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Heartware as a driver for campus sustainability: Insights from an action-oriented exploratory case study

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ABSTRACT

Literature on campus sustainability transitions is mainly focused on the hardware and software approaches, with less attention on the so-called 'heartware' approach. Heartware refers to the internal and voluntary motivation of the campus community itself to establish long-term collaboration and collective efforts for sustainability. The paper addresses this gap through an action-oriented exploratory case study research in applying the heartware approach for a long-term water conservation initiative at the University of Malaya campus in Malaysia. The case study research employed a triangulation of five types of data sources (documentation, archival records, direct observation, physical artifacts and participant observation) and two analysis techniques (iterative explanation building and time-series analysis). The case study demonstrated that the heartware approach can be an essential driver for campus sustainability, with suggestions on three ways it can be exercised: (1) Community-shared values that can inspire collective and voluntary action on campus; (2) Role of volunteers within the campus community, at various levels of power, in galvanizing efforts; (3) Heartware driven adaptive governance - where the campus community is able to self-maneuver in mediating conflicts that can possibly block long term action. The paper concludes that there can be aspirational ways to view our campuses: as a living community with concerned citizens, rather than just a complex organization to be managed. This might open up more rooted solutions for campus sustainability than what is currently available.

1. Introduction

Sustainability is about how communities at various scales of society envision and pursue social, economic and ecological well-being. This includes the campus community. As highlighted by the The Association of College Unions International (2008), "community is a broad vision for campus life that allows all groups and individuals to learn and develop to their best potential in a challenging, yet safe environment" (Harrington, 2014). Although this sense of community is increasingly taking a back seat in the age of university rankings and corporatisation (Weingart and Maasen, 2007), it is nevertheless encouraging that a number of scholars have been working to revitalize this perspective as a healthy counter-balance to prevailing trends (Boyer, 1990; McDonald, 2002; Willett, 2013; Willits and Brennan, 2015).

From a community perspective, campus sustainability as an area of sustainability research has a crucial role to play in articulating the ways in which campus communities are crafting a sustainable vision of the future, deliberating on the visions and values they represent and exploring the potential pathways that might realize such a vision (Miller et al., 2011). It is a vital area of research considering the significant role of universities in shaping worldviews, training of human capital and generating new knowledge for sustainable development (Cortese, 2003; Stephens et al., 2008; Ferrer-Balas et al., 2010; Stephens and Graham, 2010; Leal Filho,

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2011; Karatzoglou, 2013).

In line with this realization, a number of universities worldwide have been engaged in transforming their campuses to become more sustainability-oriented. Based on past review papers by Lozano et al. (2015) and Karatzoglou (2013), areas of transformation include education, research, community outreach, campus operations, assessment and reporting, institutional policy and framework and on-campus experiences. More recently, there is a trend to use universities as the loci for Living Labs (Evans et al., 2015) and as a micro-level exemplar for sustainability transitions (Stephens et al., 2008; Stephens and Graham, 2010).

Traditionally, literature on campus sustainability has been mainly focused on the management of structured processes which have resulted in the proliferation of strategic management guidelines (ISCN, 2016), toolkits (Disterheft et al., 2012; UNEP, 2013), handbooks (IARU, 2016), tools (ULSF, 2008), rating systems (AASHE, 2015), ranking systems (Suwartha and Sari, 2013) and framework proposals (Lozano, 2006; Comm and Mathaisel, 2003) to guide campus leaders in facilitating their sustainability journeys. The emphases are mostly on hardware and software approaches - hardware in the form of scientific and technological solutions, and software in the form of strategic management of human resources and institutions, including policy and legislation.

Fewer authors have dealt with what we refer to in this paper as the 'heartware' approach to campus sustainability, which pertains to the internal and voluntary motivation of the campus community itself to establish long-term collaboration and collective efforts for sustainability. In this paper, the authors proposed that the heartware approach can be used to provide a more organic foundation for campus sustainability efforts - in addition to the more structured hardware and software approaches referred to earlier. Thus far, the heartware dimensions of campus sustainability were seldom highlighted, although the role of local communities as a driver for sustainability have been generally recognized and promoted since Agenda 21 was launched in 1992.

This paper was designed to address this gap through a review of the subject, plus via concrete empirical insights from the authors five years' experience in applying heartware strategies as a part of the campus sustainability efforts at the University of Malaya (UM). The main objective is to investigate the extent to which the heartware approach can drive the process of campus sustainability transitions within the context of a Malaysian campus. It is based on the broad research question on whether a heartware approach is relevant for campus sustainability? If yes, how so and why?

The work was inspired and developed from our initial work on the so-called 'heartware' governance approach for integrated watershed management under the 'Asia Core Programme on Risk-Based Asian Oriented Integrated Watershed Management' (ACP-IWM), a bilateral research consortium between Malaysian and Japanese researchers. The approach was later adapted to Water Warriors, a campus sustainability grassroots movement on water conservation efforts at the UM campus since the year 2013. The paper describes how our experience in applying this heartware approach has been a strengthening factor in resolving water conservation issues in the university, and discusses important lessons learned to date. These theoretical and empirical insights can hopefully provide renewed appreciation on heartware (in addition to hardware and software approaches) as an essential ingredient for the long-term sustainability of campus sustainability efforts.

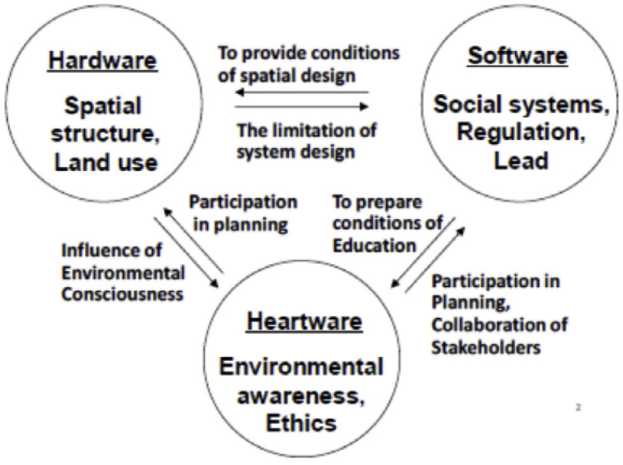
This paper consists of six sections. Section Two reviews the concept of heartware from two perspectives: a review on how the concept of heartware was originally defined and evolved from the literature on environmental planning and lake management (subsection 2.1) and how far heartware can be applicable and has been addressed in the field of campus sustainability (subsection 2.2). Section Three explains the research approach and its implementation. Section Four describes the key empirical findings, followed by discussion in Section 5. Section 6 concludes the paper.

