. Engaging support beyond the campus and viii. open the labs to the community (Cohen & Lovell, 2014).

Therefore, there is a common denominator for success in every living labs project involving University which consist of the elements of project execution, the acceptance of changes from the society, continuation of iterative and facilitation process and the involvement of a solid teamwork from various discipline due to the nature of sustainability challenges (Cohen & Lovell, 2014; Zen *et al.*, 2016; Zen *et al.*, 2018). This paper focuses on the University as living labs where more attention is given to overcome internal campus society sustainability challenges in practicing several changes as well as the urgency to create external linkages beyond their boundary.

Concerning the education for sustainable development, ESD as a tool for formal and informal educational tool to educate society about sustainable development and the sustainability science approach as a nature of project-based or action research to implement certain action or program or policy recommendation, however none of those researches (Yarime *et al.*, 2012; Cohen & Lovell, 2014; Zen *et al.*, 2016; Zen *et al.*, 2018) discuss the University living labs in more comprehensive approach. Hence, the study will utilize the ESD and sustainability science during the construct of the University living labs

by emphasizing the societal learning process in the context of ESD. Furthermore, to what extent the possible new pedagogy method supports the integration of sustainable development spirit in IHE will depend on. This is due to the nature of the research project basis, which causes less attention given to maximizing the internal capacity such as what type of learning innovation needed to support the university living labs. On the research development, various themes related to the Sustainable Development Agenda 2030 can be considered as the issues or research by University experts either benefitted the University itself or beyond the boundary.

The study aims to analyse to what extent the university can accommodate the living labs approach especially in internalizing and operationalizing the third mission of co-creation for sustainability on their site, what the suitable learning pedagogy (that) can accommodate the University's third mission and what kind of approaches need to adapt to generate more robust research output as well as to overcome the internal challenges in campus operations. Furthermore, the study conducts several contextualization during the construct of the framework by referring to several important frameworks in supporting University living labs and its third mission.

### Living Labs

An early definition of living labs in the year of 1990 was used as a mechanism to innovate technology and organizations for practical purposes. For example, to test new technology in a designed home-like constructed environment with several observations and test conducted involving users which more suitable to be called as a test bed (Ståhlbröst, 2008). It was where the mobile service of the technology developed to capture a live experience of users by providing access and review from technology used (Eriksson *et al.*, 2005).

Living labs interpreted as an *Arena* has a bounded space such as a household, a university campus or an entire city or institution that has

determined the approach that involves as key actors (Almirall *et al.*, 2012). As an approach, living labs interpreted more towards product development which covers methodology and innovation deployed without considering the bounded space (Ståhlbröst, 2012). According to this interpretation, five principles need to be considered are openness, influence, realism, value and sustainability and the five components needed are information communication technology, ICT infrastructure, management, partners and users and research and approach (Ståhlbröst *et al.*, 2013). This type of living labs that are led by utilizes, enablers, providers, or users, brings different contexts in operationalizing the living lab concept (Almirall *et al.*, 2012; Veeckman *et al.*, 2013). Hence, we might have a different interpretation of living labs by considering the role and function of a higher education institution.

In the bigger context, living labs are defined as “physical regions or virtual realities where stakeholders form public-private-people partnerships (4Ps) of firms, public agencies, universities, institutes and users, all collaborating for creation, prototyping, validating and testing of new technologies, services, products and systems in real-life contexts” (Westerlund & Leminen, 2011). JPI Urban Europe (2013) defines living labs as ‘a forum for innovating. . . [and] the development of new products, systems, services and processes, employing working methods to integrate people into the entire development process as users and co-creators, to explore, examine, experiment, test and evaluate new ideas, scenarios, processes, systems, concepts and creative solutions in complex and real contexts’. At this stage, although the specific boundary setting determines the characteristic of living labs, the functional platform for partnership with various stakeholders determine the purpose of having living labs. It can be either for product or technology development which requires an element of the iterative test, organizational transformations, policy testing in a form of program execution, monitoring and evaluation and the open innovation environment creation. Hence, living labs are also viewed

as a research concept with user-centres, open-innovation ecosystem operating in a territorial context such as city, agglomeration, or region by integrating concurrent research and innovation process (Von Hippel 1986; Almirall, 2011). This living lab approach as a research concept will consider to be develop as the university living labs.

