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Green Technologies and Business Practices

An IT Approach

Patricia Ordóñez de Pablos

Green Technologies and Business Practices:

An IT Approach

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This chapter clarifies the linkages of strategy types and levels that relate to Green IT: business, sustainability, and IT strategy. The underlying strategy framework consists of three different strategy levels (corporate, competitive, functional) and domains (business, IT, sustainability). The conceptualized framework facilitates a holistic Green IT alignment with the aid of a five-step process. In the scope of this alignment process, four different Green IT strategies are presented. These strategies are subdivided along two dimensions: competitive advantage and focus. This research is supposed to provide new insights concerning the strategic impact of Green IT and to assist practitioners in identifying the Green IT strategy that corresponds most appropriately to their firm-specific context.

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This chapter sheds light on the nature of the current paradigm shift in the field of architecture and building sector towards a concern for environmental problems, ecological awareness, and thus, sustainable design and green technologies and materials. Having conceived architecture and building practices as one of the leading economic activities globally, this chapter elucidates the role of architecture in creating business opportunities.

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Chapter 5
Not Madness but Business: A Green Paradigm Shift in Architecture and Building Industry

Murat Çetin
King Fahd University of Petroleum & Minerals, Saudi Arabia

ABSTRACT

This chapter aims to shed light on the nature of the current paradigm shift in the field of architecture and building sector towards a concern for environmental problems, ecological awareness, and thus, sustainable design, green technologies, and materials. Having conceived architecture and building practices as one of the leading economic activities globally, this chapter elucidates the role of architecture in creating business opportunities. The chapter tackles the subject from the perspective of technology and it analyzes the recent debates as well as developments in theory of architecture and building practice in construction industry. This chapter mainly argues that the ongoing paradigm shift moves beyond mere concern with environmental issues and creates an industry and economy of its own. The chapter introduces key concepts in the fields of green building and green architecture.

1. INTRODUCTION

Since the beginning of the events that laid the foundations of industrial revolution, the human species have rapidly transformed their relationships, and therefore, gradually lost their genuine connection with the complex flows and cycles of the nature and universe until recently we all discovered that the way we have tried to control, change and dominate the nature eventually fired back on us. The way we have organized our systems of production and consumption proved to be incompatible with the dynamics of nature and caused a constant state of crisis which manifests itself in every field from economy to arts and culture. Thus, nature seems to have warned us to reconsider our relationship with it. This harsh warning found its response through in almost all aspects of life and

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in all sectors of economy and industry whereby building and construction industry is no exception. In fact, it became one of the leading sectors in the recent phase of transformation of production technologies and processes from exploiting and destructive solutions to ecological, sustainable and environmentally friendly approaches. In that recent cultural context, the development of green technologies and business practices emerges as a vitally significant issue particularly in a leading industry like building construction. However, certain reservations must also be hold definitely with a skeptical and critical stance in regard to both its use in overdose and superficiality of its implementation.

Along this perspective, this chapter looks into the fields of architectural design and building sector in regard to green issues in business and the role of information and building technologies by analyzing recent developments in theory and practice. The aims of this chapter is to shed a light on the position of architectural design in regard to both the green management of the building industry in the 21st century and the well-being of all the citizens in the world.

It is discussed here that the current flux of shifting the attention of the whole industry and its market towards green architecture and building, at the level of a '*green madness*' is, in fact, not only conditioned but rather imposed by the dynamics and mouth-watering motives in '*green business*'. Hence, it is also argued here that the current paradigm shift may appear as either strategies for introducing new products and new branding into the exhausted market or well-disguised and polished moves to re-shuffle and re-distribute the customer demand among the competing actors in the field as a solution to the current inflation of supply and stagnation of the building and real estate markets.