2. Heartware as a driver for campus sustainability

2.1. Heartware as an emergent concept in watershed conservation

The paper's perspective on 'heartware' was derived from the introduction of the concept by the co-chair of the governance group[1] of the ACP-IWM consortium who was an expert in Integrated Lake Basin Management (ILBM). ILBM is a governance framework to achieve sustainable management of lakes and reservoirs through gradual, continuous and holistic improvement in the governance process (Nakamura and Rast, 2011). In this approach, good governance may require plans that go beyond conventional scientific analysis. While the importance of science in preserving the natural environment cannot be disputed, the sustainability of a lake watershed may not depend on scientific and technological knowledge alone, but also on carefully dealing with the diversity of non-tangible values that humanity places on nature and their complex relationship with each other. To this end, the budding notion of 'heartware' began to receive greater attention in the practice of ILBM over the years.

In terms of its genesis, the term 'heartware' was inspired by Harashina (1996) where it was initially used as the third leg of effective environmental planning for cities; in addition to hardware and software approaches (Fig. 1). He asserted that effective environmental planning requires dynamic interaction and overlay between three components - hardware, software and heartware. Hardware consists of the physical fabric of a city, i.e. land use and spatial structures. Software consists of sets of rules in the form of social system/institutions, regulations and laws. Heartware is an emotional mechanism – the behavior and conduct of individuals - which determines their needs, wants and wishes and the process by which their interaction with the surrounding environment takes place. He emphasized that heartware is driven by one's



Source: Harashina, 1996

Fig. 1. The three types of wares in environmental policy measure. Source: Harashina (1996).

[1] The consortium was divided into four main groups: (1) Hydrology (2) Water Quality (3) Risk Management (4) Governance.

environmental values, ethics, and norms, which are essential to build consensus for the future. A good heartware foundation would lead to increased public support for the software and hardware legs of environmental planning and the cyclical strengthening of the three '—wares' over time.

The ILBM practitioners (as mentioned earlier) then adopted Harashina's hardware-software-heartware framework in their ILBM Platform Process Framework (Fig. 2). In the ILBM literature, heartware can be generally defined as a form of "organic interventions by local communities that are driven by internal and voluntary motivation", while hardware refers to "systematic improvements through science and technology" and software as the "strategic management of human and social systems". A good heartware-hardware-software foundation can ideally drive an upwardly spiraling governance process towards solutions that are more politically sustainable in the long run (Nakamura and Rast, 2011). The words 'ideally' and 'more' are important, in that they recognize that sustainability is a long-term social goal which can never be perfectly achieved and is a continuously messy and contested process. In this sense, the ILBM platform process is an aspirational, dynamic and evolutionary framework, and is not meant to be viewed in a rigid, linear manner. It is akin to the broader evolutionary idea of sustainability transitions (Markard et al, 2012), but within the specific interest in lake governance. Similar to Harashina, the ILBM platform process also highlights the non-tangible and catalytic effect of heartware, but with emphasis on the role of local communities and stakeholders (Nakamura and Rast, 2011; Silva, 2014a, 2014b) - going beyond Harashina's focus on individual drive and action.

The attractiveness of the ILBM cyclic approach is two-pronged. First is the explicit integration of heartware together with hardware and software as essential elements in sustainability transitions that can cyclically enhance each other. Generally, the broader sustainability literature does recognize the importance of all three elements but tends to deal with them separately. Although the gap between hardware and software are increasingly reduced through the active role of technocrats in the policy making arena, investigations on Heartware are usually dealt with separately by researchers in the social sciences and humanities (Hezri, 2014). Second is the open embrace by ILBM scientific and technical community in tackling the non-tangible nature of heartware. This can be unique due to the collective appreciation of the ILBM/ACP-IWM epistemic community on the need to tap into Asian-oriented community spirit, local knowledge and cultural-spiritual-religious traditions as drivers for watershed conservation. The word "heart" was felt to have a special significance in the Japanese and Bahasa Malaysia language and it resonated naturally to members of the consortia when it was first suggested. As a result, the heartware-hardware-software framework was intuitively viewed as a plausible conceptual framework, even with the lack of concrete working definition and empirical underpinning when it was introduced. This opens up a unique opportunity for researchers to explore the approach.

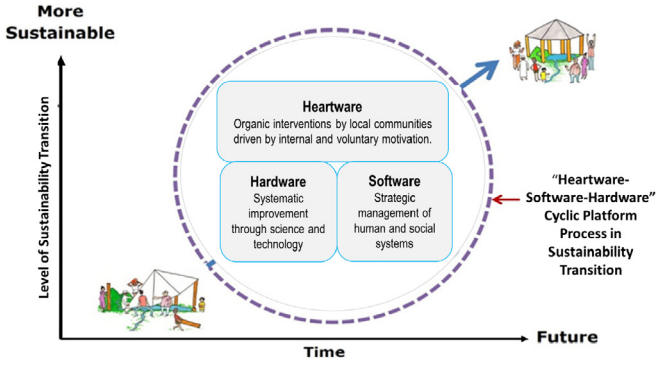


Fig. 2. The "Heartware-Software-Hardware" cyclic platform process framework source: Adapted from Nakamura (2013).

It must also be highlighted that appreciation of the Heartware concept by the ILBM/ACP-IWM epistemic community was significantly influenced by the work of Yukiko Kada, a well-known Japanese environmental sociologist. Kada's work was fundamental in highlighting that Heartware qualities are already embedded in the shared values that have evolved in the life of ordinary people in Japan for centuries – be it in the form of local culture, traditions and norms. Her intellectual project was to facilitate the Japanese community to see these as valuable, and to re-identify with these fading/faded shared values as a way to enhance current efforts in environmental conservation (Mohamad et al, 2015). When Kada eventually became the governor of Shiga prefecture, she played a fundamental role in incorporating these community shared-values more tangibly in the governance of Lake Biwa – particularly through her leadership role in the conservation and improvement of the lake (Kada, 2003). Subsequent empirical work on Lake Biwa has also provided evidence on the empowerment of community shared-values in various areas of the Lake Biwa watershed, and their positive contribution to the sustainable management of the lake (Ide, 2005; Nagai et al., 2014; Suzuki, 2014; Shimagami, 2014; Takahama, 2014; Takashi and Uitto, 2004; Watanabe, 2011; Nakamura et al., 2012).