In the context of the University living labs, emphasize is given on the coproduction knowledge process. Several points need to be considered are the involvement of consultation process between users and stakeholders during projects planning process for a more holistic solution to sustainability challenges and the iterative process of experimentation and learning at yearly basis to provide a more coherent basis for action over time (Evans *et al.*, 2015). By using the living lab projects in Manchester University, both elements are important in a university setting, joining up the institutional response to sustainability challenges and engaging students in focused and applied projects. Latest, the third core characteristic is the geographically or institutionally bounded space (Evans, 2013) which determines the nature of the living labs methods. Given the geographical context where campus as our setting, the University living lab has two potential functions; as a test bed or passive users and active user where specific teaching and learning method required (Følstad, 2008). In this context, none of the university living labs describes the learning pedagogy required in order to support the action research project to support the campus operation and how the external linkages enhance the living labs performance. Hence, this paper aims to structure the university living labs by outlining the important factors and contextualizing several frameworks related to sustainable development as well as analysing the relevant learning pedagogy to support in the context of sustainability science approach. This is also to address the real challenge of the structure of the university mentioned before.

Some learning approaches possibly deployed in campus living labs are experiential

and action learning or project-based learning. The project-based or problem-based learning requires multi-disciplinary and trans-disciplinary working together for a specific issue in the campus that allows real-world setting for the students to be exposed to the real campus problem (Cohen & Lovell 2014; Zen 2017a). Specific experiential learning is when the users are specifically defined as “learning through reflection on doing” (Felicia, 2011). This part can be extended and applied for sustainability project-based approaches on campus where the integration of sustainability initiatives into university system require an evolving process through an iterative process (Evans *et al.*, 2015; Zen *et al.*, 2016.). Action learning has emphasized on the students as a central subject and part of the education for sustainable development (UNESCO 2017). The details on how teaching and learning contribute to the campus living lab will be discussed further.

## Methods

In searching for the best method for the University implementing its third mission, several frameworks are referred to provide a significant contextual background in the building block of the university living learning lab as co-creation for sustainability. First, consider the effort in applying the concept of the university living labs where there is co-creation of actions as a combination of the element of research, teaching and learning as well as campus operation (Evans & Karoven 2011; Zen *et al.*, 2016; Zen 2017a; 2017b). Second, the quadruple helix of innovation framework of 4Ps partnership between University, government, community and private organization (Carayannis & Campbell, 2010). Third, identify the integration of the sustainable development spirit by considering the role and function of the university. Hence, the education for sustainable development goals learning the objective is therefore deployed (UNESCO, 2017). This is also a part of the global movement for the university as a living lab is one of the key components in the third mission of co-creation

for sustainability (Trencher *et al.* 2014). Fourth, the Malaysia Education Blueprint for Higher Education 2013 -2025 by Ministry of Education (2012) was referred to analyse the suitability of University's living-learning labs to support the creation of learning innovation in the Malaysia educational context. Furthermore, the paper will discuss in detail each component involved in building block campus living lab, Teaching Learning and Training, Research Development, Campus Operation and Community Industry Engagement (CIE). Here are several references to framework development and the contextualization process.

### ***The University Living Learning Lab***

From the earlier research on the university living labs, the entity of the university living lab was outlined. They were campus operation, research and teaching. The three were demonstrated inside the campus which focused more on educating the campus society on sustainability (Moore, 2005; Evans, *et al.*, 2015; Mcmillin & Dyball, 2009; Zen, 2017a). The initiatives either involved the external parties such as industry or community or government to get involved in the university as a demo site for campus sustainability or beyond the campus (Zen *et al.*, 2016; Zen, 2017b). Since the focus of this study is to exhibit and transform the university as living-learning labs, the focus is given to find a mechanism that can support the objective.

### ***Quadruple Helix Innovation Framework***

The four components of the quadruple helix of innovation concept for a knowledge-based economy by Carayannis and Campbell (2010) enhance the new perspective of the University living lab. The concept establishes important link beyond the campus which involves the University-Society-Government-Industry in their work ahead. It's due to the establishment of a centre for community industry network, CCIN in UTM and several universities in Malaysia. This movement is in line with the Sustainable Development framework where the

approach emphasizes collaboration for the four inter-connected components to operationalize the Sustainable Development Goals (SDG) Agenda 2030 and the quadruple helix approach. The effort creates reinforcing mechanism as to support the third mission of the university in co-creation for sustainability which further creates a plausible pathway and robust approach on how the university links and contributes to the SDGs.

