Sustainable Development and Building Design in Malta

Vincent BUHAGIAR
Faculty of Architecture and Civil Engineering, University of Malta, Msida, MSD 06, Malta
Internet: www.um.edu.mt; E-mail: vincent.buhagiar@um.edu.mt

Abstract
This paper spans across the three pillars of sustainability and outlines how a sustainability index can be applied in the context of the building industry, using Malta as a case study. Sustainability criteria are identified which can help promote a culture change in the way most of our clients view a project as different from a contractor's point of view. Design considerations are also dealt with pointing one way forward if Malta really wants to reduce the environmental impact of buildings. Highlighted issues touch on the visual impact (aesthetics), materials, embodied energy, lighting, space heating and finally ending with an epilogue on land use and waste management, being only the tip of the 'mountain' in Malta.

Keywords: sustainability index, embodied energy, land-use, waste management.

Introduction

"We know that the whole creation has been groaning
as in the pains of childbirth right up to the present time".

Book of Romans, Chapter 8, verse 22.

Since our early existence we have had to go through the labour pains of childbirth, upbringing and departure and all that comes in between, yet we still survive. Although methods, media & medicine have digressed worldwide throughout the years, the end result remains the same – the survival and proliferation of the human race.

Similarly, yes, we have had to go through the labour of extraction of natural resources and energy consumption to sustain a living and today's lifestyle. Only rights and rituals have changed in the context of scientific and technological development. Yet nature has endured all this to this very day. But have we exhausted our dear mother earth to the limit yet? Well, as for resources we're always posing the tedious question "are we there yet?"

Since the onset of the energy crisis in the 1970's and milestone conferences such as Rio in 1992, environmental issues have been raised to the podium beyond academic fora. The emphasis is set to increase especially as we put to practice the curator's role of protecting our environment for our children. It is also increasingly becoming a principal study area under different disciplines in schools, colleges and universities throughout the world.

The construction industry is but one major field of study. From its architectural concept through building construction to end use a building consumes energy all the way, with the latter gaining importance. Post-occupancy audits are constantly being carried out not only to ensure user-satisfaction but moreover to monitor energy use. Increasingly the activities of the construction industry through mineral extraction, materials and component manufacture, building and infrastructure development and through the use of buildings, has focused the attention of architectural design on the environment. Although those involved in the design and construction of buildings argue that they are always striving to provide us with an improved standard of living, one cannot ignore the environmental implications. We have lamented too much over this; perhaps it is high time that we take stock of the real situation. Hence the need for sustainable development.

The Three Pillars of Sustainable Development

Sustainable development has one principal goal: to improve the quality of life, for ourselves and for generations to come. It is based on three founding pillars, namely, environmental, economic and social dimensions. Figure 1 refers. Underlying all these lie fundamental values of *ethics* and *accountability* towards future generations by including all the different sectors of society, comprising people from all walks of life. Realising the need for such an approach is already one step forward. The same may be said for sustainable development in the construction industry. Malta's acute problem lies perhaps in its lack of mineral or fossil fuel resources, its relatively high population density, particularly in consideration of its limited space and diverse land-use to sustain it as an independent Small Island State.