The authors of this paper were inspired with the Lake Biwa case and attempted to experiment with the heartware approach in the Malaysian context since the year 2013 – which also included water conservation efforts at our own campus ground at the University of Malaya. We used the "Heartware-Software-Hardware" Cyclic Process Platform (See again Fig. 2) as our working framework.

2.2. Heartware as a driver for campus sustainability

Exploring the role of Heartware as a driver for campus sustainability is in line with increasing recognition that, over the next decade, researchers must strengthen their scholarship by developing and applying a more refined understanding of the organic roles of values, ethics, culture and politics in decision-making for sustainability (Kurland, 2011; Adomβent et al, 2014; Wals, 2014; Hugé et al, 2016) Nonetheless, investigations into how society apply such an understanding to guide socio-technical change according to their normative vision are relatively unexplored in sustainability research (Miller et al., 2014).

The campus sustainability literature is of no exception. Most empirical studies on campus sustainability transitions strategies mainly placed their emphasis on the more tangibly manageable hardware and software approaches of campus sustainability - while the organic role of the so-called 'heartware' approach suggested in this paper is more obscured in most analyses. For instance, in a review by Lozano et al. (2015), the only category that can be related to the heartware aspect of campus sustainability was under the "on campus experience" category, which refers to activities related to inter-faculty working groups, student experiences and employee engagement. Only two (Ferrer-Balas et al., 2004; Lozano et al., 2013) out of sixty papers that they reviewed had specifically covered this particular aspect of the literature, demonstrating the extent to which this aspect is under-explored.

Interestingly, exploration of the Heartware approach to campus sustainability is emerging, with different questions being raised. We will review several examples in this paper. In 2015, Disterheft et

al. advanced the idea that 'participatory approaches' can positively contribute to the integration of sustainability concepts into the university culture. However, they argued that "so far there have been comparatively few research studies on participation within sustainability implementation at the university level" and a more differentiated understanding of these processes is still missing. The paper addressed some of the failures and successes experienced within participatory approaches in campus sustainability initiatives, and deduced a set of critical success factors that can help to integrate the dimensions of participation more inclusively in the process. One of their key findings was that the success of participatory approaches is interdependent with the persons engaged in the process - highlighting the importance of change agents, especially their specific skills and participatory competencies.

Krasny and Delia (2015) dealt with the idea of 'nature stewardship' as a part of the campus sustainability agenda, and how this can influence broader processes on campus sustainability in the long run. They responded to the scant attention given to the dimensions of human–nature relationships in the campus sustainability literature. Their findings demonstrated that nature-based stewardship provides direct benefits to the campus environment in several ways. It enhances students' sense of place, plays a role in students' mental well-being and fosters conservation behavior. Their findings provide indications that nature-based stewardship provides a complement to other aspects of sustainability, such as those focused on reducing consumption and energy use, and supports a holistic approach to overall university sustainability initiatives. Croog (2016) addresses similar concerns, but from a different angle. Using a 'just sustainability' framework, she explored the broader socio-spatial context of a university as well as the emotional and relational realms of fostering more sustainable socio-ecological assemblages. Her empirical findings revealed that campus grassroots sustainability actors possess important knowledge for understanding how sustainability can be a tool for restoring emotional affinity with the environment as well as for enacting transformative socio-ecological changes in the urban university context and beyond.

Finally, another relevant paper was by Brinkhurst et al. (2011) in investigating the dynamics between top-down (administrative planning, policy making and assessment) and bottom-up (student-led campaigns) leadership in organizational change towards environmental sustainability. Their purpose was to investigate the leadership roles of the institutional "middle" that are usually neglected in the "top-down" or "bottom-up" dichotomy. Based on empirical investigation of several universities in Canada, faculty and staff members were found to be critical leaders in efforts to achieve lasting progress towards campus sustainability, and conventional portrayals of campus sustainability initiatives often obscure this. This change needs to be refreshed and replenished continually, and it is the faculty and staff (who make up the long-term campus population) that are critical for long-term institutional change. Using the concepts developed in business and leadership literature, the authors regard faculty and staff as universities' equivalent to social "intrapreneurs", i.e. those who work for social and environmental good from within large organizations.

3. Research strategy

The authors of this paper aim to expand upon the reviewed literature by applying the "Heartware-Hardware-Software cyclical platform process" as the analytical framework to explore the role of the heartware approach in driving the process of campus sustainability in the context of water conservation management at UM. The study is based on a 5-year (2013–2017) action-oriented exploratory case study research of Water Warriors (WW), a grassroots movement on water conservation at the university. Box 1 provides a brief description of WW. The following subsections describes the research approach used, and how data collection and analysis were conducted.

Box 1
Water Warriors as a grassroots campus sustainability movement

Under the purview of the volunteer-based University of Malaya Environmental Secretariat (UMCares), WW is a grassroots campus sustainability movement being run by a group of student, staff and alumni volunteers on campus. The group applies the integrated "Heartware - Hardware - Software" approach to assist the university in the sustainable management of water bodies – beginning with Tasek Varsity Lake, the main lake located at the heart of the campus. WW started as a bottom-up movement in 2013 through the financial support from UMCares, and intellectual support from ACP-IWM research consortia (described earlier). Since then, it has organically grown into a full-fledged campus sustainability Living Lab under the university's Sustainability Science Research Cluster, covering overall water management on campus.

3.1Research approach

The research is a combination of an exploratory case-study and action-oriented research. Case study deals with an empirical enquiry that investigates a contemporary phenomenon in-depth, within its real-life context (Yin, 2003). It is also exploratory in nature, in the sense that it precedes the more conclusive research, allowing the researcher to become familiar with concept or problem to be studied: in this case, the concept of 'heartware' and the problematique of applying it in the context of campus sustainability.

In addition, elements of action research (AR) were also combined in the study – and therefore, it is considered as "action-oriented". The AR approach challenges traditional social science by moving beyond reflective knowledge created by outside experts sampling variables, to an active moment-to-moment theorizing, data collection and inquiry occurring in the midst of an emergent structure. AR draws on the paradigms from critical and constructivist theories that view knowledge as being constructed based on the interaction between the observer and the phenomenon being observed (Reason and Bradbury, 2005).