This sudden and over excitement with integrating our buildings to nature not only brings together concerns and doubts about the sincerity of this movement but also raises questions in regard to how and to what extent this shift will be accomplished as well as in regard to what it will be the outcomes in terms of plausible losses and disadvantages. In that sense, all this mayhem around ecological, environment-friendly and green technologies may, at times, seem to move beyond a mere concern for energy-efficiency, environment and sustainability. By the same token, all these initiatives may, again at times, appear to be implemented for the sake of satisfying the needs of another industry as well as serving another green cartel. As a matter of fact, the prevailing strong winds of green technologies may arouse such a suspicion that if these comprehensive and well-integrated efforts were genuinely intended merely for the reversal of the process of environmental damage caused by the ongoing economic systems throughout the last two centuries, then the emphasis would be on reducing the over-consumption on which the economy and culture of our era is based and returning to the basic needs and conditions of living peacefully on the surface of the earth for the well being of all the citizens in the world. However, the prevailing paradigm shift appears to foresee a system in which greening is organized only for its certain components while subtly retaining the status quo in terms of economy and its main driving force, that is to say the over consumption. With particular reference to the ongoing greening process of the building construction industry, various and obvious inconsistencies reinforce these concerns. Especially the way cities are planned and the way our urban morphologies are still created despite minor attempts to reduce energy consumption at the scale of single buildings and vehicles seems to conflict with each other. To be more specific, planning of cities encouraging sprawl on much larger scales that is based on maximized commuting and the encouragement of private automobile ownership as well as expansion of the car production industry may show clear inconsistency with the policies of environmental sensitivity. Nonetheless, the green technologies significantly contribute to the

current markets and enhance the industry which not only expands the current economy but also creates an economy of its own. Therefore, this chapter mainly argues that green technologies go beyond mere concern with environmental issues and actually are driven by business.

Indeed, it would be next to impossible for environmental concern to receive such a welcoming ground if the greening was not profitable as proved in the past by the fierce struggles among environmental groups, governments and leading bodies of the industry. Hence, environmental concern had to become an economic asset so as to overcome these tensions. In other word, the means had to become the aims. The green technologies have become another form of consumerism. Thus, the fields of real estate, construction technology and building industry as well as architectural design have been infested with discussion of ecology, sustainability, energy-efficiency, energy-conservation, alternative energy sources, active and passive systems as well as greening the built environment. Despite the great deal of confusion over the terminology, there is a relatively widespread and considerable interest in the topic of sustainability and sustainable construction. The main areas or subjects of focus emerges as the following; Renewable energy, energy saving, water saving, waste management, reduction of CO_2, minimization of emissions, reduction of waste, elimination of pollution. The concerns were extended not only to issues such as; energy consumed in the production, construction as well as transportation of the building materials, heat and radioactive substance release, but also to health issues such as; design of chemical products and processes that reduce or eliminate the use of hazardous substances. In this context, the companies interested in environmental friendly investment started to promote research and development for bio-fuels, green walls, energy efficient buildings and waste reduction. Furthermore, recent researches to investigate the impact of the green economy activities and technologies on occupational requirements have identified new and emerging green economic sectors, increased demand for careers, as well as new and emerging jobs. The success of any green sector relies on the availability of highly skilled and qualified workforce. Manufacturing sector could create about millions of direct and indirect jobs in related industries. Therefore, it is fair to suggest that green buildings have become, and seems that it will continue to be the new industrial paradigm in our era.

The business aspect of green technologies is of special interest to the audience of this book and this chapter in particular. In fact, it is almost possible to mention of the existence of a very profitable 'sustainability sector' in the world today. Besides, green technologies have rapidly become the subject of a survival issue in business because 'traditional' or 'conventional' industries have to struggle with the public's increasing environmental consciousness. It is argued here that methods and principles of green building technologies might have been slightly deviated to intervene with the current inflation (and resulting crisis) in real-estate and building sector, and thus, shifted towards a new market formation, if not control of it. Having considered the ongoing debates which seems to accommodate few conflicts particularly about environmental issues at urban scale, this chapter accentuates the need for reserving ethical concerns regarding the plausibly disguised benefits of involved parties at the peril of public assets, despite sharing the prevailing optimism about the improvement of the relation between forms or processes of human settlement and those of nature.

