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# BUILDING ENVIRONMENTAL ASSESSMENT TOOLS AND THE MULTI-DIMENSIONAL PATHWAYS TOWARDS SUSTAINABLE ARCHITECTURE

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## Summary

As the concepts of environmental architecture and sustainable architecture have continuously been evolving, the practice has opened to many interpretations, forming different schools of thought, and thus different models of strategies and approaches. It is observed that the natures of these approaches are diverse, and from time to time, inconsistent to one another. This has created a maze of fragmented strategies to the development of sustainable architecture.

The paper has taken the proposition that with the large coverage of issues and multi-facets of sustainable development, all the various contemporary practices are relevant and valid in one way or another, and all have contributions towards sustainable architecture development. Working along this perspective, a matrix of multidirectional pathways towards sustainable architecture will be constructed based on analyses and compilation of all the possible strategies from the approaches of three general fields of knowledge – socio-economics, architectural design, and building environmental performance.

Taking the established matrix as a milieu, the second half of the paper is to analyse and discuss the practice of building environmental assessment in relation to the multidirectional pathways towards sustainable architecture. By doing so, it is aimed to shed some insights to (1) the current roles, scope of influence, contributions and limitations of building environmental assessment tools in sustainable architecture design, and (2) the possible future development of such tool so that its practice can not only further contribute to the environmental performance of sustainable architecture, but also enhance its reciprocal relationship with the other two domains – architectural design and socio-economics (rather than confronting one another due to conflicts leading to compromises), for better integrated approaches towards sustainable architecture.

## 1. From environmental to sustainable architecture

The root of environmental concern in architecture lies on the relationship between human and the environment, and can be traced back for centuries, when early societies live closed to nature out of necessity and for survival (Jones, 1998). However, this practice has changed in accordance with the changes in worldview, which is 'Man is the measure of all things' (Lloyd Jones, 1998 quoting Protagoras) in the Renaissance. This worldview was amplified in the Industrial Evolution, when humans started to exercise resource- and energy-intensive activities for profit. The oil crisis in the 1970s triggered the green movement and formally brought back the environmental concerns in architecture, often known as 'environmental architecture'. The most recent development was the official definition of sustainable development at the 42nd UN Congress in 1987, from which the concept of 'sustainable architecture' derives.

The movement from ' environmental architecture' to ' sustainable architecture' has brought up many new challenges to architectural theories and practice. These resulted from an attempt to include the ' soft side' of social and economic factors, on top of the existing ' hard side' of environmental science facts and environmental responsive techniques and technologies. The practice of sustainable architecture has been opened to many interpretations, forming different schools of thought. As a general observation, there are three main fields of knowledge –Science (including Ecology and Building), Sociology and Architecture – forming the three domains engage directly in sustainable architecture – building environmental performance, socio-economics (including other aspects relating to users), and architectural design. The perspectives and contributions from these three knowledge domains are all relevant, but each places emphasis on one or two, but not equally all, domains of the issue. As observed by Clayton & Radcliffe (1996), the current large

number of literatures on sustainability from different professional perspectives are, on one hand extremely pertinent to the issue, on another hand 'disparate and often fail to connect to an underlying analysis that could link these suggestions together into a coherent rationale and programme for change'.

## 2. Three domains of sustainable architecture

### 2.1 Building environmental performance

Acknowledging the severe environmental impact of building development and operation, the practice of building environmental assessment emerged as a mean to encourage and to promote the development of environmental friendly building. Building environmental assessment methods provide many physical- and technical-based criteria to reduce environmental degradation as a result of building design, construction and operation. However, from an architectural perspective – where the 'loose fit […] between form and performance: a space in which cultural pressures can produce strange distortions' (Maxwell's foreword in Hawkes, 1996) – the practice of building environmental assessment methods are insufficient. The main reason is that the practice of building environmental assessment methods requires a pre-determined solution that is rectified through technical and physical means but does not reflect the user or occupant dimensions.