This strategy of combining research and action is quite similar to the 'community arena' approach suggested by Wittmayer and Shapke (2014) in the way that action research was applied to improve the process of sustainability transitions in a particular community. The ultimate objective of the research was to better understand the internal and external contexts that influence the ability of individuals and local communities to deal with sustainability challenges, while facilitating and learning about processes that can enhance their transformative potential towards sustainability. However, unlike Wittmayer and Shapke, the AR project was not thoroughly undertaken. Although the decision to experiment with the heartware approach was made from the beginning of the authors' involvement in WW, the decision to systematically analyse the journey was only made about a year later, with no systematic AR design in place. The case study instead used a triangulation of data collected until the end of 2017. However, recognition of the "action-oriented" nature of the research is necessary because the

authors were directly involved in driving WW's campus sustainability activities since 2013 to the present time. As shown in Table 1, all the authors are volunteers under Water Warriors (Box 1) and have played various roles throughout its evolution.

3.2. Data collection and analysis

The research triangulated five types of data sources that are usually employed for a case study research: documentation, archival records, direct observation, physical artifacts and participant observation (Yin, 2003). Box 2 provides a brief description of how these data sources were used in the research. The data was collected between the years 2013–2017.

An iterative explanation building technique was applied for the analysis, in which the goal is to build an iterative explanation of the case, in order to establish a set of observations and relationships. This strategy is considered suitable because the relationships between factors are more complex and difficult to measure, due to the exploratory nature of the research question. Additionally, the research also employed a simple time-series analysis technique, in which the data is analysed according to the time sequence. The ability to track changes over time is very important as it enabled an evaluation of whether there was a significant impact in the way that the heartware strategies drove the process of campus sustainability transition at different time periods. The findings have been shared and vetted by the research team and key actors in the water conservation efforts on campus.

Finally, it is important to acknowledge that the use of case study method can raise the question of generalizability i.e. whether the findings are useful for other contexts. There are ongoing debates on the deluge of case study research in the campus sustainability literature that does not live up to its potential for improving empirical practice in the field (Corcoran et al, 2004; Dillon and Reid, 2004; Barth and Thomas, 2012). Important to emphasise here that the exploratory and action-oriented case study research in this study does not offer such claim for generalizability - but aims to provide its contribution through grounded, in-depth empirical insights to inspire future theoretical and empirical work.

4. Case study: watershed conservation as a campus sustainability initiative at the University of Malaya (2013–2017)

In this section, results of the analyses will be arranged in the form of a longitudinal narrative of the main processes of the grassroots movement in water conservation at the UM campus for the past 5 years (2013–2017). It briefly summarises the key heartware, hardware and software activities throughout the years. Salient features of the analysis will be coded and analysed accordingly: [A] for Heartware, [B] for Hardware and [C] for Software. The empirical data will be used to assess the extent to which the heartware approach has enabled the growth of the hardware and software approaches in the cyclic platform process. The analysis is summarized in Table 2, and described in the following subsections.

Box 2
Data sources used in the research

(a) **Archival records**: Collection of historical records through WW FB Page (https://www.facebook.com/umwaterwarriors) and e-mail exchanges (archived in Gmail) between 2013 – present.
(b) **Documentation**: Various documents including WW website, reports, minutes of meetings, presentations slides, conference papers, conference posters, brochures and news clippings.
(c) **Participant observation, direct observation and physical artifacts**: These three types of data are used during the author's continuous observation of the transition process, based on their role as WW volunteers/staff.

4.1. 2013: Building the heartware foundation through community shared values

The beginning of the UM Water conservation heartware activities began when WW (see Box 1 and Table 1) was established as a grassroots movement by a community of student alumni and staff at UM [A1]. Inspired by citizen science activities in Japan, WW began by training student volunteers as citizen scientists to conduct water monitoring activities on their immediate surroundings. [A2] The Varsity Lake, the only lake within the campus, was chosen as one of the training sites. The water quality assessment revealed that the lake was highly polluted.

WW took the initiative to informally discuss the issue with the main stakeholders of the lake: The Department of Development and Estate Management (JPPHB) and the Sports Centre [A3]. From the discussion, key issues were revealed, i.e. unclear ownership of the lake, suspicion of a nearby Faculty being the main source of pollution and concerns by the Sports Centre on whether water-based recreational activities at the lake will be forced to discontinue. It was apparent that there was a lack of vision, cooperation and trust among the key stakeholders. Consequently, the appointment of a new Deputy Vice-Chancellor of Development (DVCD) who had a larger vision of 'campus development' to lead JPPHB at this time provided a new impetus to the movement. Being a horizontal leader, he was keen to meet the campus sustainability volunteers, including WW, to discuss the ways forward. WW highlighted problems associated with the lake and proposed possible solutions based on the three '-wares' derived from the ACP-IWM research experience: Hardware, Software and Heartware. The suggestions were received positively by the DVCD, but no

Table 1
Roles of researchers in Water Warriors and their period of involvement.

Name of researchers	Roles	Period of involvement
Affan Nasaruddin	Co-Founder/student volunteer/Project officer	2013 – present
Siti Norasiah Abdul Kadir	Co-Founder/alumni volunteer/Research assistant	2013 – present
Zeeda Fatimah Mohamad	Staff volunteer/Co-Researcher/Principal Researcher	2013 – present
Nobumitsu Sakai	Staff volunteer/Co-Researcher	2013–2015
Halim Sulaiman	Staff volunteer/Principal Researcher/Co-Researcher	2015 – present
Mohammad Shahrul Amin Mohd Salleh	Student volunteer/Research assistant	2013 – present
Fathiah Mohamed Zuki	Staff volunteer/Co-researcher	2015 – present
Hazreena Hussein	Staff volunteer/Co-researcher	2016 – present

Table 2
Evolution of Heartware alongside Hardware and Software approaches of Water Conservation Initiatives at University of Malaya (2013–2016).