1.1. Concept of Greening the Man-Made or Built Environment

Human history is nearly parallel with the urbanization history. The evolution of the universe or the nature and social evolution of the human species are not irrelevant either (de Landa, 1997). From this perspective, we can conceive; firstly, the cosmos

as a self-regulating organism that consists of many interacting organisms, secondly, all phenomena (including humans and social events) as dynamic flows of material and energy in a constant movement through complex fluctuations between states of balance and imbalance as the driving force of life in nature, and thirdly all physical manifestations as crystallizations (*i.e. solidifications through transmission, transportation and transformation of materials by various organisms and various forces*) of all these flows at the transition thresholds in the continuum of the transformation of the organisms through an evolutionary process. According to this view, elements that shape our physical environments (including the built environment) are crystallizations of various (*natural or processed*) materials and available energy (*mainly fossil*) under pressure due to extreme intensity and density of material and energy flows that pushes the phases of transformation. Seen from this angle, the way humans used to build their environment until Middle Ages represents total harmony with the flows and cycles of nature through its ephemeral character. The way humans changed their method of building their settlements after Middle Ages until the industrial revolution, however, displays a more static yet still organic and complex character. Along with industrial boom and with modernity as its cultural medium, that manner humans built their environment, thus their cities, have radically changed as another form of crystallization under the pressures of human density. This substantial change, which attempts to control, modify and dominate the resources in the nature, had an extremely mechanical, artificial and over-simplified character that eventually failed to overrule the dynamics of the nature.

In that regard, the physical settings of human species have drastically changed and turned into accumulation of artificial and sterile materials that totally exclude elements of nature particularly with the leaps globally observed between 1950s and 1990s. During these periods housing floor space requirements have folded several times. These forms of crystallizations have resulted in various by-products such as; heat islands, vacant lands in urban areas and underused spaces as well as large wastelands whereas agricultural land has been gradually destroyed. In result, solar radiation, sunshine duration and wind speed is significantly reduced in urban areas while the electricity loads on air conditioning demands, precipitation and cloud formations have been rapidly increased. The impact of these crystallizations on the environment has been recently discovered to be immense. For instance, the energy consumption of buildings is almost equal to nineteen millions barrels of oil a day, which is approximately equals the entire daily production OPEC countries. Today, buildings are known to be responsible for 18% of CO_2, 10% of CO, 6% of SO_2, 4% of NO emissions. Strikingly, inner city consumption is 30% higher than that of outer city which the density is much less.

Doubtlessly, these consequences are directly related to the way we transform the materials in form of these specific forms of crystallizations. As a matter of fact, today, building materials constitute 40% of global economy and the building sector is responsible for 50% of material taken from nature. Moreover, 20% of these materials are wasted during construction phase whereby conventional construction systems produce 35 kg/m^2 solid waste while ecological about 5 kg/m^2 (Lenssen & Roodman, 1995).

1.2. Emerging Paradigm Shift towards Greening the Man-Made or Built Environment

The fact that human species have lived, for the last two centuries, beyond their means, which is characterized by population, production (Daniels, 1999) and consumption explosion has eventually resulted in the destruction of our environment as explained above. Inevitable and increasing awareness of the incompatibility of the way humans construct their built environment with the natural environment, which manifested itself with Kyoto

agreement, have lead to a significant paradigm shift in the way we perceive, understand and reproduce the manmade environment (Streimikine & Girdzijauskas, 2009). Along this line of thinking, sustainable building has turned from an emerging concept to mainstream issue (Gies, 2008). This major shift had various ramifications such as; reversal from 'buildings that *need* energy' to operate to 'buildings that *produce* energy', or re-utilization of the inherited intelligence rather than artificial and over-simplified pseudo-scientific techniques of formulating for understanding nature as well as looking at the basic state of things simply by going to primordial condition. Such a shift obviously requires a way of living in harmony with nature and learning from ancestors. The motto 'less is more' is re-adapted as the basic principle for this new way of living. In that sense, the motto of 'cradle to cradle' (McDonough, 2002) is suggested as a template for cities with the principles of eco-effectiveness and eco-efficiency. It necessitates making the most of all passive means provided by building's fabric by revisiting back to a state which was formerly characterized by willingness to blend with and adapt to rather than to control, to exploit and to dominate the nature.

Sinha (2009) defines this new state-of-mind as a mental shift towards a sustainable future whereby green building plays a key role. Having considered this over-densification of human species in the world and especially in urban settlements as an intensification of material and energy, and this paradigm shift as a phase transition in the overall evolution, the notion of 'green buildings' is rapidly becoming the center of attention by various parties involved in the 'crystallization of our environment' at this point in time. There is a substantial amount of literature and previous research indicating that real estate market players have an upraising interest towards environmental sustainability (Pivo, 2009). Nevertheless, the drivers for developing, constructing, acquiring, maintaining, and occupying the sustainable buildings are quite different for the different market players.