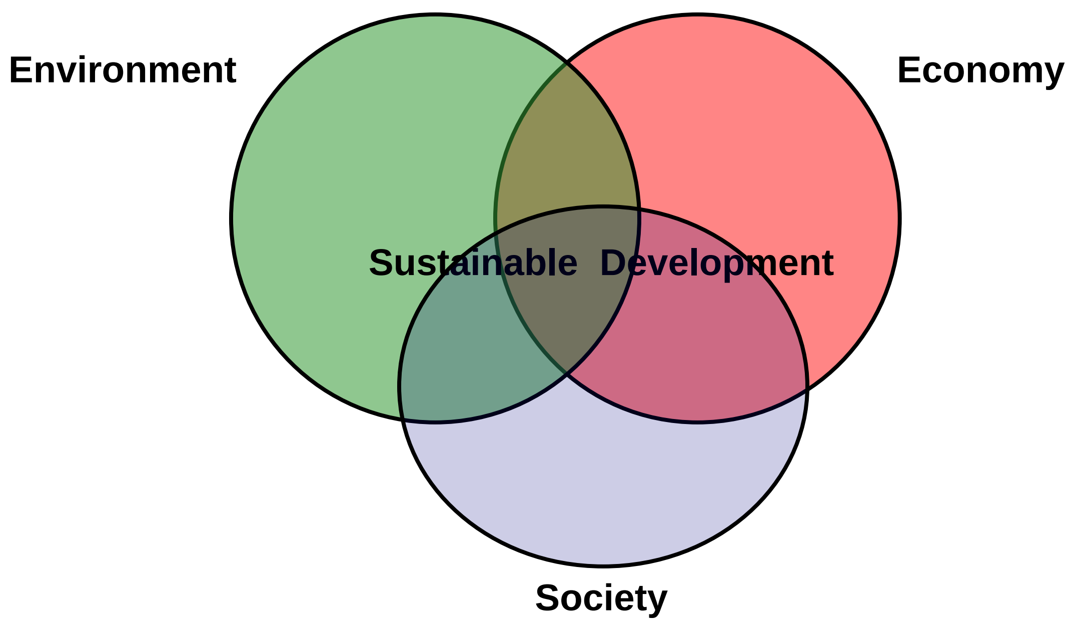

Fig. 1: The three pillars of sustainability

Sustainability in Practice

Poor architectural design could lead to a losing sight of these three important components as applied to the built product. An effective design solution should achieve a sound financial return on investment, make a reasonable valid contribution to society while minising the impact on the environment. It is therefore crucial that architects not only embrace principles of sustainable design but are also able to manifest their concept to reality in their practice. With the aim for greater environmental protection, increased development controls have the effect of forcing designers to find new solutions to deliver clients' requirements that are neither cost prohibitive nor environmentally harmful. On the other hand even if marginally dearer, such solutions, although seemingly less economic to developers, are typically more beneficial to society.

Veritable sustainability, for the majority of projects may seem an unrealistic expectation at first glance. However as architects conceive and implement ideas that approach this goal on a regular basis, society will benefit from new facilities that are less intrusive and which will not become operational burdens for future generations. In time existing buildings that perform poorly may still be upgraded to higher standards with a lower energy demand on resources, but the energy input to achieve this is unwarranted since it could be avoided through an effective design solution in the first place.

Sustainability Index

Sustainable development is the effective balance between economic progress and environmental conservation, and can be characterised by comprising two essential attributes. Once attribute deals with economy-centred performance, measured in terms of delivered *value for money*. The other deals with society-centred performance, measured in terms of the *improvements in the quality of life*. Value for money is defined as the maximisation of wealth and the minimisation of resources consumed in the process. Quality of life is defined as the maximisation of utility and the minimisation of associated impact. All four criteria can be combined together into a single decision criterion, known as the sustainability index. This new approach is derived from an earlier concept of a sustainable development philosophy in agriculture. Taylor et al (1993) describe the index as the *Farmers Sustainability Index,*[1] today applied to the construction industry.

The sustainability index avoids assigning dominance to monetary criteria, and alternatively measures the relative ranking of projects from a more holistic viewpoint. It expresses sustainability performance in terms of individual criteria, assessed using different units. It supports weighting of *economy-centred* and *society-centred* attributes to reflect the specific context of the development. For example, private sector development may ascribe more weighting to *value for money* considerations, whereas public sector projects may ascribe more weighting to *quality of life* considerations. [e.g.s: two new hospitals in Malta: St. Philip's (private) as opposed to Mater Dei (public); a private apartment block versus social housing project; private versus public school].

In order to ensure that all criteria are allowed to influence a decision, it is recommended that the proportion of either attribute is not to be less than 25%. Figure 2 illustrates this concept and derives a formula for the objective measurement of the sustainability index. The higher the index the more sustainable is the project.