	Heartware approaches [A]	Hardware approaches [B]	Software approaches [C]
2013	A1. Volunteer movement by alumni and staff. A2. Communal activity via citizen science A3. Informal stakeholder engagement A4. Awareness building via heritage video in social media. A5. Heartfelt motto A6. Open communication and feedback A7. Informal multistakeholder deliberation		
2014	A8. One staff member joined as core volunteer A9. Open communication and feedback A10. Re-introducing life A11. Communal activity via *gotong royong* A12. Awareness building via artwork A13. One-off symbolic event: Re-launching event & symbolic gesture by a respected figure	B1. Research & monitoring programme. B2. Infrastructural improvements B3. Technological innovation	C1. Policy: First formal multi-stakeholder meeting C2. Policy: Initiation of an official conservation programme C3. Policy: Conservation as prioritized agenda C4. Policy: Concrete action plan C5. Regulation: Specific issue guideline (responsible construction practices)
2015	A14. Communal activity via *gotong royong* enhanced. A15. Communal activity via community festival A16. Communal activity via citizen science and environmental education programmes enhanced.	B4. Research and monitoring programme. B5. Remedial action B6. Infrastructural improvements	C6. Institutionalization: Grassroots movement formally upgraded as a Living Lab. C7. Funding: short term financing C8. Human capital development: grassroots volunteer formally employed. C9. Regulation: Park codes developed for the lake
2016to 2017	A17. Communal activity via *gotong royong* expanded A18. Communal activity via citizen science expanded. A19. Awareness building via environmental education A20. Two staff members joined as core volunteer	B7. Research and monitoring programme expanded. B8. Technological innovation B9. Infrastructural improvements B10. Remedial action	C10. Policy: First multi-stakeholder review and long-term visioning meeting C11. Funding: Long term financing C12. Institutionalization: Expansion of Living Lab's responsibility

clear commitments were made.

Inspired by the use of traditional local shared values to drive the heartware of Lake Biwa in Japan, WW experimented with a similar strategy to be used in the context of Varsity Lake. To establish the groundwork, WW produced a YouTube heritage video entitled 'Varsity Lake, University of Malaya: Then and Now'.[2] The video became popular in the internet, and sparked public conversations on the future of the lake[3] [A4] In time, the WW Facebook page also began to attract feedback from staff and alumni of the university who were around during the lake's heyday. The lake was increasingly regarded as a valuable heritage, and open support for its revival and long-term conservation increased. After watching the video, the DVCD was quoted as saying: "When I saw how the lake looked in the past, it brought tears to my eyes! Simply said, the lake needs to be fixed.". The video also popularized the motto: "*Tasek Varsity Lake* as the Heart of UM" due to its location at the heart of the campus. [A5]

From then onwards, the DVCD with the support of WW began reporting the condition of the lake through the campus mailing list, thereby raising community receptiveness for solving the pollution problems. One of his e-mails was titled: 'Ailing Lake & Heart Breaks: We will fix it *InshaaAllah* (Local expression for God willing)' [A6]. A month after the meeting, however, the condition of the lake worsened, with more than 1000 fish found dead and floating on the lake surface. The dead fish were collected separately by JPPHB and the Sports Centre. At that point, it was evident that the two key stakeholders were not working well together. Being a technical entity, JPPHB had a strong "technical, quick fix" approach and wanted to start fixing the lake immediately. However, WW managed to convince JPPHB to postpone the idea and suggested instead that they lead a roundtable session with all relevant stakeholders to develop a more holistic and long-term solution for the lake [A7]. The suggestion was accepted.

[2] The video can be accessed from this Youtube link: https://www.youtube.com/watch?v=ZqmPk3t2gRY.

[3] Today, the video has approximately 7700 views.

4.2. 2014: Lake ReviVaL - integrating heartware, hardware and software approaches

Based upon the heartware foundation established in 2013, it was easier to encourage participation from the campus community to create more concrete hardware and software solutions. The first lake revival meeting was organized by JPPHB early in the year with an open call for interested stakeholders within the campus to participate in the effort [C1]. The DVCD code-named the project as ReviVaL (Revive Varsity Lake) [C2]. The meeting was attended by 34 interested individuals from various units. It was collectively decided that Project ReviVaL was to be divided into two hardware components: research and technical-fix, and one heartware component: bringing 'life' to the lake. In terms of software, project ReviVal itself was a large scale-conservation action plan for the lake undertaken by the university [C3] where JPPHB was determined to turn the lake into one of their top development priority in 2014 [C4]. During this period as well, an experienced ecology and limnology Professor joined WW as a core volunteer [A8].

Under the research phase, WW was to be supported by JPPHB to conduct monthly water quality monitoring for a period of six months based on the Malaysian National Water Quality Index (WQI) [B1]. It was found that the lake's current average water quality was at Class IV, i.e. polluted and not suitable for body contact. The lake was immediately closed down from water-based recreational activities. During the six months' research period, WW decided to probe further on an on-going building construction at the nearby Engineering Faculty, one of the lake's main sources of pollution. The team discovered construction workers living as squatters next to the building, where wastewater was channeled directly into the lake. In addition, a main sewage line was cut off during construction and sewage was directly discharged to the lake. Concerns about this were reported to JPPHB and immediate instructions were given to set-up a temporary sewage line. The situation was immediately explained to the campus community in the DVCD's e-mail entitled "The Case of Pollution at Lake Varsity" [A9]. A better guideline for contractors was put in place as a result of this investigation [C5].

In terms of a short-term technical fix, the lake was drained, dredged and desilted. As for the mid-term solution, JPPHB explored the possibilities of technically rerouting the drain as the main source of pollution from the lake to the nearby river [B2]. Concerns were voiced out by WW about cosmetically solving the problem without properly treating the pollutants before releasing the water from the drain to the river. The issue: in the efforts to *'save'* the lake, the river could be negatively affected. The DVCD decided to proceed with the original plan due to time and budget constraints as he felt pressured to complete the project before the Convocation Festival in September, 2014. He readily apologized and confessed that it was a difficult decision. However, all stakeholders agreed on the immediate installation of an artificial wetland and future fixing of the main sewage line as a long term strategy [B3].

Finally, as a complementary heartware approach, efforts were made to introduce 'life' into the lake. Ducks and local fish species were introduced in order to attract the community to view the lake as a space to connect with nature [A10]. JPPHB staffs were stationed at the lake as care-takers for the animals, and this gave them a sense of ownership towards the lake. Since then, they began to voluntarily participate in many lake-related programs. In addition, a communal clean-up session (locally known as *Gotong-royong*) was organized by WW to increase community participation and lake appreciation [A11]. The response was very encouraging - it was attended by about 150 volunteers among UM staff and students. The findings of the communal clean-up were astonishing: car clamps, shoes, toiletries, plastics etc. Some of the items were kept and later were made into a nature art collection named "Treasures of Tasek Varsiti". The artwork has been used to increase awareness of the campus community's poor waste disposal habits [A12].

After about a year of collective efforts under the Revival project, the effort succeeded in improving the lake's water quality from WQI Class IV to Class IIB (Suitable for aquatic species and recreational activities). The lake was finally ready for public use after being closed from any water-based recreational activities for about two years. For the first time, JPPHB and Sports Centre collaborated to organize this re-launching event. The DVCD was the first to dive into the lake as a symbolic gesture [A13].