The living labs as an emerging innovation platform, bring forward the quadruple helix model of a so-called Public-Private-People-Partnership (4Ps), where citizens have a strong influence on the innovation process in the bigger definition of living labs. Lately, the university innovation mode is in a quadruple helix as knowledge production and innovation and the application of living labs in the university have the potential to support the university's innovation model. The university's living labs involve stakeholder's engagement in a form of public-private-people-partnerships (4Ps) of firms, public agencies, universities, institutes and users, it stresses on the multi-stakeholder partnerships, the real-life context and the various stages of the development process. In this context, different stakeholders cooperate and share their resources, knowledge and expertise in the bigger context of the societal learning process.

### ***Sustainable Development Goals, SDG 2030***

Sustainable Development used as the main context in this paper provides the direction of the mechanism of how the campus translates it by using the living labs approach. As one approach to applying the sustainable development agenda in the university (Leal Filho, 2011; Trencher *et al.*, 2014; Zen, 2017b), the living labs become a global trend where the university collaborates with government, industry and civil society for sustainability (Trencher, *et al.*, 2014). Sustainability becomes one of the major responses to a complex challenge of climate change in human history.

In the context of innovation where the user-centric is given more emphasis, the living

labs provide a platform for the campus society involving in co-design and co-implementation of creative ideas of innovation to be adopted in order to translate the sustainable development agenda into action or practices. Active participation from users allows the co-creation of knowledge and conceptualization innovation as the collaborative development (Allen *et al.*, 2009; Trencher *et al.*, 2014) which is part of the learning curve development process. This point creates a boundary and scope for contextualization of living lab approach in this paper as well as strong emphasis on the users learning process. Furthermore, the study used the ESD as the approach that contributed to linking and operationalizing the SDG 2030 in the context of the university. The details on how ESD would contribute to campus living learning lab will be discussed in section Teaching and Learning.

Considering campus sustainability as living labs that provide a platform for the continuous societal changing process, iterative learning process plays important roles in transforming the campus society to be a sustainable society. Iterative learning allows the campus sustainability initiatives to be conducted, monitored and conducted again with improvements from the previous round, in order to generate useful knowledge in a real-life setting. These iterative learning loops are pursued to improve future products, services as well as societal and technical structures with the potential to be applied beyond the campus environment such as in the urban environment (Evans, 2013; Ståhlbröst & Holst, 2013; Zen 2017).

Furthermore, we use Admirall *et al.* (2012) definition of 'users' in a living lab where it has emphasized on user's involvement as one of the driven definitions of Living Labs. Users are considered as co-creators on equal grounds with the rest of the participants more specifically in experimenting with the real-world setting. Living labs provide structure and governance to user participation in the innovation process

(Admirall & Wareham, 2008). This approach provides an opportunity for public and private partnership (Evans & Karnoven, 2014). The partnership mode involves researchers, citizens, companies and local governments while at the same time broadens the socio-technical innovation opportunity (Cohen & Lovell, 2014). The study used this justification to develop the fourth element in the campus living-learning labs framework explained in section Community Industry Engagement (CIE).

The implementation of UTM campus sustainability since 2009 has been focusing on how the universities in Malaysia functioned as a catalyst for the translation of sustainable development with more tangible results (Zen, 2017b). The university living lab approach allows the interaction of the basic three elements of campus society, namely the students, academic and administrative/ professional staff (Moore 2005; Mcmillin & Dyball, 2009; Zen *et al.*, 2016; Zen, 2017). The research on campus sustainability conducted by Alshuwaikhata and Abu Bakar (2008) emphasizes the needs of integration of three strategies, namely: university environmental management system (EMS); public participation and social responsibility; and promotion of sustainability in teaching and research. The two indicate a loose definition of the components involved in developing the university living labs framework.

### ***The Malaysian Education Blueprint for Higher Education***

Malaysia Educational Blueprint 2015 – 2025 (Higher Education) (MEB (HE)) which was announced in early April 2015, focuses on how to transform Malaysia's higher education sector. It was stated in MEB (HE), "A fundamental transformation of how the higher education system and higher learning institutions (HLIs) currently operate". Several areas were addressed by improving graduates' critical thinking, communication and language proficiency, especially in English. This blueprint offers a productive collaboration between academics and industry, as well as to improve

the productivity and efficiency of the higher education system and to enhance the overall financial sustainability of the current system (MEB (HE) Executive Summary 2015). These characteristics have a similar approach to the living lab.