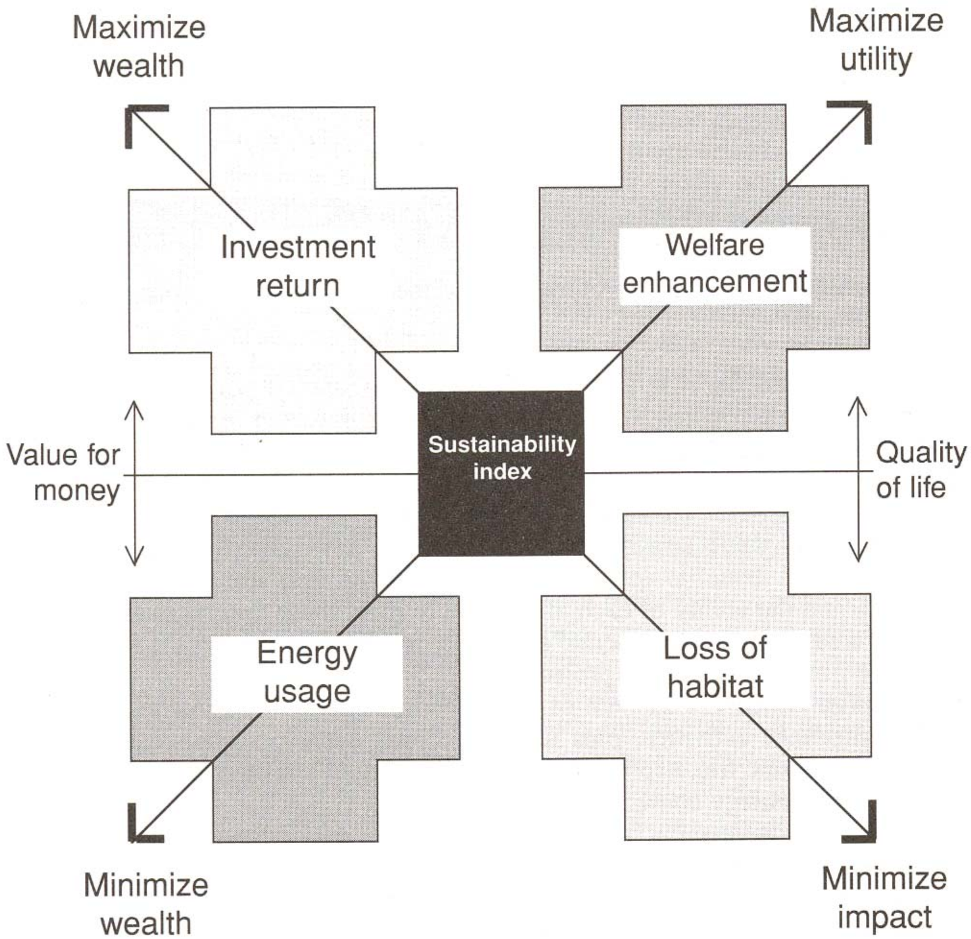

Fig.2: Sustainability Index

$$\text{Economy-centred performance (value for money)} = \frac{\text{maximise wealth}}{\text{minimise resources}}$$

$$= \frac{\text{investment return (benefit-cost ratio)}}{\text{energy usage (total energy)}}$$

$$\text{Society-centred performance} = \frac{\text{maximise utility}}{\text{minimise impact}}$$

$$\text{Sustainability index} = \frac{\text{investment return * welfare enhancement}}{\text{energy usage * loss of habitat}}$$

$$= \frac{\text{benefit-cost ratio (:1) * social benefit (weighted score)}}{\text{total energy (GJ/m}^2\text{) * environmental damage (\% risk)}}$$