### 2.2 Socio-economics

Many factors from socio-economics have much implications to the environmental issues related to the built environment. By bringing these factors into consideration, the discourse of environmental built environment can begin to transform to the one of sustainable built environment. From a pessimistic perspective, the emergent socio-economic trends of affluence, consumption, mobility, smaller household structure, have scale down the endeavour towards sustainable built environment. Taking mobility as an example, resident moves have implicit implication to environmental and sustainable issues, by means of resulting in social instability and wasting environmental resources. Firstly, the outcome social instability from resident mobility lies in the resulted imbalanced demographical settings. For example, the immigration of younger people group to newer urban areas with attractions to newer facilities and modern lifestyle, leaves the older and less wealthy people groups dominating the older urban area. Such a demographical setting starts the process of degrading and making derelict the older urban area, resulting social unsustainability. Furthermore, resident mobility has also impact on the community ties and resident sense of belongings to a particular place; which once lost, make residents more 'careless' to their surroundings and the environment. Secondly, resident mobility will also lead to wasting environmental resources, through activities associate with housing renovation and personalization, and through making redundant the infrastructure and public facilities that have already been planed and developed for a certain population and demographical settings.

In response to the socio-economic constructed issues, there have been strategies from socio-economic approach developed and implemented to bridge the gaps occurring between user behaviours and sustainable objectives related to the built environment. These approaches include education, social incentive, economic incentive, and policy making.

### 2.2 Architectural design

What lacks in this environmental performance practice is the spiritual dimension from the built environment to motivate users towards sustainable lifestyle. As remarked by Kellert (1999), there is a need to positively reveal 'how sustainable development can foster a richer and more satisfying experience of self and community'. The issue of sustainability originates from a 'common theme; our alignment to nature – the relationship between her formative processes and ourselves. This is a spiritual, not a technical problem. At its rout lies disconnection' (Day, 2002). Therefore the issue of sustainable architecture should be rather approached from reconnecting the 'disconnection', in the other words bringing the values of aligning with nature to occupants through the built-environment, so that human physical and mental well-beings in connection with nature are promoted.

To this point, the question raised is how to make visible the spiritualist approach of architectural design. Hints to the answer can be found in the statement of Day (2002):

'We can address elemental principles 'materially' as conservation of resources, water and energy, and pollution minimisation (for air quality) […] (but) to nourish the human soul – and the ecological health of places – we need to balance and interweave earthiness, fluidity, airiness and thermal qualities. This is the 'soul' side of micro-climate design, building biology and ecological architecture. It is how 'sustainable' design can sustain us. It isn't about numbers any more. It's not just that 50 percent of energy, materials, waste, CFC and HCFC is a criminal price to pay for buildings. If buildings everywhere – not just those for 'greenies' – are for 'human sustenance', deeply and healingly, they must also be the environmentally responsible. If they are 'environmentally responsible' (fully and holistically) they must also sustain the human spirit.'

In doing so, several conventional distinctive approaches of the architectural professional that can undertake sustainable built environment issues, including spiritualist, qualitative, contextual, inclusive and innovative approaches (Cam, 2005).

## 3. A case of energy performance in Singapore public housing

In Singaporean housing context, it is perceived that two main factors have contributed to the success of public housing (Wong & Yeh 1985). Firstly, the slum living condition and the severe housing shortage in the 1960s led to the initiation of mass public housing development. Secondly, the planning and design of housing forms, housing qualities, and housing policies have continuously been evolved and transformed in response to the changes of socio-economic conditions. The coverage of public housing has changed from merely targeting very-low-income households in the 1960s and 1970s to including middle-income households since the 1980s. This evolution of housing development has kept the public housing stock flexible and adaptable through both the good and bad times, and thus become the major housing form, currently housing more than 85% of the Singaporean population.