There are five (5) key aspirations and eight (8) key target sectors to operationalize the transformation. The vision for implementing the blueprint is framed in around ten (10) shifts that represent both the challenges and opportunities for the sector. The first four (4) shifts focus on outcomes for key stakeholders in the university including academic students, technical and vocational, educational and training, (TVET) pathways, academic society and all citizens who are involved in lifelong learning. The other six (6) focus on the enablers for the university which cover funding, governance, innovation, internationalization, online learning and delivery.

Hence, how the campus sustainability is by using university living learning lab with MEB HE in order to adapt and translate sustainable

development into the university in Malaysia will be discussed further in Result and Discussion. It provides the significance of how the University living learning lab approaches enhance the MEB through its five (5) key aspirations which co-related with the living-learning labs tools describe above.

**Results and discussion**

The earlier effort on the university living labs involved the research development and students involving actively in a project-based approach for the improvement of the campus operations (Evans & Karoven, 2011). How the campus operates in providing a conducive physical environment, green infrastructure and facilities to support the university agenda on sustainability need are needed to consider in developing the campus as a living lab. Meanwhile, the interdisciplinary approach of campus-developed to deploy sustainability affects the approach of research and development to consider during the framework development. Hence, this



Figure 1: Malaysia Educational Blueprint 2015 – 2025 (Higher Education) (MEB (HE))

study constructs the three big elements of the university which are university as a teaching and learning institution, as a research institution and as services provider or enabler for operating the university (Evan *et al.*, 2015; Zen 2017b). This is also outlining the basic three types of the university community. I. the students which are not permanent, II. Academics staff who are researchers and lecturers who are playing a crucial role as a knowledge provider, the mastermind to create relevant research theme that has a significant impact on the campus sustainability and III. Non-academic staff or practitioners such as the professional and administrative staff who are also the permanent player as well as the agent of changes. They need to empower sustainability will lessen the burden of academic staff in implementing sustainability. By considering the university as living labs, the emphasis given to address sustainability comprehensively by involving these three basic communities in University and in the context of the societal learning process. Hence, the University living labs are more appropriate to be renamed as University living learning labs.

Moreover, in the context teaching and learning, students' needs to be involved actively for the real exposure, research output needs to be tested in the real-world setting of the campus environment and is shared with the operation department for further improvement in delivering the services (Zen *et al.*, 2016). All the processes need to be conducted in a consultation process between the pools of experts in sustainability with the operation department which is rich in tacit knowledge for co-creation knowledge for sustainability. Nevertheless, students experience difficulties and challenges faced during the project execution or implementation provide a real-world exposure for the students to be more realistic in the research learning process.

### ***Teaching, Learning and Training***

In exploring the suitable pedagogy approach that supports the spirit of sustainable development in university living learning lab, the study

refers to the key principles and component of Living Labs as 'Approached' by Ståhlbröst *et al.* (2013). Hence, the 'Sustainability' principle, the framework of the Sustainable Development Goals (SDG 2030), education for sustainable development, ESD and sustainability science to be our context to internalize 'Sustainability' in our University's living-learning labs framework. It was considered as 'Approach' that stimulates the inclusive part of sustainability teaching and learning, either in a form of formal or non-formal education during the campaign conducted related to campus sustainability. Several campaigns in UTM Campus Sustainability were identified as the informal approach of ESD (Rahman & Zen 2015) which detailed out the possible link of campus living lab with specific SDGs goals (Omar *et al.*, 2018).

In the context of ESD, the concept empowers the learners to make informed decisions and responsible actions for environmental integrity, economic viability and society for present and future generation (UNESCO 2017). As a holistic and transformational education which addresses learning content and outcomes, pedagogy and learning environment. It achieves its purpose in transforming society if it is translated into action research. Hence, ESD is considered as a transformative and integrative tool to educate the campus society in translating and operationalizing sustainable development. However, the role of ESD and sustainability science was not clearly mentioned as one of the pedagogies. Pedagogical approaches i.e. project-based approach, PrBL and problem-based approach, PBL (Tanev *et al.*, 2011; Cohen & Lovell, 2014; Evans *et al.*, 2015; MIT Sloan, 2016b). Most of them are emphasized on the innovative approaches.

