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Improving Sustainability Concept in Developing Countries

Materiality and Architecture: Potential Strategy for achieving Sustainable Design

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Abstract

This study proposes that the impact of the built environment on the natural environment can be mediated by adopting a sustainable approach to building material selection and specification, particularly when articulated at the design stage of the building process. The aim is to identify the main drivers and barriers to sustainable material specification by built environment design professionals. This study carried out for Cyprus where attempts have been made to uncover the attitudes of Cypriot built environment design professionals towards the natural environment, identify the process employed in specifying building materials, and the extent to which they draw inspirations from the natural environment.

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Keywords: Built Environment; Material Specification; Built Environment Professionals; Sustainable Development

1. Introduction

Evidently, the built environment sector is not only natural resource consumption intensive; it also generates huge amounts of wastes, resulting in major environmental pollution and degradations. This study proposes that the impact of the built environment on the natural environment can be mediated by adopting sustainable approaches to building material selection and specification, particularly when articulated at the design stage of the building process. Evidence abound suggesting that a sustainable approach to material selection and specification can reduce built environment material consumption intensity by as much as 60 per cent, assigning a prominent role to built environment design professionals in the delivery of sustainable development. (Coulson, J. R., and R. J. Fuller 2009). The policy implication is that global environmental sustainability can be achieved proactively, requiring effective strategy to drive the process. Little is known of the process used by built environment designers to select or specify construction materials, what drives or hinders this process, and the extent that environmental concerns influence the process. (Gluch, P., & Baumann, H., 2004).

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Thus, the aim of this study is to identify the main drivers and barriers to sustainable material specification by built environment design professionals. Having such knowledge is critical to any efforts directed at motivating and

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encouraging built environment professionals to fulfil expected roles required of them by society in the delivery of sustainable environment. (Bond, S., & Perrett, G., 2012). This study is carried out for Cyprus where attempts are made to uncover the attitudes of Cypriot built environment design professionals towards the natural environment, identify the process they employ in specifying building materials, and the extent to which they draw inspirations from nature and historic buildings. A questionnaire survey is the instrument used for data gathering, and the Statistical Packages for Social Science (SPSSx) was used to analyse the data. The results identify a number of drivers and hindrances to sustainable material specifications by Cypriot architects, allowing a number of policy recommendations to be drawn. This study is expected to be of benefits to policy makers contending with issues of sustainable development strategies.

2. The Impact of Built Environment on the Natural Environment

Throughout the world the building industry is responsible for high proportions of the pollutions as a result of the energy consumed during extraction, processing and transportation of raw materials. For instance, the energy for manufacturing and transporting building materials represents nearly 8% (350 PJ per year) of all primary energy used in the UK, whereas 50% of all energy consumed is attributable to occupation of the dwellings (Adalberth K 1996). These sums exclude energy consumed during the construction process, added together, buildings are energy intensive. Thus, Architects have an important role to play in global environmental sustainability by ensuring designing buildings to sustainable principles and criteria. (Bryan, et.al 2004) Importantly, if the need to design out non-renewable materials completely is not feasible, efforts must be directed at designing buildings that minimise the consumption of non-renewable materials throughout the life-cycle of the building. While the non-renewable use in buildings, not mainly at the construction stage, but also, at the post-construction stage when buildings are in use. Hydes and Creech (2000) concluded that though sustainable buildings are perceived to be relatively more expensive compared to conventional buildings, the associated environmental benefits in reduced carbon emission together with lower running costs are positive outcomes not to be ignored.

2.1. Traditional Architecture in Cotemporary Built Environment.

In most developing countries it can be clearly seen that with the modernization of the construction sector the traditional knowledge that previously underpinned climate responsive vernacular designs are rapidly declining. Instead, modern building designs pervade, often paying little attention to local materials and traditional methods of construction, hence local climate conditions (Bodach, S., Lang, W., & Hamhaber, J., 2014). Vernacular architecture exudes strong local content both in traditions, materiality, building skills and methods, and responds to local needs. Thus, vernacular buildings tend to be less natural resource intensive, generating materials and structures that are far more environmentally sensitive compared to conventional buildings and materials (John, G., Clements-Croome, D., & Jeronimidis, G., 2005)

2.2 Displacement of Traditional Local Building Materials by Conventional Materials

In traditional architecture, buildings are built with materials gathered within 400 yards of their locations. This rule seems almost universal for simple vernacular buildings, due to the cost and difficulty of transporting building materials over long distances. This means that buildings are designed specifically in view of materials and skills available locally, in addition to local environmental conditions. This being the case, it means material selection for traditional buildings is reflective of local climatic conditions. In essence, designing to local conditions not ensure buildings are integrated with local surroundings, but this leads to significant savings in embodied energy. As traditional cultures receded, and replaced by popular cultures fuelled by industrialization, the demise of traditional material specification in house building was only a question of time. This manifest change to traditional materials' use in dwellings are reflected in increased use of manufactured materials; these are often imported, and even where manufactured locally, they remained foreign to local contexts.