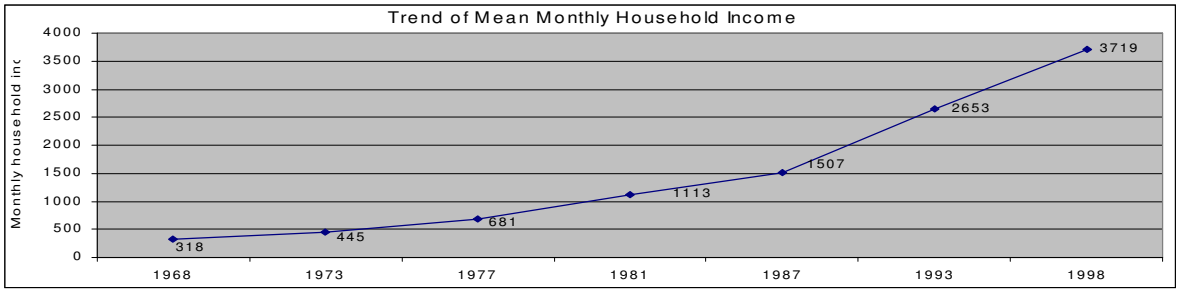


*Figure 1 Trend of Mean Monthly Public Housing Household Income (Source: HDB, 2000)*

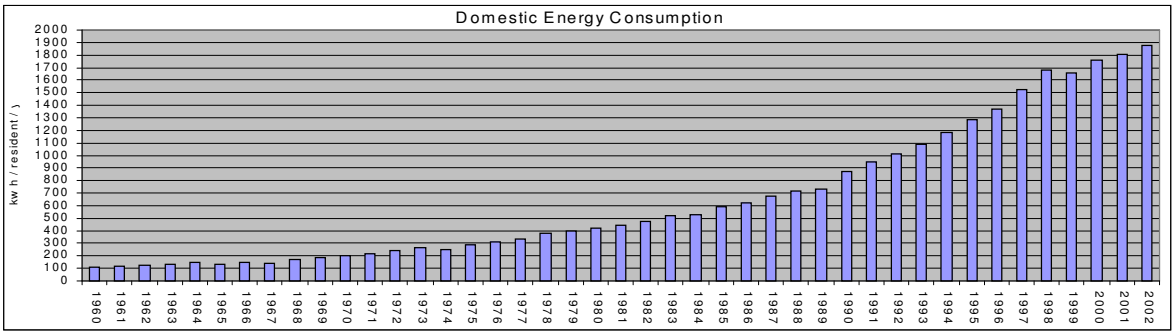


*Figure 2 Domestic Energy Consumption (Source: Compiled from Department of Statistic. Yearbook of Statistics Singapore. Various Issues)*

In the evolutionary process, there is an increasing trend of affluence of households in public housing since the 1960s (Figure 1). As society becomes more affluent, residents' aspiration changes and consumption increases. This happens in two aspects – owning of household appliances and energy consumption. When correlating the trend of household affluence (Figure 1) to the trend of energy consumption (Figure 2), there appears a concurrence between the two. However, over the evolution of public housing, there have, from time to time, been attempts to improve housing design in terms of environmental performances – natural ventilation, day lighting, and using low-energy lighting ballast – with objective to reduce the domestic energy consumption in public housing (HDB annual report 1967 & 1983). From environmental performance practice, the above practices are the main factors determining energy consumption performance of a building. However, from socio-economic perspective, it is resident affluence that leads to that ' we are buying more and more appliances for our homes, whilst industry is becoming ever more capital (and machine) intensive. This leads to a greater and greater energy demand' (Smith, Whitelegg & Williams, 1998).

In Singapore context, increasing energy consumption in public housing is often thought of as the increase in air-conditioner installation and usage to condition the indoor environment. From environmental performance practice, this phenomenon implies that the designs of public housing in later decades are less energy efficient. However, from the socio-economic perspective, the trend of resident affluence over the last few decades can also be the main cause for increasing domestic energy consumption.

On the other hand, statistic data on ownership of air conditioner by public housing flat type (Figure 3) indicates that higher percentage of households in larger flats own air conditioners. There are two propositions to elucidate this phenomenon. The first one is that households in larger flat have higher income (Figure 4) and thus are able to afford air-conditioner in compared to those households in smaller flats. The second proposition is that, in compared to the smaller public housing flat size, public housing of larger flat size has less indoor environmental quality, i.e. natural ventilation and thermal comfort, which forms the driving force for increasing air-conditioning usage.