Energy Conscious Design

Although there is no standard ‘recipe’ for an energy conscious design concept or as a ‘quick-fix’ solution for refurbishment, there are however several notional characteristics which have already demonstrated a sensitive contribution to a holistic energy conscious design approach. These range from a choice of structure, appropriate materials including radical design strategies that embody both passive and active energy solutions to create more comfortable spaces at reduced cost, and energy overheads. Fundamental design considerations include proper orientation and siting, exploiting natural light and ventilation, shading, thermal mass and insulation as appropriate. The long-standing design philosophy of the “3-Ls’: *long life, low energy, loose fit*” originally applied for most of our historic building stock has now come back in fashion. This now characterises modern development, winning credits in most international architectural design competitions, even possibly overriding aesthetic considerations, or perhaps making a debut in the architectural expression itself. Apart form the aesthetic quality of the built environment, admittedly it has largely been established that environmental benefits do give added value to any property today, and moreover tomorrow, with the depletion of natural resources and possibly greater development control. An overview of some of these energy sensitive measures is now outlined.

Visual Sensitivity

“Any building will have a visual impact on its immediate surroundings and its users” according to Bartlett & Prior. It is a fair statement to make extending to the fact that such buildings will eventually mould the urban built environment as each individual project will be laid out on a town plan matrix. Since aesthetics and design are highly subjective, it is equally difficult to put in place and implement regulations that control the appearance of buildings. Today in many major cities it now hardly matters what a building looks like as the surrounding area is so crowded with largely unplanned urban cohesion that architects pay little attention to the built environment but instead design in isolation. However in historic town centres this is not the case as overlying policies of urban conservation strive for the preservation of the urban fabric, even if non-listed buildings are permitted to be gutted out leaving only the skin to house a modern interior.

In Malta, local legislation for village cores proposes just that: any village core development is to adhere to a standard policy of using local globigerina limestone, arches instead of exposed concrete lintels and timber elements among other items. Although claimed as guidelines, applications are vetted against such criteria without which the permit would not be issued. Hence as aforementioned, although often viewed as a restriction or added economic burden to the developer, they are in reality contributing to the social dimension of a better overall visual quality.

In such instances the whole (streetscape) becomes more important than the parts (buildings). One such example is Valletta, where although buildings vary in age, size and style, they all exhibit a fairly consistent streetscape and skyline.

On the other hand in most new towns no such aesthetic guidelines exist except for height limitations and scheme density (bungalows, semi-detached, terraced dwellings). General zoning is laid out as per Malta's first structure plan published in 1990, by the then Planning Authority (PA), now renamed as the Malta Environment & Planning Authority (MEPA). Although original local legislation still dictated the use of stone on facades this is hardly ever enforced, thus permitting practically all types of finishes and materials along our streetscape. Some more adventurous architects have made good use of this through bold architectural expressions of both structure and finishes.

Materials

Virtually all building materials have an impact on the environment in some way: form the extraction of minerals such as iron ore and bauxite, to the disposal of demolished material at the end of a building's life span. Most of the impact is related to energy, energy that is used to extract, process and transport raw materials. These are further processed as building components, again transported and installed on a building site. After a number of years these will eventually be dissembled and removed from site, inclusive of the possible demolition of the structure of which they were part of. All the energy is typically quantified, even if in broad terms, as the embodied energy of a building element. The more energy intensive the material is, the greater is the environmental degradation it leaves behind – even though elsewhere around the globe. Here we are now moving from the selfish N.I.M.B.Y. (not in my backyard) approach to a greater social responsibility. Hence the durability and longevity of a building is of paramount importance in sustainable development.

In Malta traditional vernacular architecture such as farmhouses and townhouses, were originally a quarry and building site en-suite. The farmer derived the stone for his house by excavating a small quarry in the centre of the large courtyard extending beneath the ground floor rooms, typically used for livestock. This not only ensured the stable environment of the stone but moreover eliminated the need for transportation altogether (zero energy). Stone off-cuts and loose residual stone chippings were also used as infill material between the two skins resulting in a monolithic 760mm wall with a high thermal mass (zero waste). An added benefit was that the same quarry was trimmed and often used as a water cistern collecting the precious rain water from sparse winter showers for use in the dry summer months (water conservation). This also served as a thermal sink enhancing comfort in both summer and winter, with the farmer perhaps naïve of his overall self-sufficiency. Today we have lost all this 'robust simplicity', making way for modern buildings supported by energy guzzling services through 'intricate complexity' by employing the technologically advanced Building Management Systems (BMS) [2].