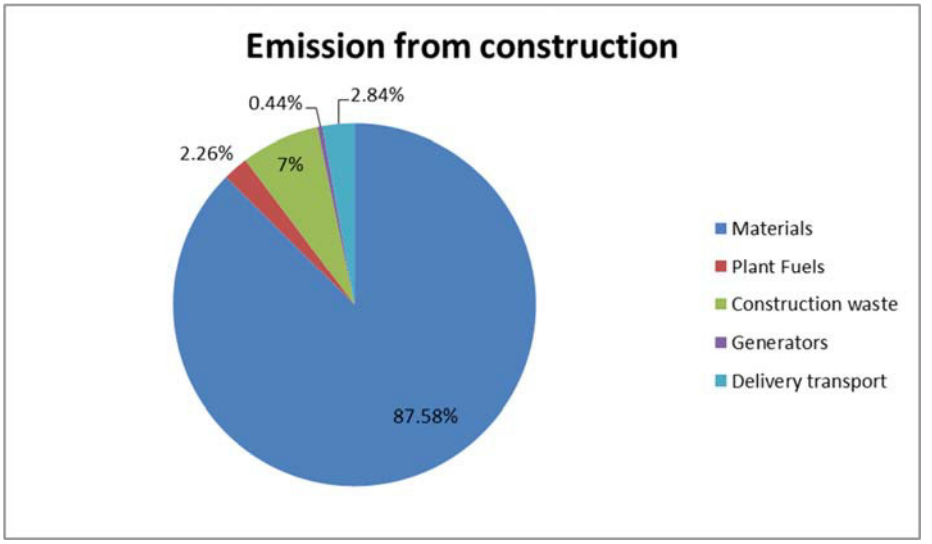

Figure 1 Carbon Emission from Building Construction

This phenomenon is most pronounced with buildings at the high end of the building chain, such as corporate headquarters of international businesses, these organisations by nature, often replicate their corporate headquarters in the host countries. While the use of manufactured building materials are most pronounced in the commercial sectors of Cyprus, their use in residential and industrial building have become common and pronounced. Caen stones, limestone, marbles, hard stones imported from different parts of the world are commonly in use. Although shipping remains the means of transporting these materials is shipping, a relatively low-energy intensive mode of transportation, there are nevertheless some Carbon emission implications CO_2 emission. Generally, [Fig.1], shows, emissions from building materials predominate in total construction emissions. Thus, designing buildings to sustainable principles, particularly with materiality in mind is a starting point in decoupling buildings from natural resource intensity, hence, attendant environmental pollutions.

3. Material Experience in Architecture

3.1. Building materials Selection and Specification Process

Abeysundara et al. (2009) highlighted the importance of selection of building materials, and hinging materials choice on their environmental impacts. Indeed, the choice of building material use in architecture can be considered codes of social practice and even ideology. As material culture, architecture becomes a metaphor for human engagement and symbolic communication (Serena Love 2013). This has the implications for selecting building materials, which has to be based on their performances for the entire duration or life-cycle of buildings. In other words, design for durability, flexibility and disassembly are essential elements of a sustainable building (Andrew Walker-Morison, Tim Grant & Scott McAlister, 2007). Material selection is a complex and delicate task determined by the immense number of building material options. The importance of environmental building assessment is well recognized as a way for promoting environmental awareness among building professionals. The practicality of assessment methods can be extended from a checklist-type single evaluation method, to a multiple criteria framework that includes physical quantification of criteria for material assessment (Akadiri 2011)