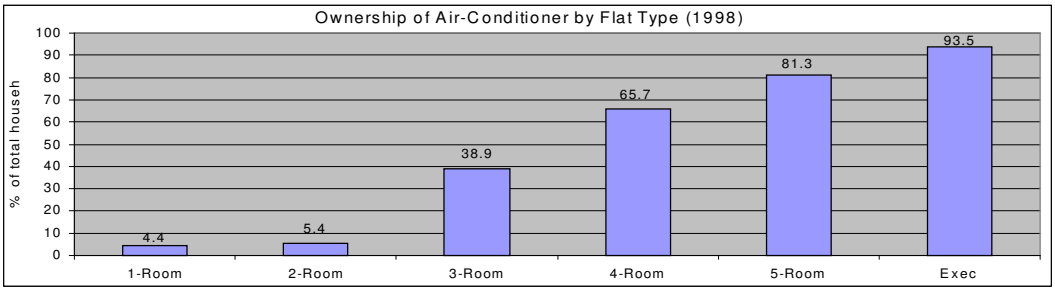


*Figure 3 Ownership of Air-Conditioner by Flat Type in 1998 (Source: HDB (2000)*

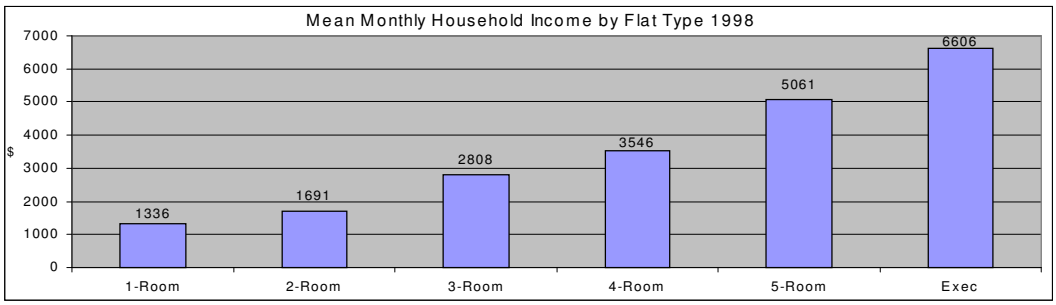


*Figure 4 Mean Monthly Household Income by Flat Type (Source: HDB 2000)*

Although there have not been studies to verify the actual progression of environmental performance trend of various public housing designs through times, or the performances of indoor environmental qualities among different flat types, the above two correlating settings show the tendency of the considerable impact of resident affluence to energy consumption, bypassing the environmental performance of the physical environment. This initially poses questions to the effectiveness of the approach from physical built-form improvement per se in attempt to reduce the operational energy consumption. What have not been included are the influencing factors of resident's habits and usage patterns. These user-related factors are much influenced by the socio-economic context – in terms of increasing in demands for comfort and entertainment. The focus on environmental performance per se has least, if not no, room for discussing or at least considering these qualitative considerations.

## 4. Matrix of multidirectional pathways towards sustainable architecture

The approaches towards sustainable architecture, as analysed in session 2, are diverse and even inconsistent to one another, due to certain assumptions and emphases from each of the knowledge domains of building environmental performance, socio-economics, and architectural design. With the large coverage of issues and multi-facets of sustainable development, all the approaches are relevant and valid in one way or another, and all have potentials and contributions.

Working along this perspective, a matrix of multidirectional pathways towards sustainable architecture performance is constructed based on a compilation of all the possible strategies from the approaches of socio-economics, architectural design, and environmental performance. In the matrix (Figure 5), although there are three constituent domains, there are 10 different possible pathways towards sustainable architecture performance. In details, they are:

- Pathway 1: starts with socio-economic strategies (e.g. socio-economic incentives, policy controls, and educational means) as stimuli to influence user behaviours to a more sustainable one.
- Pathway 2: is the self awareness or practice of users in their everyday activities that are sustainable or contribute to sustainable architecture performance.
- Pathway 3: starts with architectural design that promotes, encourages and supports the positive aspects in user behaviours (e.g. as a result of its spiritual approach), which then contribute to sustainable architecture performance.
- Pathway 4: is the contribution from architectural design (e.g. on account of contextual approach and innovative design to minimise damages or even enhance the ecological value of the building site) towards sustainable architecture performance
- Pathway 5: starts with the demands and desires of users for positive daily activities in terms of sustainability. These demands and desires act as a brief, to which architectural design responds. The process forms another pathways contributing towards sustainable development.