At the end of 2014, an unexpected institutional shake-up occurred. Due to a new high level mandate by the Ministry of Education, a sudden reshuffling was made to the administrative structure of UMCares - the university's volunteer-based environmental secretariat that had provided financial and institutional support to campus level volunteer initiatives like WW. The secretariat was upgraded to become a full-fledged Community and Sustainability Centre. Morale amongst the former UMCares volunteers was significantly reduced. The voluntary, creative and independent nature of their activities didn't seem to go well with a formalized centre with its bureaucratic administrative structure, in spite of the university commendable ideals towards a more institutionalized sustainability approach.

4.3. 2015: Campus Sustainability Living Lab - surviving possible collapse

Nonetheless, due to the strong voluntary foundation of the UM campus sustainability initiative, the various staff volunteers who were involved in its evolution (including those who now has become members of the higher management) took the initiative to collectively reflect on the problem and to quickly seek ways to sustain the effort – especially in maintaining the survival of UMCares' flagship volunteer initiatives, including WW. As a result of this collective deliberation, the UM Living Lab programme was launched on April 2015 as a one-year trial solution. [C6] It was decided that the Living Labs would be jointly managed and funded by both the DVCD and the Deputy Vice Chancellor of Research and Innovation (DVCRI). This was the first arrangement of its kind at the university [C7]. The administrative responsibility of the Living Lab was temporarily given to the Sustainability Science Research Cluster, a unit under DVCRI. It was a smooth transition, mainly because key staff members of the research cluster also happened to be staff volunteers of UMCares, the former volunteer-based environmental secretariat. Under this Living Lab programme, WW was formally institutionalized as an action-oriented research entity. This enabled the young co-founders to be employed as research assistants, and one student volunteer to be appointed as a junior research assistant [C8]. It also enabled the enhancement of WW's research and monitoring activities at the lake [B4]. Fig. 3 provides a visualization on how WW was positioned in the campus sustainability network before and after the restructuring in 2015.

A few weeks after the lake re-launching ceremony, an unexpected problem occurred. A sudden 'attack' by an invasive weed species was detected at the lake, covering 25% from the total lake surface. This reduced water quality and hampers recreational activities at the lake. WW suggested two solutions: manual harvesting and biological control [B5]. Driven by a stronger heartware foundation - WW, JPPHB and Sports Centre voluntarily joined efforts to quickly resolve the problem. Since then, more voluntary collaborations took place – which demonstrated a strengthening of heartware among the stakeholders. A new program called 'Responsible Lakers' was launched and co-organized by WW and the Sports Centre to continuously maintain the cleanliness of the lake and to encourage the community's sense of ownership. [A14] The program was conducted once every two weeks, providing the opportunity for the campus community to enjoy water-based activities while helping with the lake clean-up and collecting data on rubbish assessment. The 'UM Fishing Competition' events at the lake saw another close collaboration between JPPHB and Sports Centre through common interest in fishing [A15]. JPPHB also improved the public space value of the lake through various technical improvements [B6] and the introduction of a park code [C9]. Since then, the lake has been revived as a site for social gatherings, community events and recreation as it was in the past. Citizen science and environmental education activities were also enhanced [A16].

However, broader systemic problems, which were difficult to resolve in the short term, remained. For example, the problem of the nearby river overflowing into the lake during heavy rains could not be solved as long as the concrete structure of the channelized river was not changed. Also, the nearby sewerage system could also overflow into the lake. Fixing these big structural problems are very

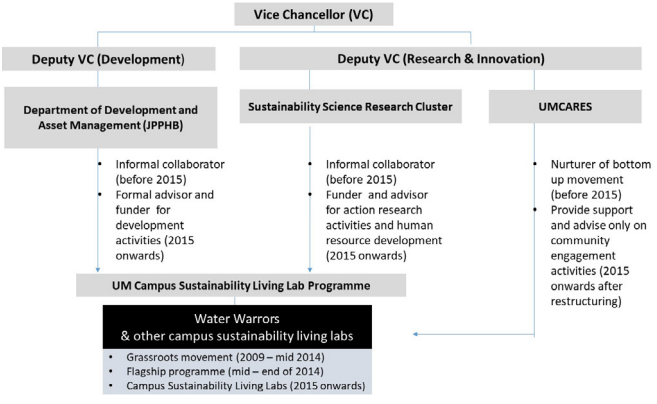


Fig. 3. Positioning of WW before and after the institutional restructuring of UMCares in 2015.

expensive and beyond the university's remit and jurisdiction, although the structures are located within the campus. Both the channelized rivers and the sewerage system are under the legal responsibility of federal level agencies.

4.4. 2016–2017: Living lab expansion to broader water management

In January 2016, a multi-stakeholder meeting was organized by WW to discuss the current state of the lake and its future visioning [C10]. Overall, the stakeholders agreed that the lake should now transition more sustainably, not only for recreation, but also in maintaining its conservational, historical and educational value. This led to the continuation and enhancement of research, monitoring, innovation and infrastructural improvement activities by the key players [B7,8,9]. However, during this meeting, ongoing problems were also detected even from solutions implemented under the ReviVaL project. This included increased pollution from landscaping activities and animal feeds. Immediate measures were eventually taken by reducing the number of ducks at the lake, reducing fish feed and using chemical-free fertilizers [B10]. More systemic issues involving federal level agencies were acknowledged, but these were recognized to take a longer time to resolve. The inclusion of WW in UM's budget under 11th Malaysia Development Plan for the water conservation on campus until the year 2020 is another clear commitment by the leadership to provide long-term support to the effort [C11]. One of the JPPHB civil engineers openly exclaimed at this juncture that the "The ReVival Project brought a new sense of vision for the lake and provided creativity to our development work. We should have more of this kind of projects."

In April 2016, it was decided that the pilot phase of the Campus Sustainability Living Lab programme was successful and will be continued as a new research programme for the university. The current management encouraged WW to expand its efforts by also looking into the issue of integrated water management on campus [C12]. The holistic aim was to translate the community's increased appreciation of water resources such as lakes and rivers with their day-to-day habits in water consumption. With regards to conservation of water bodies, the main aim for 2017 onwards was to expand the work beyond the lake to also include the rest of the campus watershed, which includes new technical/infrastructural improvements and policies supported by long-term community-based activities such as communal clean-up [A17], citizen science [A18], and educational programmes [A19] The vision is to ensure long-term integrated water management on campus to be taken up by the campus management by the year 2020. This new mandate inspired two lecturers from the Faculty of Engineering and Faculty of Built Environment to join WW as volunteer researchers to support the effort in early 2016 [A20]. The expansion has proven to be fruitful when UM was ranked at number 34 (from 619 universities globally) in the University Indonesia Green University Metric (Suwartha and Sari, 2013) for 2017. The 'water management category' was considered as one of UM's highest achievement.