1.3. Historical Overview of the Idea of Greening the Man-Made or Built Environment

It is of interest to overview the near past in a historical perspective so as to legitimize the validity of the arguments introduced above. As mentioned before, the process of changing the relationship with nature had started at the beginning of the 19th century. Following a century of mass production and accumulating environmental impacts, the first half of the 20th century witnessed global wars and resulting destructions in terms of material and population losses. Thus, the second half of the 20th century has become a period of the reorganization of production and consumption systems. In that context, this period has been characterized by efforts of comprehensive recovery, thus massive production and rapidly increasing consumption which together not only required increasing demand for energy yet also caused the extreme exploitation of fossil sources. As a result of the oil crisis of the 1970s, the notion of energy saving in both the construction and operation of buildings has been a strategic issue in the building industry (Ngowi, 2001). Hence, various groups in the civil society began to advocate 'radical change', suggesting alternative modes of development and revisions of consumption intensive lifestyles, which later led to the first eco-communities (Melchert, 2007), The practices of 'environmentally aware construction' emerged as an attempt to transform the very concept of dwelling during this period (National Dubo Centrum, 2000). The dwelling was considered not only as a place to live but also as part of a broader ideology, a connection between man and nature. The first and the most widely adopted measures were the use of grass roofs and various techniques to improve the heat insulation, advocated by those who were concerned with environmental care as well as public health.

The European countries started to hold a leading position in attempts to establish the environmental awareness in building industry. However,

the first initiatives received some sort of resistance since they were considered as threats to the ongoing modernist building production systems. The process of the institutionalization of environmental policies in the Dutch building sector epitomizes the evolution of the idea of sustainable building practices. The first practices in the field of sustainable building in the Netherlands came within this conflict prompted by eco-centric / radical approaches in architecture, which were regarded as either too idealistic or impracticable by society. In this period which can be defined as the 'de-modernization' phase, the proposed measures were too costly, alternative or environmentally sound construction materials were too troublesome to procure, and radical change incited an image of an alternative lifestyle, which most citizens did not wish to be identified with. A more moderate approach in reducing the environmental impacts of building stocks emerged one decade later in the Netherlands, when it was realized that construction approaches and lifestyles did not have to break away completely from modernity but instead, have to adapt technologies of construction towards managing the environmental impacts through a combination of passive, nature based and low technological approaches, and active and state-of-the-art solutions and techniques which can even contribute to the modernist industries. In the early 1980s, which can be called the 'ecological modernization' phase, energy efficiency and energy diversification became the key subjects of the building industry. A series of new programs were undertaken in housing, office buildings or other commercial and industrial buildings. Thus, a new phase in the institutionalization of sustainable building practices in the Netherlands started to emerge as the sustainable development discourse which came to the foreground, introducing the idea of closed loops for materials, energy saving and efficiency and the promotion of quality as primary lines of policy. The policies such as climate change, ozone depletion, acid rain, fertilizers, and waste disposal were also emphasized as it was understood that environmental issues were not only limited to the dimension of energy conservation. This period coincided with the first scientific discussions about climate change and the establishment of the United Nations intergovernmental panel on the matter, raising the possibility international environmental agreements forcing particularly developed countries to significantly reduce the gas emissions which cause climate change. Moreover, the negative impacts of construction materials on the environment started to be dealt with more seriously, as the building industry was identified as a prime target group to reduce climate change. Indeed, the building industry is responsible for a large part of the world's environmental degradation as buildings converge in themselves major indexes of energy and water consumption, raw material employment and usage of land. In order to cope with the services they provide, such as lighting, water and climate control, buildings generate considerable amounts of greenhouse and ozone-depleting gases throughout their life cycles, which will have enormous impacts on nature (Anink *et al.*, 1996; UNEP, 1996).