Energy

Buildings, no matter which type, shape or size, are major energy consumers. The building sector accounts for over one third of the delivered energy used in most developed countries, with an even greater proportion of electricity use attributable to buildings. Janda and Busch (1994)[3] estimated that electricity used in developed countries is consumed directly by buildings: 31% residential and 26% in commercial buildings. Today, over ten years later this figure has soared to 33% and 40% respectively, with the rest going to industry inclusive of energy generation and distribution itself. In the UK alone the building sector accounts for over 60% of the national energy bill, while the global average lies around 40% [4]. Similar official figures for Malta are still unknown, however a national population census to be held at the end of November 2005 should give an indication of domestic energy consumption trends[5].

Space Conditioning and Artificial lighting

Most of the energy used in buildings is devoted to heating, cooling and lighting. In 1997 in the US up to 86.5% of electricity generated was attributed to such energy demands[6]. In most major developed countries in the Commonwealth, such as Australia this figure ran up to 70% for heating, ventilation and cooling (HVAC) while artificial lighting took up another 15%. Much of the energy consumed through electricity contributes to greenhouse gas emissions (GHG). Energy use in domestic buildings is divided differently with space heating/cooling taking up the largest single use (38%), followed by electrical appliances including lighting (30%), domestic water heating (27%) and cooking (4%). Although these figures are still unknown for Malta, a national energy and water audit is on the cards of Enemalta and the Water Services Corporation (WSC) respectively. These are the only two local (government owned) utilities on the Island.

Natural Ventilation and Daylighting

Monitored data suggests that the greatest demand for power in buildings is that used for HVAC systems combined with artificial lighting, as highlighted earlier. This adds considerably to GHG emissions. Naturally ventilated buildings or hybrid ones (mixed mode systems) have been proven to provide adequate comfort conditions for occupants yet provide the much needed reduction in CO_2 emissions.

There is evidence from post-occupancy analysis that mechanical systems are often oversized by a factor as much as 2.5 times their requirement, typically because engineers take certain safety measures to ensure health standards are complied with. On the other hand such surveys have shown that there is less absenteeism and greater productivity from occupants working in naturally ventilated buildings[7].

Although typically in northern Europe the emphasis is on heating interiors, in a Mediterranean Island such as Malta there is a greater concern for keeping buildings cool. Power demand at the stations in summer has now exceeded demand in winter. This is principally due to the fact that over the last ten years there has been an almost 200% increase in the importation of air conditioning units for domestic use. Most bread-winners consider them as just another domestic appliance, oblivious to their running costs since its electricity metering is done holistically, with all units lumped with all the rest as one bill. With the latest increase in electricity tariffs stemming from increase in oil prices on the international market, people are becoming more aware of their consumption. This may in fact prove to be one deterrent to slowing down purchasing of further air conditioning units for cooling.

On a Mediterranean Island abundant of natural light and winds one could easily be disdained as we turn our back to these two natural resources. Modern buildings in Malta emulate environmental control systems designed for sealed deep plan buildings, taxing the local infrastructure with unwarranted energy demands for cooling and lighting. Our forefathers had the speculative know-how of allowing for controlled drafts in summer across small sized openings facing the prevailing wind direction (NW), yet having large loggia openings facing south to maximise natural light and solar gains in winter.

Waste Management

Inert waste is generated both during construction as well as from demolition, whether as part of a refurbishment or a complete building knock-down. Developers and contractors are becoming more aware that by reducing waste dumping a variety of benefits are accrued. These include reduced environmental impact, cleaner and therefore safer sites, and last but not least lower dumping fees – albeit even if considered as a necessary evil – the latter's results have proven to be a positive disincentive.