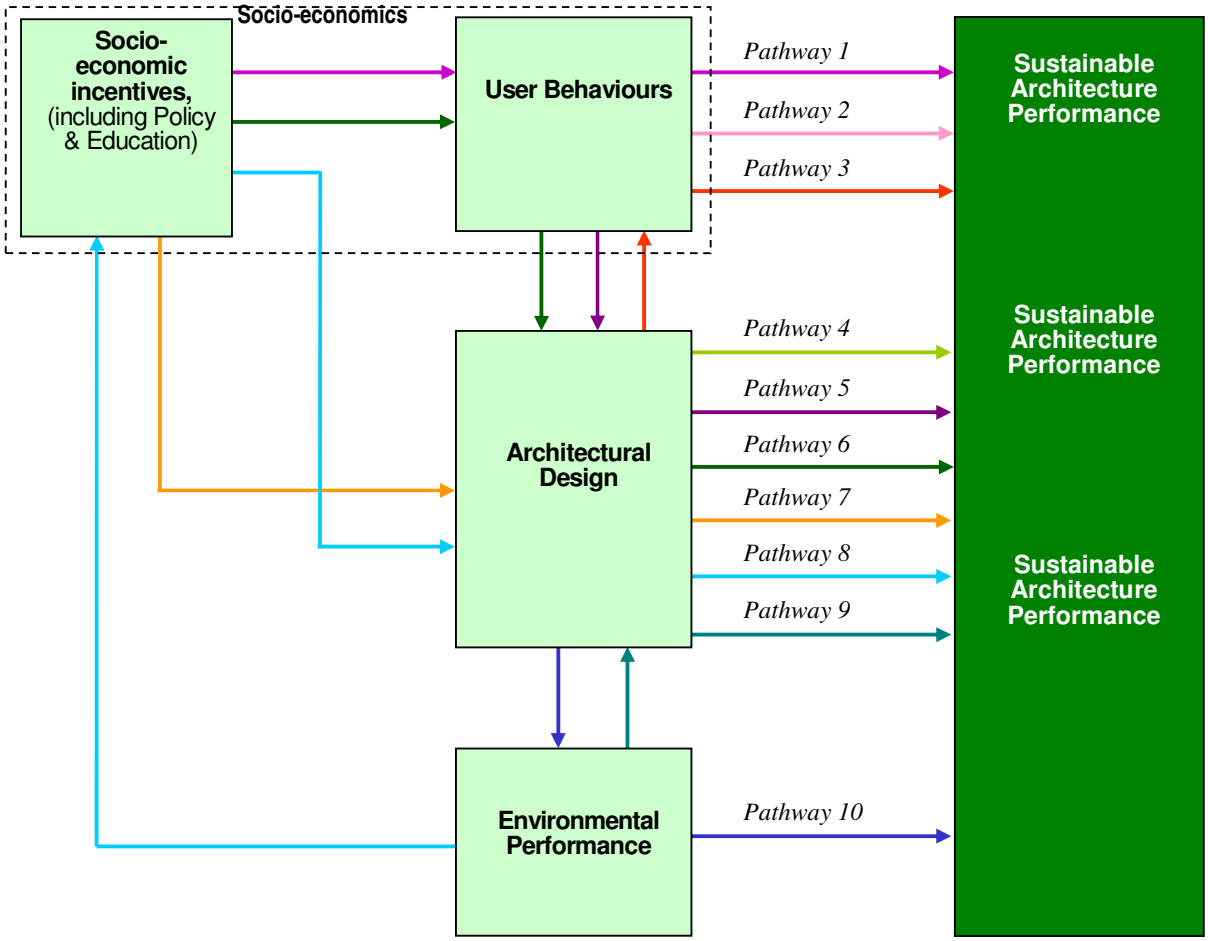


*Figure 5 Matrix of multidirectional pathways towards sustainable architecture performance*