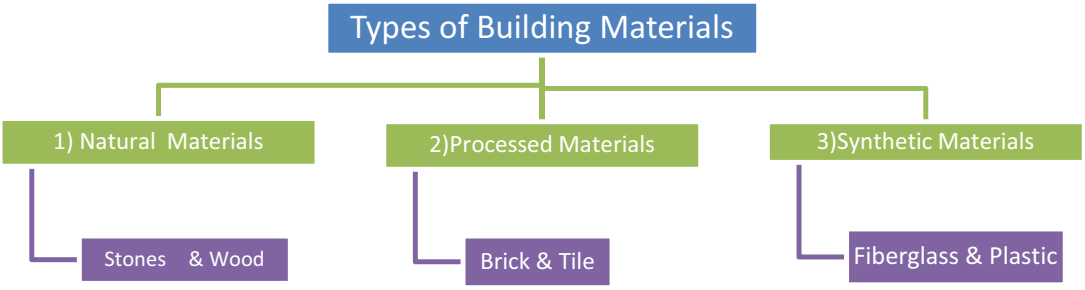

Figure 2 Building Materials Typology

Likewise, multiple factors are often considered by the architect when evaluating the various categories of building materials. As a result, these sets of factors or variables often present tradeoffs that make the decision process even more complex (Ibuchim Ogunkah and Junli Yang 2012). Nevertheless the broad research study on materiality and tools, little is known of the process used by built environment designers to select or specify construction materials. In particular, what drives or hinders this process, and the extent that environmental concerns influence the process remain relatively unknown. (Gluch, P., & Baumann, H., 2004)

3.2. Sustainable Approach to Material Selection

"What is the use of a house if you do not have a decent planet to put it on?" Henry David Thoreau

The awareness of the need for sustainable development exists for decades. The challenge has been how to deliver sustainable development, particularly in the construction sector. Owing to the macro dimension assumed by sustainable development, it has been a major challenge addressing micro problems, and the realisation of which resulted in the adoption of the United Nations Agenda 21 that reconised that every sector of the economy has a role to play in driving sustainable development. This ushered in the sectoral focus on the construction industry, and most experts have emphasised the importance of designing and specifying building materials with low environmental impact. (Calleja, Vale, 2015) The selection of building materials is seen as not only key to a sustainable construction process (Shi, Xu 2009), but also an important influencing factor for future environmental performance and functionality of buildings (Estokova, Porhincak 2015). Indeed, many architects are now paying the desired attention to materiality and gaining knowledge on the life cycle of building materials from the raw state to manufacture, delivery, and disposal, as shown in Figure 2.

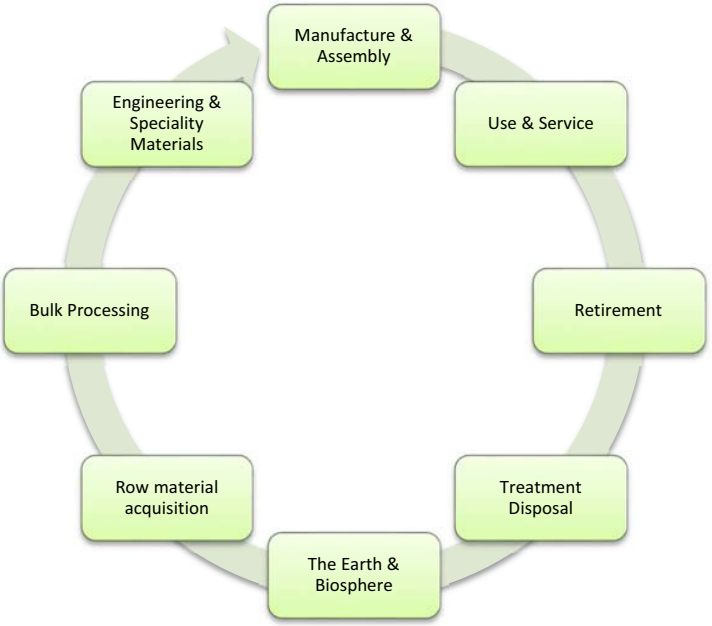

Figure 3 The Life Cycle System of Building Materials

3.3. Green Building Materials Selection Criteria

This study aims to identify the main drivers and barriers to sustainable material specification by built environment design professionals. Such knowledge would be crucial to any effort to motivate and encourage built environment professionals to fulfil the huge roles they are now expected to play by the wider society in delivering sustainable environment. (Bond, S., & Perrett, G., 2012) Sustainable building materials respect limitations of non- renewable resources, work within the patterns of nature, and the inter-relationships of the eco-systems. Thus, an environmentally friendly building should incorporate as many renewable local materials as possible, supporting local economies.