Waste disposal is inevitably a sensitive issue on an Island with a high population density. Malta stands at 1.8p/km^2, rated as the third dense in the world, according to a demographic survey held in 1995 and 'Eurostat' records, 1999[8]. According to the last census (1995), population records currently standing at almost 400,000 is also on a steady increase at an average rate of 0.8% per annum[9]. This year's population census (carried out every ten years) has yet to confirm whether the demographic growth is still on the increase, with people living longer outweighing the fact that families are getting smaller.

Running parallel to these trends is the increase in consumerism, especially the accent being placed on disposable goods, of any sort. From any domestic plastic container to a disposable camera or an irreparable refrigerator, all these formerly end up at the 'Maghtab' dump, now in an approved engineered landfill instead. One average family produces approximately 1.5 tonnes of waste per annum. The building industry alone disposes of more than 1 million tonnes of excavation and construction waste a year[10]. Construction and Demolition waste alone totals up to 80% by weight of all the solid waste formerly dumped at 'Maghtab'. This landfill alone received well over 1.0 million tonnes of inert waste every year until 1998, according to the State of the Environment Report, and this volume is ever on the increase, today considered a 'national tumour'[11].
A BICC waste management report recommends land reclamation as one feasible way forward after carrying out a comprehensive environmental impact assessment (EIA)[12].

Land Use

Land is also a scarce commodity in Malta with a superficial area of 316 sq.km. Apart from population growth there is also a concern for increase in land use per capita. It has often been lamented that when considering that we are building up the Island at the rate of 'one Valletta a year' in area, we should therefore seriously consider high-rise buildings and reclamation. The MEPA is currently processing an average of more than 7,000 development applications per annum with a regular backlog of files every year[13]. There is sufficient pressure to open up the building development schemes once more but this is tantamount to another sprawl as we had in the 1960s and 1970s, further eating up our countryside. Statistically Malta is already over 20% built up. This is considered high when compared with the average European standards where similar figures are much less for the UK (12%), Germany (15%) and Switzerland (9%).

The NCSD

As a follow-up to the Johannesburg summit in 2002, Government has taken up its commitment towards Agenda 21. Through a purposely set up commission, the National Commission for Sustainable Development (NCSD), is charged with the task of drawing up a National Strategy for Sustainable Development for Malta. Its underlying role is also to raise awareness for such a strategy in order to ensure that the three pillars mentioned earlier are sustained and well balanced. After circulating a first draft with various sectors, government entities, NGOs and local Councils, the Construction Industry's consultation was coordinated by the undersigned o.b.o. the *Kamra tal-Periti* (KTP), formerly called the Chamber of Architects & Civil Engineers. Through feedback from the consultation meeting the following salient recommendations are being considered by the editors:

Utilise all available resources on a new building site, i.e. build using stone quarried on site thereby saving on quarrying activities, transport and laying. This should generate a new mentality reviving traditional craftsmanship combined with today's building technology for a less labour intensive job.
Encourage adaptation of existing buildings and their re-use, particularly in village cores, inclusive of recycling existing materials through incentives, such as tax credits in building levies.
Land reclamation should not be ruled out, but should only be implemented with caution, after carrying out the necessary EIA for each site, especially in view of the indigenous marine ecosystems around the Islands. Areas not environmentally sensitive should be selected.
Encourage research on reducing, reusing and recycling of construction materials, including local globigerina limestone, structural concrete and timber among others .
Educate all parties involved in construction (architect, developer, contractor, end-user) in incorporating sustainable practices in their trade or profession.
Promote new initiatives towards building refurbishment, rehabilitation and renewal of town centres, complemented with incentives sound financial packages of support for ventures promoting a holistic sustainable development.
Apart from conservation of land-use and natural resources, a broader concept of sustainability needs to be better promoted and embraced such that it incorporates energy use in the built environment, inclusive of the whole processes, from extraction of raw materials to production transport and delivery on site.
There are still some 'white' areas in the Structure Plan which need to be zoned with planning parameters specified, since these had already been earmarked for development since 1992. Their lack of approval creates uncertainties as to what constitutes " promoted legal development" vs "land preservation".
A greater land efficiency was suggested such that sprawl is reduced to a minimum, even within one's own plot. This should apply to all three main sectors, namely residential, commercial and industrial buildings. Increase in floor heights is one way forward especially in certain new areas. Going high-rise is one solution to compensate for land scarcity, but we should identify lessons to be learnt from others' experiences.