- Pathway 6: starts with socio-economic incentive, education and policy as a mean to motivate, inform and regulate (in the case of policy) user behaviours and lifestyles for a more sustainable one. This in turn becomes a brief for architectural design to respond to in order to provide a supportive built environment.
- Pathway 7: starts with socio-economic incentive, education and policy (e.g. building regulations or architectural professional development to inform architects with sustainable design knowledge). They are catalysts to architectural design to contribute towards sustainable housing.
- Pathway 8: starts with the practice of building environmental assessment methods, which acts as socio-economic incentive to the society and public, which in turn becomes a demand or driving force to architectural design to deliver environmental-friendly housing.
- Pathway 9: starts with building environmental performances, which is considered as goals, objectives, and even technical assistances for architectural design to deliver environmental-friendly housing.
- Pathway 10: starts with architectural design that through contextual response and innovative design, delivers built environment with excellent environmental performances, which finally contribute to sustainable architecture performance.

In the matrix, a number of observations can be noted to further understand the three knowledge domains and possible pathways towards sustainable architecture performance. Firstly, it is observed that among the three, architectural design domain is the most popular node which connects the most number of pathways. Additionally, architectural design also has the most direct contributions. This has made architecture the central role in the overall endeavour through linking, integrating, influencing both to and from, and even balancing with and among, other domains of environmental performance and socio-economics. However,

not all the pathways need to involve architectural design – e.g. pathway 1 and pathway 2 under socio-economic domain. This fact indicates the operational boundary of architectural design.

Secondly, socio-economics is the second most influencing domain towards sustainable architecture performance. This domain is comprised of two sub constituent parts – user behaviours and socio-economic incentives. While resident behaviours have direct effect to sustainable architecture performance, socio-economic incentives are the catalysts to positive user behaviours. Although most socio-economic strategies have interactions with architectural design and environmental performance domains, some (in pathway 1 and 2) contribute directly towards sustainable architecture performance. These are the professional contributions from the field of sociology and economics studies.

Thirdly, the domain of environmental performance engages in the least number of pathways towards sustainable built environment. It has closely two-way interaction with architectural design. The economic incentive of the practice of building environmental assessment methods demonstrates a potential strategy in making public awareness of environmental sustainability, and motivating different players in the construction industry to develop environmentally-friendly housing. What seriously lacks is the two-way interaction between environmental performance and user behaviours.

## 5. From building environmental performance to architecture sustainable performance

### 5.1 Roles and scope of building environmental performance – a revisit

The domain of environmental performance contributes to sustainable architecture performance with more tangible and technical manners. The contributions lie on its main concern of environmental issues and thus the practice of building environmental assessment, which is also a mean to interact with socio-economics and architectural design domains in their pathways towards sustainable architecture performance. There is a confidence among building professional that the practice of building environmental assessment is able to solve the environmental crisis associated with building activities through scientific understanding and technical solutions. From there, the solutions can extend its contributions to sustainable development. Although this mentality has been under a critical review, which has revealed the incomprehensiveness and limitations of the practice from sustainable architecture perfective (Cam & Ong, 2004), the belief from this practice is logical because the notion of sustainable issues is, nevertheless, rooted from the scientific phenomena, facts and data (e.g. global warming, lost of biodiversity, natural resource deficit, air and water pollution, acid rain, and many more). From this understanding, the contributing aspects of building environmental performance practice' s approaches – materialist, quantitative, structural, hierarchical and knowledge-based (predefined) – are acknowledged. In more details,

- Materialist approach: to tackle environmental problems from source, which is the physical aspect of building – e.g. the use of recycle and low embody-energy materials;
- Quantitative approach: to provide bases for comparing and monitoring the improvement process, as well as for better understanding and enriching qualitative analysis in design or discussion of architectural built form;
- Structural approach: to facilitate an overall framework for understanding and designing environmental-friendly architecture. The framework of building environmental assessment methods can be used as a backdrop for integrating with other considerations in sustainable architectural design and discourse;
- Hierarchical approach: to facilitate decision-making process when facing the ultimate conflicts (beyond any reciprocal solutions); and
- Knowledge-based approach: to facilitate precedent studies and references to further improve the existing knowledge and to avoid precedent mistakes in heuristic process.