3.4. Drivers and Barriers to Sustainable Material Specification

Barriers

The main barriers to adaption of sustainable buildings identified in Green Values Report (Davis 2005)

1) Perception that green build is more expensive and carriers more risk
2) Lack of research and knowledge about green build
3) Lack of experience with green build
4) Building and planning codes that do not address green build
5) Leases that do not account for green build elements
6) Companies fail to realize that a green build market exists.
7) Companies put off by the effort required to change business model.(Lack of incentives)
8) Lack of proof that green build delivers improved value.

Griffin, C. T., et al (2010) also supports the view that barriers to sustainable building materials use in buildings exist. The main barriers that have been identified include perceived increase in cost, building regulation codes that do not recognize innovative sustainable materials and systems, and the availability of the materials themselves. The lack of readily accessible and reliable information comparing alternative structural materials and systems also poses a significant barrier during the design and selection process. Sustainability attributes and characteristics of building materials do not feature prominently in education curriculum in the university, and little opportunities exists to learn about building material in practice. There is a steep learning curve, and few examples of best practice exist. Only deeper knowledge and appreciation of sustainable materials and their selection and use in buildings hold for future global environmental sustainability (Andrew Walker-Morison, Tim Grant & Scott McAlister, 2007)

Drivers

Drivers for green building, other than financial performance, are outlined, for example, by Yudelson (2010), and include:

- Utility cost savings for energy and water.
- Maintenance cost reductions.
- Increased value from higher net operating income, due to higher rents and greater occupancy in certified buildings.
- Increased occupier productivity, due to improved health of tenants, and reduced absenteeism.
- Marketing benefits, especially for developers and building owners.
- Public relation benefits, especially for developers, building owners, and managers.
- Recruitment and retention of key employees.
- Demonstration of commitment to sustainability and environmental stewardship.

4. Context : Cyprus

The ‘ecological footprint’ of Cyprus may be small but it is growing. There are many options for Cyprus to pursue, including utilizing existing brownfields and climatic conditions to positively impact both the supply and the demand side of labour. Redevelopment can lead to new jobs, healthier neighborhoods, increased local tax revenues and less suburban sprawl. Current situation requires huge effort and strategies for sustainable development planning in order to achieve holistic sustainability - economic, environmental and socio-cultural.

Positive ingredients for success:

- The gradual realization by all that there is no inherent contradiction between economic development and protection of the environment.
- Plan our activities for a cooperative and balanced relationship with the indigenous environment, in order to sustain ourselves within it. It is important to highlight that the balance is crucial; otherwise natural resource consumption may lead to irreversible plague in terms of natural environment deterioration.

Contribution between policy makers and design professionals is compulsory in order to convey regulation and standards in to sustainability framework.

Figure 4 Natural Deterioration can be observed; Kyrenia Mountains has been excavated for manufacturing building materials

4.1. Attitudes of Cypriot Built Environment design professionals towards the natural environment

To design sustainable buildings, Cypriot architects need to integrate the concept of sustainability into their practice. In this role, they will be able to define a process to preserve, improve and create a sustainable built environment. However, anecdotal evidence suggests that Cypriot architects use economic and technical parameters remain the basis for building material specification, sustainability is hardly considered, as a factor.

4.2. Material Contents of Traditional Buildings in Cyprus

Main local building materials used are: adobe (sun dried mud bricks) and mortar of the same material as the adobe units, stone, and timber. Common building method is that of mixed construction, with stone used wholly or partially for ground floor, and adobe preferred for upper floors. The use of these local materials also helps achieve socio-cultural sustainability by creating an identity that defines boundaries between public and private spaces. (Figure 5) Additionally, these materials achieve high thermal performance critical to thermal comfort in dwellings. Thus, vernacular architecture is sustainable given the intensive use of renewable resources and the associated low maintenance. This contrasts markedly with conventional buildings heavily dependent on manufactured material and mechanical systems to function and provide adequate thermal comfort. These materials and systems were designed and specified by architects, which is why their roles are critical to attaining global environmental sustainability. In other to ascertain the attitudes of built environment professionals towards sustainable development in Cyprus, particularly, the process and criteria for selecting and specifying building materials, a questionnaire designed and surveyed on practicing architects in the country.

Figure 5 Traditional Adobe Dwelling built in 1930s (Still in Use)

Figure 6 Clash of new and old on urban texture

5. Questionnaire Survey

5.1. Method

A questionnaire survey is one of the most cost effective ways to involve a large number of people in the process in order to achieve better results, as recommended by McQueen and Knussen (2002). A questionnaire survey is the instrument used to gather the necessary data, and the Statistical Packages for Social Science (SPSSx) was used to analyze the data. The questionnaire was divided into three main sections for easy analysis and reporting. For most of the questions, respondents were required to specify the level to which they agreed with a given statement, on a five point scale: 'strongly agree', 'agree', 'neutral', 'disagree', and 'strongly disagree'. For other questions, respondents were asked to rank some provided factors.