5. Key findings and discussion

The longitudinal empirical evidence in Section 4 described how the Heartware approach has developed alongside hardware and software approaches to drive sustainable water conservation efforts at the UM campus. It has identified a list of strategies that have been employed under each approach that has successfully evolved over the years to enable campus sustainability transition in this context. Fig. 4 contextualizes the findings within the theoretical framework of the 'heartware-hardware-software cyclic platform process' introduced earlier in Fig. 2.

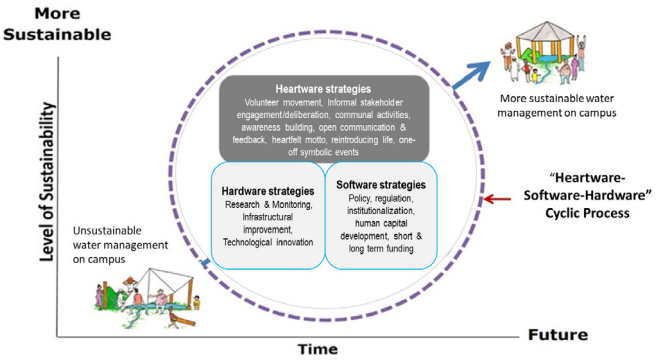


Fig. 4. Heartware strategies driving the cyclic platform process in the case study.

Based on this evidence, this section will narrow down the discussion on the heartware approach, and how the heartware strategies employed have driven the campus sustainability transition through the discussion of three key findings: (i) Cultivation of community-shared values through heartware strategies; (ii) Heartware as galvanization of community-shared values through multi-level collaboration; (iii) Heartware-driven adaptive governance to sustain transitions.

5.1. Cultivation of community shared-values through heartware strategies

In the beginning, the combination of two elements of traditional shared-values in the form of campus heritage and the spirit of being an alumnus to the university were powerful drivers in developing the initial heartware foundation for watershed conservation in UM. As the oldest university in the country, heritage is a unique shared value for the campus community. Hence, many parts of the campus, including the lake, have a long history. This created a deeper sense of belonging by the present generation when an awareness building exercise took place through the lake heritage video. In addition, the founders and almost all of the core volunteers of the grassroots movement were alumni of UM and were already active volunteers under UMCares, the broader campus sustainability movement which was initiated much earlier in 2008. This re-enchantment to traditional share-values and the inherent spirit of local community was similar to the heartware strategy observed at the Lake Biwa case in Japan.

Subsequently, building upon this existing heartware foundation, other forms of community shared-values has to be organically experimented and developed over the years through the movement's on-going activities in the cyclic platform process: These includes:

- Strengthening and renewing *dynamically strengthening* through the addition of core volunteers to address new challenges
- *Crafting symbolic meaning* about the lake by introducing a heartfelt motto and reintroducing 'life' to the lake.
- *Nurturing collective responsibility* through open communication and feedback, awareness building and informal multi-stakeholder engagement/deliberation.
- *Cultivating a sense of belonging* through continuous communal activities.
- Organising one-off events to provide shots of *heartware rejuvenation* to the cyclical process.

From this observation, one could observe that the use of

traditional community shared-values as a heartware strategy (Mohamad et al, 2015) can be useful to jump-start the heartware process, but may not be a sufficient driving force in the long run. Traditional shared-values need to be further complemented by new shared-values that are in line with on-going need and circumstances of the cyclic platform process. It is also important to highlight that the cyclic momentum for both hardware and software approaches was initiated after a yearlong effort to build the heartware foundation for water conservation. This lends support to the proposition by Jasanoff (2003) and Miller et al. (2014) that the role of values in the maneuvering process must be moved upstream in the sustainability efforts rather than be treated as an externality to be adjudicated separately and/or later.

However, there are limits to this finding that needs to be considered. The evidence gained is in the context of a case study that is predominantly place-based – meaning, it revolves around a sustainability issue connected to a natural area within the campus i.e. water bodies. Psychologically, it is relatively easier to evoke social and emotional connections to sustainability issues that are visible as a landscape, compared to less visible ones such as climate change and energy consumption. Krasny and Delia (2015) have provided a synergistic insight in dealing with this matter by arguing that nature-based stewardship can affect our commitment to broader areas of environmental conservation. Further empirical research is needed to build upon their promising claim.

5.2. Heartware as galvanization of community-shared values through multi-level collaboration

The potential of community-shared values to a heartware strategy to drive sustainable water conservation could only be actualized through the role of diverse members of the community, at different levels of power, in order to translate the shared-values into inspired action. Although the initial phase of the transition was led by individuals from the grassroots movement, this bottom-up initiative could not have made a substantial impact without the voluntary support of top-down leadership. It was only when the movement captured the imagination of the higher management that it was able to effectively move forward. The cyclic process was also supported by a unique multiple bottom-up, middle-ground and top-down positioning of the academic staff members of the grassroots movement. Their multiple positioning provided these individuals with the legitimacy as multi-level intermediary agents that have the flexibility to negotiate with actors at different positions.

In addition, three emergent features of multi-level collaboration which began to be cultivated through the grassroots movement and top-down horizontal leadership. New culture in inclusivity, egalitarianism and transparency provided a nurturing heartware environment for creative collaboration to take place:

- *Inclusivity*: For the first time, a bottom-up multi-stakeholder platform were set-up to develop a clear shared vision for water conservation, and to deliberate on what should be done collectively to achieve the vision. The action plans were executed after it received general support from key stakeholders.
- *Egalitarianism*: The transition was driven by a combination of a new style of horizontal leadership by the higher management and distributed voluntary activism led by the grassroots movement. This provided a dynamic environment for decision making.
- *Transparency*: The higher management together with the grassroots movement provided on-going updates about the progress of conservation efforts, and would openly entertain feedback from the community.