To further ensure the positive aspects of the above approaches in the process towards sustainable architecture performance, without falling into its limitations as analysed in session 2, the roles of building environmental performance domain need to be re-clarified. They are:

- Being an institutional setting to raise awareness of building environmental issues to the public and to provide economic incentive to different players in the design and construction sectors in delivering environmental-friendly housing;
- Setting benchmarks for building environmental practice to safeguard the minimum performance standards, and evaluating architectural design against these benchmarks; and
- Providing a platform for inspiring new designs, ideas and technical solutions. The restraints of environmental considerations, although are often considered as hindrance to architectural design, can be a stimuli for innovative design (Hagan 2003).

### 3.2 Towards architecture sustainable performance

Shifting to building sustainable assessment is a possible direction for future development of building environmental assessment practice (Cole, Howard, Ikaga & Nibel, 2004). However, in prior to do so, there are issues (covered in recent literature) needed to be clarified, particularly are the following two:

- Absolute vs. relative assessments (Cooper, 1999): Absolute assessments are considered to be more appropriate and meaningful in assessing sustainability, so that the progress (against targets or time frames) can be monitored.
- The issue of scale (Cole, 2001): individual building is considered as too small a scale to address sustainable development issues. The economic and social attributes of sustainable development can be better address at planning and master planning level.

In the matrix of multidirectional pathways (Figure 5), the term ' sustainable architecture performance' (SAP) has been introduced as the ultimate goal for the various approaches of the three constituent domains – socio-economics, architectural design, and environmental performance. SAP refers to the specific achievements, which are temporal and spatial specific, reflecting through the domain of socio-economics. SAP, although borrows the performance concept of ' building environmental performance' , set a very different objective. The principal difference lies at the process to achieve them. In current practice, the term ' building environmental performance' refers to ' performance' as a result of only building design techniques and technological application; where as ' sustainable architecture performance' means ' performance' as a result of integrating process among the three domains – socio-economics, architectural design, and environmental performance.

By introducing the term SAP, the above two issues can be addressed. Firstly, SAP forefronts relativism through the acknowledgement of the facilitation/limitation of local socio-economics context in pursuing sustainable architecture. It is suggested to not view the sustainable performance of a project based on absolute criteria and benchmarks for all regions around the world, in order to

- avoid the unreasonable requests for building designs in certain region, which can lead to disappointment, frustration, and thus giving up attempts to deliver sustainable architecture;
- avoid imposing strategies, techniques, technologies, and user behaviour; which has been identified to have side-impacts to sustainable development; and
- avoid undermining diversities and local-specific opportunities for sustainable development.

At this point, the concept SAP also addresses its viewpoint over the scale issue, that is: scale of project, be it individual building or city, should not be an issue in sustainable assessment. By taking relativism, SAP highlights the positive aspects and also recognises the imperfections in terms sustainability at the building scale. There is nothing wrong with these imperfections because they are the nature of ecosystems, in which buildings are a sub-component. Ecosystems operate at different scales and follow the principles of: the macro-level systems absorb the imperfections of the micro-level systems (Ong, 1996). It is particularly crucial, however, to maintain minimum imperfections at more micro-level systems to avoid straining the absorbing capacity of the macro-level systems. Therefore, there should not be a compromise to have sustainable assessment at individual building scale.

## 6. Conclusion

The paper began with recognising the present context of fragmented and even contested practices and approaches to sustainable architecture from the three domains of environmental performance, architectural design, and socio-economics representing three fields of knowledge – building and ecology science, sociology and architecture – respectively. Through a broad survey of approaches from the three domains, the paper drew out that the approaches from environmental performance domain through the practice of building environmental assessment methods is not robust enough to account for sustainable architecture. This is because of the limitation of the practice' s physical and quantitative approaches that can not account for socio-economics and other factors related to users. From there, a matrix of multidirectional pathways towards sustainable architecture performance has been constructed to visualise all positive approaches from the three domains and their interactions in contributing towards sustainable architecture. The matrix also facilitates the analysis of strength and weakness of the practice of building environmental assessment. By recognising the endeavour towards sustainable architecture is a process that embraces all the approaches from socio-economics, architectural design and environmental performance domains, in an integrated and reciprocal manner, the concept of ' sustainable architecture performance' is introduced as an opportunities for future development of ' buildig environmental performance' and building environmental assessment methods. The objective is to call for a more holistic development of the practice of building sustainable assessment that closely reflects sustainable architecture practice.

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