As can be seen above, the transition of sustainable building practices in the Netherlands from the 1970s until today shows a continuous, smooth but rapid character. These practices were originally embedded in a discourse on 'de-modernization', which attempted to improve the environmental performance of buildings through self-sufficient technologies, whereas nowadays they adopt a framework of 'ecological modernization', with integrative approaches aiming to improve the environmental performance of building stocks through more efficient—rather than self-sufficient—technologies. Therefore, the current Dutch sustainable building framework has managed to achieve a pragmatic and widely accepted rationale (Melchert, 2007). A very characteristic example dating from this period is the NMB Bank, currently ING Bank in Amsterdam, Netherlands. This building was the result of the bank's ambitious

board of directors, which had some members keen on the anthroposophical philosophy of Rudolf Steiner, who commissioned a building complex to be environmental and human-friendly, aiming not only to improve the staff's well-being but also to provide the image of a 'people friendly' building, that is, of a non-intimidating bank for its customers (Vale, 1991). The commission was given to the Amsterdam architects Alberts & van Huut, specialists of the 'organic architecture' style inspired by anthroposophical concepts by which the building provides a 'third skin' for people (i.e. after skin and clothing), with the architecture attempting to represent the natural environment as much as possible (Press LMS, 2005). Various energy saving technologies that were state-of-the-art at the time were used in this building.

Another example from a totally different location and culture is the IBM headquarters Kuala Lumpur, Malaysia. It was first designed of in 1989 and finally completed in 1992. IBM asked the office of T.R. Hamzah & Yeang Architects for a building which was a high-tech corporate showcase for their highly visible site and high-technology industry. Ken Yeang designed this building as a practical example of his bioclimatic skyscraper principles. The building adopts basic of traditional building models and their translation or evolution into modern principles. It represents the vision of the tropical garden city as an attempt to transform the impact of high-rise emphasis in the ecosystem of cities. Sky gardens that serve as villages while the facade serves a filter whereby the louvers and shades relate to the orientation of the building and allow or reduce solar gain. The building design deployed the principles such as; spiraling vertical landscape, recessed and shaded windows on the East and West, curtain wall glazing on the North and South, single core service on hot Eastern side, naturally ventilated and sunlit toilets, stair ways and lift lobbies and spiral balconies on the exterior walls with full height sliding doors to interior offices. Thus it became a symbol of climatic and ecological design at the end of the last century. Having overviewed the evolution of green technologies in building sector through the first typical examples, it is now of interest to review the definitions, aims, criteria as well as the facts about the notion that prepare the ground for the arguments of this chapter.

2. MADNESS OR BUSINESS: FACTS AND DEBATES ON GREEN BUILDING

Prior to the discussion of whether green building is a type of frenzy that humanity is lately going through or it is another manifestation of corporate activity, it is more appropriate to start by the definition of the terminology and its objectives, and later, continue with the conceptual background of the idea as well as the statistical facts about the idea of greening built environment.

2.1. Definitions

A simple yet clear definition for a 'green building' is given by ASTM International (2001), as "a building that provides the specified building performance requirements while minimizing disturbance to and improving the functioning of local, regional, and global ecosystems both during and after its construction and specified lifetime of service." Moreover, "a green building optimizes efficiencies in resource management and operational performance; and minimizes risks to human health and the environment." The notion of 'green building' sets a clear goal for improved eco-efficiency although it does not directly define specific targets for environmental sustainability. The idea of 'green building' also embraces economic and social dimensions of sustainable development by emphasizing requirements for energy performance and human health. AIA define sustainability continue functioning into future without decline through exhaustion and

overloading key resources that system depends (Mendler & Odell, 2000).

2.2. Objectives and Criteria

The aim behind the notion of a sustainable environment that is composed of green buildings is to provide satisfactory levels of specified building performance (ASHRAE, 2001; ASTM Int., 2001) whilst minimizing consumption and environmental loadings over a buildings life cycle. Kilbert and Grosskopf (2005) argue that the ideal green building should have five major features; integration with local ecosystems, closed loop material systems, maximum use of passive design and renewable energy, optimized building hydrologic cycles, and full implementation of indoor environmental quality measures (Burnett, 2007). Principles behind the green building (ERI, 2004) can be summarized as; the use of alternative and renewable energy, reduction of gas emissions and wastes, production of more energy than to be consumed, utilization of passive systems as much as possible, adoption of recycling methods, use of natural materials rather than synthetic materials. These principles are formulated as a specific design approach (Williams, 2007) in architecture and planning, which can be named as sustainable design.