The ESD approach in university's living-learning lab has core dimensions, namely, learning outcome, pedagogy and learning environments, learning outcome and societal transformation. The pedagogy and learning environment require the teaching and learning design as an interactive, action-oriented and transformative learning (UNESCO 2017). In



this case, the Student Center Learning (SCL) of a New Academia Learning Innovation (NALI) developed by UTM has a potential platform to integrate ESD (UTM 2016).

It is for rethinking campus as learning environments – physical as well as virtual and online – to inspire learners to act for sustainability. The learning content covers integrating critical issues, such as climate change, biodiversity, disaster risk reduction (DRR) and sustainable consumption and production (SCP) into the curriculum. The content at the same time provides direction for research and development to be applied in a new framework of campus living lab. The learning outcomes involve stimulating learning and promoting core competencies such as critical and systemic thinking, collaborative decision-making and responsibility-taking for the present and future generations. At last, as a societal transformation, it empowers learners of any age, in any education setting, to transform themselves and the society they live in.

The framework also considers campus society as an individual learning process which is related to more concrete issues related to the learner and the learning context (Breunig, 2009). It also differs from experiential education which has a broader philosophy of education. This consideration is important where we reframe the living labs in the context of campus as a living learning lab with several pedagogical approaches. The last definition emphasizes the learning experiences of the student and campus society as a boundary setting but not limited to reach out beyond the campus setting. Therefore, experiential learning in campus sustainability is concerned with more concrete issues related to the learner and the learning context in the campus mainstreaming sustainability.

Another important dimension of experiential learning is the reflection process on certain experiences which cannot be obtained from the practical aspects of learning such as hands-on learning (Pallot, 2009). Experiential learning reflects the student's experience and involvement in the certain project which may not necessarily include the hands-on learning

(Edutopia 2014, MIT Sloan Management, 2016) where students play an active role rather than passive which is taken from didactic learning (Pallot, 2009). It is related to but not synonymous with other forms of active learning such as action learning, adventure learning, free choice learning, cooperative learning and service learning (Kusiak & Tang, 2006). This experiential learning in student's involvement in the real world setting of campus sustainability initiatives is crucial where the campus operation support the physical environment, infrastructure and services as a platform for learning and innovation.

### *Campus Operation*

Referring to the nature of the ESD project and sustainability science approaches, the showcase of sustainability integration was demonstrated in campus operation. Although, it was not familiar yet how the user-based approaches of campus living lab are integrated to improve the existing campus operation (Tiew *et al.*, 2010; John *et al.*, 2012), there is proven result to do that (Moore 2005; Mcmillin & Dyball, 2009; Zen *et al.*, 2016). One of UTM Campus Sustainability key initiatives, the Green Office, is an integrative approach providing platform for the campus society to implement the effort to reduce the side effect of campus operation such as perform recycling, saving paper and energy and etc, which involves student in educational campaign and integrate the research output to improve waste management in campus and establish the governance sustainability with outside stakeholder (Zen *et al.*, 2016; Zen 2017b). Despite trans-disciplinary in nature, the Green Office involves various experts' disciplines. The initiative is mainly to introduce the environmentally and friendly practice of office acts as the nature of the HEI. This characteristic is considered as 'Realism' aspect of key principles of living labs approach (Ståhlbröst *et al.*, 2013). The approach was created as one of the characteristics of the university living labs. Such integration has been established very well in campuses in the west (Almirall *et*

*al.*, 2012; Cohen & Lovell, 2014; University of Manchester, 2015).

As to enhance better sustainable campus living, sustainability in operation plays a crucial role as an enabler. In UTM, the operation is led by the Office of Asset and Development (OAD) which is responsible for the operation and facility management which has a mission of “Providing the Sustainable Facilities”. Hence, together with the UTM Campus Sustainability office, the key strategic initiatives launched were Sustainable Arcade to promote the Sustainable lifestyle. The Green Office initiatives involve various entities showing sustainability governance (Zen *et al.*, 2016) and the Sustainable Energy Management Program (SEMP). The approach is more on the user-centric approach where the communities are involved as a subject rather than the techno-centric innovation of living lab approach. The same approach applied in Manchester University, where the Estate Department becomes a major driver in implementing the living labs approach (Evans *et al.*, 2015). However, the moderate technological approach has been adopted to complement and stimulate the behavioural and managerial aspect.