The findings are interesting because it opened up one's conventional understanding of top-down and bottom-up approaches for campus sustainability. As argued earlier by Brinkhurst et al. (2011), top-down does not necessarily have to begin from clear-cut campus sustainability policies approved by the very top, and bottom-up does not have to be associated with small changes. The two can be combined through middle ground changes or via 'social intrepreneurs'– referring to individuals working together inside an organization to develop and promote practical solutions to social or environmental challenges when progress is stalled by systemic failures. In this case study, the social intrapreneurs refers to the collective yet diverse roles of the deputy vice-chancellors, middle management, lower management, professors/lecturers, researchers, students and alumnus in organically maneuvering the direction of campus sustainability, both inside and outside of the formal process. This is also in line with the findings by Disterheft et al (2015) in their recognition of the important role of multiple change agents and their voluntary action within the campus.

5.3. Heartware-driven adaptive governance to sustain transition

Although community shared-values and multi-level collaboration were found to be effective drivers in strengthening campus sustainability transition - the longitudinal evidence clearly showed that the transition has the potential to break down due to shocks caused by conflicting perspectives, strategic miscalculations and unexpected challenges. In order for the transition to continue, such breakdowns had to be resolved in a timely manner. This occurred several times during this case study:

- First, was a conflict of priorities between the higher management and the grassroots movement about rerouting the drain from the lake to the river. Although the short- term solution decided by the former was received with much disappointment by the latter, the conflict did not cause a collaboration breakdown because the issue was transparently deliberated. The final decision was acknowledged by all involved. Appropriate apology was made by the higher management to reduce tensions.
- Second, was the unexpected institutional shake-up in 2015. A new bureaucratic set-up was not suitable to support the inter-institutional and organic nature of the campus sustainability initiative as initially envisioned. However, frank reflections and proactive self-organising efforts by different individuals in the university to creatively develop a new living lab programme proved to be useful.
- Third, a few months after the momentous re-opening of the lake, a massive eutrophication caused by an invasive weed species suddenly occurred. A study was carried out and different solutions were swiftly experimented by the key stakeholders. The solutions were successfully implemented through proactive cooperation.

The three incidences caused different types of shocks and required different collective solutions based on a strong heartware foundation of shared-value and trust. The first incident in conflicting policy perspective was resolved through the act of transparency, humility and compromise. The miscalculated institutional strategy of the second incident was resolved through honest deliberation and proactive efforts to restructure. Finally, an unexpected problem caused by the invasive species was addressed through timely research activities and proactive collaboration by multiple stakeholders to swiftly and effectively implement the

agreed-upon solutions.

The ability to face shocks and the social flexibility in dealing with them could be attributed to the stronger "heartware-hardware-software" foundation of the campus community. This has been termed in the broader sustainability literature as 'adaptive governance' (Chaffin et al., 2014) - the evolution of formal and informal institutions to increase the resilience in managing socio-ecological interactions in the face of uncertainty. From the lens of the cyclic process platform, the heartware dimension provides the informal strengthening of the process, but it has to co-evolve in a way that constructively supports the more formal hardware and software processes to follow through. This ability for adaptive governance is increasingly viewed to be an essential systems condition for long term sustainability transitions (Loorbach, 2010; Olsson et al., 2014) - but is currently not often investigated in the campus sustainability literature. Although there have been attempts on theoretical deliberations (Stephens et al., 2008; Miller et al., 2011; Stephens and Graham, 2010), empirical work at the moment rarely investigate the endurance of these formal and informal processes in the long run, and their co-evolution throughout the campus sustainability journey.

6. Conclusion

This research paper is a response to recent calls by contemporary researchers that more scholarly work is needed to provide constructive insights on the informal, participatory and organic dimensions of campus sustainability. As reviewed earlier, the current literature is still nascent in this regard, and careful reading of review papers on campus sustainability clearly show that it is a marginalized dimension compared to the more tangible and structured approaches. The contribution of this paper as a response to this call is three-pronged: conceptual, methodological and empirical. Conceptually, the paper introduced the concept of heartware to provide a more workable umbrella conception to address this aspect of campus sustainability more integratively. The heartware concept was then embedded within the "Heartware-Software-Hardware Cyclic Platform Process Framework" as an analytical tool to analyse this phenomenon in a dynamic and long-term manner. Analysis using longitudinal data from action research on water conservation at UM was then used as a case study to analyse the role of heartware in strengthening campus sustainability transitions. This can be considered as a novel conceptual and methodological attempt as it allows the analyses of formal (hardware and software) and informal (heartware) processes in campus sustainability transition as co-evolving entities. This action-oriented, cyclical and longitudinal approach of heartware research has yet to be attempted in the campus sustainability literature.

Overall, the empirical evidence from this research demonstrated that the heartware approach has been a strengthening factor to hardware and software approaches in campus sustainability transition. First, the findings identified different categories of heartware strategies that can be used to both revive traditional community shared-values and create new shared-values. Although these strategies were implemented in the narrow context of water conservation in a campus, the categories appear to be general enough to be experimented for other sustainability initiatives in other campus settings. The empirical evidence has also broadened our understanding that the use of traditional community-shared values is invaluable, but may not be sufficient in the long run; its effectiveness depends on how traditional values can be strengthened with new values that are more in line with contemporary circumstances. Second, community-shared values need to be translated into action in the form of inspired role played by members of the community, at various levels of power, in voluntarily galvanizing efforts for campus sustainability. This collective inspired action, however, could only evolved within a nurturing environment that had to be cultivated by top-down, bottom-up and middle ground actors - where principles of inclusivity, egalitarianism and transparency are widely exercised. Third, the research findings highlighted the role of heartware in enabling adaptive governance, where the community is empowered to collectively self-maneuver in mediating clashes of values that can possibly block long-term action.

In conclusion, the paper has provided grounded and in-depth empirical evidence that the heartware approach is an essential component for campus sustainability - not only as a strengthening factor to hardware and software approaches, but also as a necessary foundation to withstand the increasing complexity of the transition process in the long term. This paper, therefore, proposes that the heartware approach needs to be acknowledged and explicitly incorporated by campus sustainability managers and advocates to ensure a much more holistic strategy for the long-term resilience of campus sustainability efforts. Due acknowledgement on the importance of the heartware approach can equip those who are involved in the process with a more situated understanding about the power of local communities, and how this can enable the governance of campus sustainability to be more reflective and adaptive. In short, the paper highlights a more aspirational view of our campuses in the sustainability journey i.e. as a living community with concerned citizens, rather than just a complex organization to be managed - opening up the field for more rooted solutions than what is currently available.

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