2.3. Context and Background

The notions of ecological living, sustainable environment and green building have multi-faceted dimensions. It is directly related to economics and politics. McDonough's (2002) notion of 'sustainability triangle', which is a conceptual model of his fractal ecology, clearly shows its relationship to these issues. In this model, he positions what he calls 'ecologism' between socialism and capitalism (which used to be positioned in bipolar manner), thus respectively, 'ecology' between equity and economy. He suggests that only one part of this triangle is currently utilized in the prevailing economic and political system whereas the system should cover the entire triangle for a sustainable way of living. The issues of efficiency, marketability, profitability, are currently in conflict with social concerns such as welfare, equality, and respect in the ongoing bipolar system. The concern for effective use of resources to generate prosperity and revenue dominate the economic, and thus, political activity on the world. The ecologist approach that he suggests proposes not only a return to primordial state by becoming native to place, indigenous to planet, whereby rights of nature and other species in the habitat are concerned, but also principles of design with sustainability (McDonough, 1991) whereby cities are conceived like forests and buildings perform like trees.

The idea of sustainability focuses on the ability of the human population to live within the earth's environmental limits (Lehmann, 2008). Environmental sustainability requires natural capital to be maintained, both as a provider of resources and as a depository for wastes. This capital is a prerequisite for social and economic sustainability (Costanza and Daly, 1992; Goodland, 1995; Burnett, 2007). Girardet's (2000) concept of a sustainable city seems to lie somewhere between sustainability and sustainable development. In other words, "a sustainable city is organized so as to enable all its citizens to meet their own needs and to enhance their well-being without damaging the natural world or endangering the living conditions of other people, now or in the future." Although Blassingame (1998) argues whether sustainable city is inevitable, Girardet's concept remains an ideal. Today's reality is to strive for cities that are progressively more sustainable, considering the fact that those entrusted with the overall responsibility for city planning, development and management are only able to offer incremental approaches towards this ideal. The development of cities is a matter for governments through land use planning, standards and guidelines, but much

city land is for buildings, mostly private buildings which aim generating individual capital.

As a matter of fact, there are many ways to interpret and approach the creation of sustainable architecture. Green architecture has relevance beyond merely choosing intelligent or certified building materials. Although very useful, endeavors like certification of LEEDS, which will be discussed below, do not often consider the broader concept of "sustainable communities" that also accommodate social, economic and cultural aspects of sustainability (Frobeen, 2006). Frobeen (2006), referring to T.Hancock's (2002) notion of '*soft infrastructure of a healthy community*', whereby it is suggested that "sustainable city is one that is more than its physical form," raises further issues to be included in the scope of green building industry. In addition to the fact that both the location and the way buildings are built affects the ecosystems around us in countless ways, the buildings themselves create new indoor environments that present new environmental problems and challenges. Furthermore, the increasing use of synthetic materials, solvents and artificial or mechanical systems of environmental control within buildings constitute serious threats to physical and psychological health and personal well-being (Hanie *et al.*, 2010). Thus, this recent concern has various parallels with the notion of "Sick Building Syndrome" (SBS) which was used about a decade ago to describe the condition where people easily get mental and physical diseases by occupying a particular building (Edwards, 1998). In result, the demand for green buildings has arisen although the real estate sector's central parties, the investors, occupiers, contractors, and developers, still argue around the 'circle of blame', arguing that they would go green if there is more support. For example, the insufficient choice of buildings has been ranked as the most important factor impeding the tenants from occupying green buildings (Cushman and Wakefield, 2009). Barriers reported by investors are mainly; insufficient financial performance, lack of information, and legal restrictions (Pivo, 2009). Nonetheless, there is a large body of literature and research proving that real estate market players have an interest towards environmental sustainability (e.g., Pivo 2009).

2.4. Facts on Greening the Built Environment

There is a comprehensive body of research putting forward not only the impact of buildings on the environment and its deterioration but also on the capacity of greening building sector in terms of economics. In other words, the statistics show that building activity has not only a major impact in the environment, thus a crucial role in the greening the man-made environment, but also has a substantial economic capacity. This section will tackle the statistic in these two channels.