Most of studies conducted in campus which are related to infrastructure in campus environment in Malaysia were conducted without the intention to focus on user-based and integration of research output to improve the existing campus operation (Tiew *et al.*, 2010; John *et al.*, 2012) or in the context of the University living labs (Evans & Karoven 2011). It is more on a test bed rather than integration of the triangulation of the University Living Labs.

From the operation part, the creation of a new system in universities is an effort to gain campus sustainability which was led to important projects. For example, Griffith University has come up with approaches and principles that would help organizations to manage e-waste they generate while seeking sustainability (CAUDIT, 2006). University Living Labs program at Manchester University aim to enable a living lab style as a learning environment through three key elements which

generating a pipeline of living lab projects on campus, the construction of the new engineering campus as a living lab and the development of institutional visibility (Evans *et al.* 2015). Queen’s University moved a step further from recycling, reuse to landfill services into the action of reducing, reusing and recycling within the waste management hierarchy (Oskamp, 1995; Hamburg *et al.*, 1997), especially when it comes to an e-waste management system. Kelly *et al.*, (2005) indicated that successful recycling programs depend not only on technology, but also on the involvement of people and maintenance of environmentally responsible behaviour. Hence, we found that project-based action research where there is an element of co-creation and co-production of knowledge through a consultancy in the iterative processes will execute and strengthen the initiative (Zen *et al.* 2016). The effort was connected to the third element, research and development.

### **Research and Development**

Considering living lab as an open system and the wide range of the 17 Goals of Sustainable Development Goals, SDGs, it drives the sustainability as most of research themes covered in UTM. There was a total of 62 projects recorded that addressed various aspects related to sustainability issues worth RM 9.21 million during the year 2011 until 2013 (Rahman & Zen 2015). From that number, 59 were the government funded projects worth MYR 9.04 million and three private and international funded projects worth MYR 0.17 million. For the university living labs demo site, there were three strategic sustainability projects dedicated based on the issues and the needs. It was awarded in the year 2013 as the first attempt to involve cross-disciplinary projects and issue-based approaches. The three are the bio composting projects to support Sustainable Food Arcade (Khademi *et al.* 2014), the development of campus sustainability index to create own measurement and the use of social marketing to enhance pro-environmental behaviour. Key campus sustainability initiative such as Green

Office institutionalize waste minimization by using sustainability science approach allowing inter- and trans-disciplinary approaches with a tacit knowledge built to suit the local context, with an iterative process and consultation between the operation department and campus sustainability offices and another department which create the internal governance of sustainability (Zen *et al.* 2016, Zen 2017). The result from the action-based research involving student, non-academic and academic staff, was used to improve the campus operations towards sustainability. Hence, by defining the university living lab as an arena, it creates a platform for the implementation of sustainability science is created.

The living lab process described above was adopted the sustainability science approach. The multidisciplinary approach described by Pallot (2009), has a similarity with the inter- and trans-disciplinary approaches of sustainability science where contextualization requires action learning versus demonstration and showcase arena on campus. For the living labs research project to be successful, there are five (5) recommendations that need to be considered. I. The clear strategic intention, II. Minimum shared value creation and sharing among all stakeholders, III. The minimum level of openness, IV. The minimum set of users and establish strong communication and V. Mixed set of living lab tools to discover new opportunities (Veeckman *et al.*, 2013). The establishment of Sustainable Arcade at UTM CS is not only for the purpose of the lean and clean operation but also as one of the key living lab platforms for research and development and student's experiential learning environment (Omar *et al.* 2018). For student conduct an educational campaign for pro-environmental behavioural changes such as 'No Plastic Bag Campaign' and 'Bring Your Own Food Container' campaign. The plastic bag charges imposed while points collection given for those to bring their own container to the sustainable arcade. However, the continuous campaign is required to sustain the program despite the provision of green facilities to educate campus society on a sustainable lifestyle. The approach

was contributed to Holistic, Entrepreneurial and Balance Graduates of the ten sif of MEB HE.