Conclusions

Almost any building can be re-designed to use between 50 to 70% less energy than a typical building of its type, if the method in which building systems interact and the way it functions as a whole are considered at the early concept design stage[14]. The key approach in energy-efficient design is that the building is considered to be more than just structure and cladding, but all the elements contribute to the overall performance of the building particularly in terms of its interaction with the climate. By utilising natural resources of lighting, heating and cooling, additional energy for these requirements is minimised. Dwellings can be enhanced with energy efficiency principles to allow for daylighting, solar winter heating, summer cooling and natural ventilation through proper orientation, thermal storage, insulation, appropriate glazing, cross-ventilation or stack effect, external shading and internal zoning.

Increasing energy efficiency is one principal responsibility of the architectural profession. Increased awareness over the past decades has virtually made it the main thrust of building design today on the threshold of the 21st century. Energy use is the dominant source of greenhouse has emissions, with 55% of total emissions generated by the combustion of fuels to provide stationary energy. Global output of CO_2 is expected to increase by 70% by 2020 compared to 1995 levels. Energy levels will rise by 65% over the same period if no mitigations are taken. Up to 95 % of the CO_2 produced will come from fossil fuel usage[15]. When considering that 60% of the energy used goes into buildings, architects and civil engineers worldwide are largely accountable for this. Therefore Commonwealth architects can go a long way to cutting this down when considering it is composed of 1.8 million people in 53 countries spanning 5 continents.

References

1 Taylor, D.C, Mohammed, Z.A., Shamsudin, M.N., Mohayidin, M.G., and Chiew, E.F.C. (1993), 'Creating a Farmer Sustainabiulity Index: A Malaysia Case Study'. *American Journal of American Agriculture*, Vol. 8, no. 4. pp.175-84.

2 Bordass, B., Leaman, A. (1994), 'Comfort and Complexity: unmanageable bedfellows?' *Workplace Comfort Forum'*. RIBA, London, March.

3 Janda, K.B. and Busch, J.F. (1994). 'Worldwide Status of Energy Standards for Buildings'. Energy, vol. 19, np.1, pp.27-44.

4 Downloaded data from http://www.bre.co.uk/newsdetails.

5 Population Census, (2005), Centre Office of Statistics, Govt. of Malta.

6 Department of Energy, Energy Information Administration, 1998.

7 Wilson, S., and Hedge, H. (1987) *The Official Environment Study: A Study of BuildingSickness*, Building Use Studies, London.

8 Eurostat 1999 – EU Publication: Overview of statistical records based on data collection from respective member/candidate states, Brussels, 1999.

9 Population Census, Centre Office of Statistics, Govt. of Malta, 1995.

10 Media Publication, Ministry for Resources and the Infrastructure, Works Division, Floriana, 2002.

11 State of the Environment Report, MCST, 1998.

12 Waste Management Working Party, Technical Report, BICC, 2002.

13 Planning Authority, Malta, Annual Report, 2000.

14 Sullivan, E. (1998). 'The Whole Building Story: A Special Report on Star Buildings and Related Strategies for Improving Energy Efficiency'. *Building Operating Management*, September. <httpfacilitiesnet.com/fn/NS/NS3b8ij.html>

15 Lardner, P. (1998). 'World Air Pollution to Balloon'. *Planet Ark*, 13 November.