5.2. Data

Descriptive statistics are used to present the main geographies of a collection of data in quantitative terms. This included the use of frequencies, percentages and resources for presenting description finding of the survey. These techniques were employed for analyzing data related to the characteristics of the respondents, their organizations, and open ended questions and comments.

5.3. Data Analysis

Data analysis was performed with the assistance of SPSS Statistics v16. measure, ensuring that factor analysis was going to be appropriate for the research.

Variable Number of respondents Percentage (%)

Table 1

Work experience		
<4 years	10	17.9
5-10 years	20	35.7
11-15 years	2	3.57
16 - 20 years	12	21.4
>20 years	12	21.4

Table 2.

Area of Building project specialism		
Commercial	28	50
Residential	48	85.7
Institutional	12	21.4
New	46	82.14
Renovation	30	53.57
Public	24	42.86
Private	30	53.57

5.4. Results

One of the drives of this survey is to examine the environmental awareness and attitudes of architects and design professionals to the environment. The responding architects and designers indicated they are aware of the impact of construction activity on the environment: all the 56 respondents considered environmental assessment an important issue for building project and agree that the impact of environmental effects needs to be incorporated into the material selection process. Correspondingly the question arouses; if the awareness towards the need and importance of sustainability in the built environment exist then what hinders design professionals from apply the concept in practice?

Survey included statements on the possible barriers to professional from designing sustainably and respondents were expected to indicate on scale 1-5 the level to which they agreed with a given statement. Results presented that following statement are specified as major barrier.

- Lack of information on sustainable construction materials
- Difficulty in evaluating information
- Lack of tools and data to compare material alternatives
- Difficulties in balancing environmental, economic & social issues

Focusing on the first statement, 82% of respondents agreed, this creates a paradox, since all respondents indicated that they are familiar with sustainable material selection, yet do not design buildings and specify material to sustainable criteria. Cross-tabulation analysis has been used in order to gain further insights to the perceptions of respondents regarding sustainable development.

A cross-tabulation table relating awareness of the sustainable material selection and the number of years in practice is revealing. As Table 3 shows, irrespective of the years in practice, all the architects surveyed are aware of the need to specify sustainable materials in building construction in Cyprus. However, the degree of awareness vary considerably; only 29 percent of respondents declared that they are very aware of the need for sustainable specification of materials. If those who are somewhat aware combine with those barely aware, it means that 71 percent of respondents are not sufficiently informed of the need for specifying and designing to sustainable principles, hence the criticality of materiality to the overall sustainability of the built environment, particularly buildings.

Table 3

Cross tabulation Frequency Percent		**How familiar are you with sustainable material selection?**				
		Very	Somewhat	Barely	Not at all	**Row Totals**
Years in Practice	1-4 years	2	4	4	0	**10**
	Row Percent	20%	40%	40%		**17.9%**
	5-10 years	2	12	6	0	**20**
	Row Percent	10%	60%	30%		**35.7%**
	11-15 years	0	1	1	0	**2**
	Row Percent		50%	50%		**3.57%**
	16-20 years	6	4	2	0	**12**
	Row Percent	50%	33.3%	16.67%		**21.4%**
	Over 20 years	6	5	1	0	**12**
	Row Percent	50%	41.67%	8.33%		**21.4%**
	Column totals	16	27	14	0	**56**
	Column Percent	**28.57%**	**46.43%**	**25 %**	**0**	**100%**

6. Conclusion

In conclusion, building material selections and use in buildings are critical to achieving environmental sustainability, and for a small Island country such as Cyprus, adhering to the principles of sustainable development to enhance the environmental integrity of the Island. As with other parts of the world, urban population is rising, and tourism is booming, the need to decouple natural resource consumption from increased buildings is overwhelming. As indicated in the analysis, materiality has huge influence on the energy in use, and post construction maintenance and affordability of buildings.

However, designing to sustainable principles and specification of sustainable materials are possible with the full awareness of the impact of buildings on the natural environment. As analysis has shown, Cypriot architects are not

sufficiently verse on sustainability issues. It is vital that appropriate measures are taken to empower and educate practicing architects on sustainability.

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