Furthermore, the initiative aims to tackle the food waste issues in Sustainable Arcade, where the bio composting integrates for the campaign 'From Fork to Farm'. It is to foster the biodegradable composting around campus. The reduction in waste campus generated saving in campus operation has a potentially significant contribution to the Financial Sustainability and Empowered Governance as part of the ten sif of MEB (2015-2025).

Those examples demonstrate the action-based research of sustainability science as well as the education for sustainable development, ESD approach in the instrumentalization of campus living-learning labs. These approaches have not been considered in the earlier definition of campus living lab (Evans & Karoven, 2011; Evans *et al.*, 2015). The wide spectrum of sustainability research also fosters by the establishment of community-industry partnership as the connector with the outside stakeholder as a special mandate from the Ministry of Education of Malaysia. Hence, we consider the additional fourth element of campus industry engagement to foster co-creation for sustainability which explained in the next section.

### ***Community Industry Engagement***

The establishment of the Centre for Community and Industry Network (CCIN) in the local universities in Malaysia, such as University Malaya, Universiti Sains Malaysia, Universiti Putra Malaysia and Universiti Teknologi Malaysia aimed to enhance university-community-industry collaborations by engaging the full of academic resources for the enrichment of civic and community life in Malaysia. The centre connects students, faculty and community organizations together in a collaborative and innovative process that translates academic knowledge into a civic responsibility to promote positive social change (Universiti Teknologi Malaysia, Center for Community and Industry Network 2019). Using the quadruple helix

approach, the approach included sustainability-based projects. There were 35 community engagement projects related to sustainability involving 285 staffs and 2500 students for the year of 2012 conducted by CCIN in UTM (Rahman & Zen, 2015).

As a part of the collective actions in reducing Malaysia carbon emission by 40 percent per GDP by 2020, UTM co-creation for sustainability in IHE in Malaysia adopted Low Carbon Cities Framework (LCCF) and assessment system by using UTM campus sustainability as a test bed. Showing that IHE in Malaysia is moving towards the global trend. The collaboration does not only function as a test bed but also provides an example to the local authorities involved in nationwide LCCF projects in contributing to carbon reductions (Zen, 2017b). This partnership form categorized under the ‘Openness’ criteria of Key Principles of Living Labs Approach (Ståhlbröst et al., 2013).

Considering the Living labs as an open and user innovation framework (Carayannis & Campbell, 2010; Almirall et al., 2012;

Schuurman et al., 2013), it creates a platform for collaboration with bigger and various actors or stakeholders. A form of collaboration such as public-private-people partnerships (4Ps), helps in operationalizing the firms, public agencies, universities, institutes and users (Westerlund & Leminen, 2011). The partnership provides co-creation of initiatives that benefit multi parties which shared the same goals. Furthermore, practical guidelines on how living labs should be managed on the levels of community interaction, stakeholder engagement and methodological setup to succeed in implementing living labs project as well as the creation of user-centre innovation were detailed by Veeckman et al., (2013). Finally, the study came up with a university living learning lab model as a comprehensive approach to addressing the role and function of the university which functions by creating the plausible pathway on the university living learning lab contribute to the Malaysia Educational Blueprint as well as the Sustainable Development framework. The four components are closely related and contribute to each other interchangeably, the success of campus as the university living learning lab has

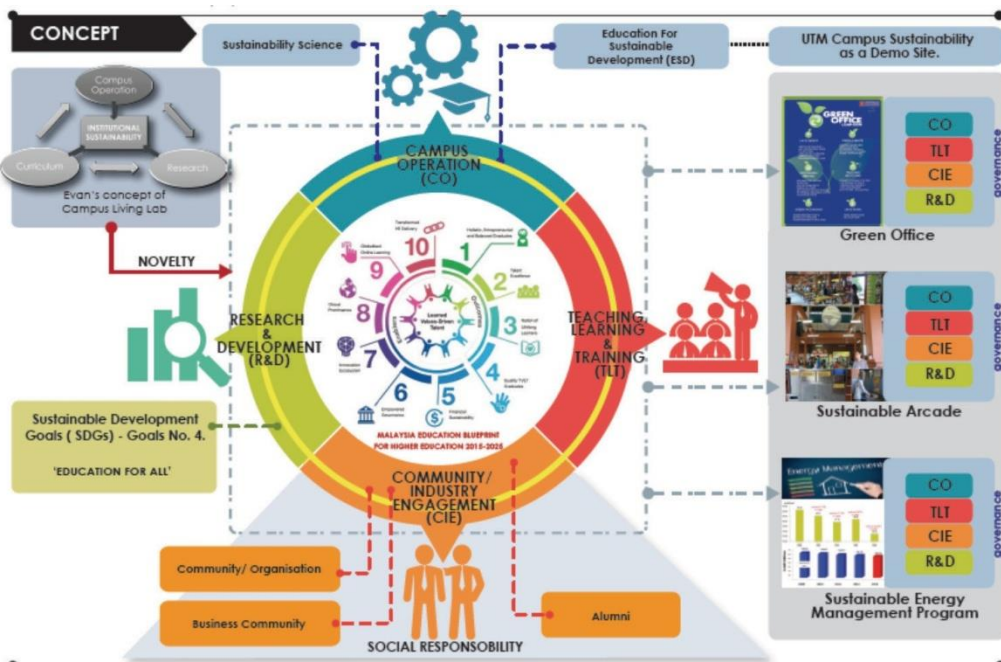


Figure 2: The transformative and integrative approach of the university living learning labs

a multidimensional and complex measurement. Upscaling the Living lab model for HEI in Malaysia specifically for sustainability has the potential to accelerate the high-income economic development and enhance the new Malaysia Educational Blueprint. The latest has been recognized in empowering the sustainability governance in terms of financial sustainability, innovation ecosystem and higher education delivery system. Finally, the improvement of campus living lab suggested from this study as present in Figure 2.

### ***Plausible Pathway of Campus Living Learning Labs with MEB HE Framework***

The study found out seven potential significant shifts out of the ten shifts of MEB HE framework. Out of the four outcomes stressed on MEB HE, Campus Living Learning Lab contributed to the development of 'Holistic, Entrepreneurial and Balanced Graduates' through the ESD approach and Students Centre Learning (SCL). For example, through experiential learning and hands-on learning (Pallot, 2009). Experiential learning was obtained from students' experience and involvement in a certain project such as in key initiatives of campus sustainability where students played an active role rather than passive (role) which was achieved from didactic learning (Pallot, 2009; Zen *et al.*, 2016; Zen 2017a). It contributed to providing an Innovation Ecosystem to the campus society which allowed more robust research output or campus as a research platform.

For the Global Prominence, the campus living lab networks have a greater chance for the global contribution as referred to the SDG 2030, the ESD approach as well as the quadruple helix innovation approach. Campus living learning lab has a significant contribution to '*Empowered Governance*' and '*Financial Sustainability*'. Implementing a new mechanism in the socio-environ-techno centric approach provide a platform to contribute to the carbon emission reductions (Zen 2017b). The students' involvement by using the sustainability science with a combination of issue/problem-based

learning will accommodate the inter-linkages of teaching education and research in the context of research in a real-world problem (Zen *et al.*, 2016). Hence, the living-learning lab framework creates a clearer picture of how the approach requires openness, influence, realism, value and sustainability (Ståhlbröst *et al.*, 2013). While the idea behind LLs contribution to the co-creation of innovative ideas is a brilliant source of transformative and integrative approaches, it should be recognized that they are also resourced constraints.

### **Conclusion**

This study develops an integrated framework of the university living learning lab which added the fourth element of community and industry engagement as part of the three elements of triangulation, which are research, teaching and learning and campus operation. It is to enhance the university's third mission of co-creation sustainability by using the university as a demo site and considers the several practices on sustainability in the University in Malaysia. The addition provides more enrichment in terms of results, robust result as well as a clear pathway on how the university living learning lab contributed to a bigger open innovation system. Hence, the 4Ps approach mode of collaboration is crucial. Furthermore, the third mission of co-creation for sustainability is strengthened by maximizing the internal capacity of research-teaching and learning - campus operation by using the PBL and PrBL as an approach in translating ESD in the University. Moreover, the application of sustainability science in the university living learning lab helps to facilitate inter-, trans-disciplinary and issue-based approach by using the new academic learning innovation such as PBL and PrBL application and open innovation. Finally, the campus living learning lab framework generation allows the synergistic interaction and response for each component where it shows the interdependence of four components; Teaching, Learning and Training, Research and Development, Campus Operation and Community Industry Engagement.

However, further study needs to be conducted to test the conceptual framework applied in the real world e.g. by using the framework method and other qualitative and quantitative approach.

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