Firstly, the statistics reveal the fact that buildings constitute the major source for energy consumption. Buildings represent 38.9% of U.S. primary energy use (i.e. including fuel input for production) (EIA, 2008). Buildings are one of the heaviest consumers of natural resources and account for a significant portion of the greenhouse gas emissions that affect climate change. In the U.S., buildings account for 38% of all CO_2 emissions (Energy Information Administration (2008). Materials Buildings use 40% of raw materials globally (3 billion tons annually). According to Dimson (1996), building construction accounts for 25% of the virgin wood and 40% of the raw stone, gravel and sand used worldwide each year. Globally, buildings consume 16% of the water, 40% of the energy used annually, and close to 70% of the sulphur oxides produced by fossil fuel combustion are produced through the creation of the electricity used to power houses and offices. In organization for economic development and co-operation (OECD) countries, the building sector generates about half the total carbon dioxide output - the use (or abuse) of which can be greatly influenced by policymakers, urban planners, designers

and engineers (Edwards, 1996; 1998). Buildings represent 72% of U.S electricity consumption (EIA, 2008). Water Buildings use 13.6% of all potable water, or 15 trillion gallons per year (US geological survey, 2000). Buildings accounted for 38.9% of total U.S. energy consumption in 2005. Residential buildings accounted for 53.7% of that total, while commercial buildings accounted for the other 46.3% (BED, 2006). Moreover, buildings accounted for 72% of total U.S. electricity consumption in 2006 and this number will rise to 75% by 2025. 51% of that total was attributed to residential building use, while 49% was attributed to commercial building usage. Moreover, the average household spends at least $2,000 a year on energy bills over half of which goes to heating and cooling of their houses (US EPA ENERGY STAR program). Out of the total energy consumption in an average household, 50% goes to space heating, 27% to run appliances, 19% to heat water and 4% goes to air conditioning. Studies show that buildings in the United States contribute 38.9% of the nation's total carbon dioxide emissions, including 20.8% from the residential sector and 18.0% from the commercial sector (DOE, 2008).

On one level, cities, as agglomeration of buildings, constitute a major threat to environment. For instance, the annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F (1–3°C) warmer than its surroundings. In the evening, the difference can be as high as 22°F (12°C). Heat islands can increase summertime peak energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality (US EPA).One study estimates that the heat island effect is responsible for 5–10% of peak electricity demand for cooling buildings in cities (Akbari, 2005). Total land area in the U.S. is 2.3 billion acres. Urban land area quadrupled from 1945 to 2002, increasing at about twice the rate of population growth over this period. Estimated acreage of rural land used for residential purposes increased by 21 million acres (29%) from 1997 to 2002 (DOA, 2002). On another level, building related activities create significant amounts of waste. For example, building-related construction and demolition (C&D) debris totals approximately 160 million tons per year, accounting for nearly 26% of total non-industrial waste generation in the U.S. Combining C&D with MSW yields an estimate that building construction, renovation, use and demolition together constitute about two-thirds of all non-industrial solid waste generation in the US (excluding debris related to road, bridge or other infrastructure development) (OSW, 2003). Sources of the building-related C&D debris waste stream include demolition (accounting for approximately 48% of the waste stream per year), renovation (44%), and new construction (8%). An estimated 20 to 30% of building-related C&D debris is recovered for processing and recycling. The materials most frequently recovered and recycled were concrete, asphalt, metals, and wood (OSW, 2003).

Secondly, the statistics reveal the fact that buildings constitute the major potential for creating economic value through greening the built environment. Indeed, the building activity is a major economic activity as the following examples clearly reveal. Nearly 4.9 million office buildings existed in 2003 in the U.S (http://www.eia.doe.gov/emeu/cbecs2003/introduction.html). Every year, approximately 170,000 commercial buildings are constructed, while nearly 44,000 commercial buildings demolished (MCD, 1995). The overall green building market (both non-residential and residential) is expected to reach to more than double from today's $36-49 billion to $96-140 billion by 2013 (McGraw Hill Construction (2009). The value of green building construction is projected to increase to $60 billion by 2010 (McGraw-Hill Construction (2008). The construction market accounts for 13.4% of the $13.2 trillion U.S. GDP (Department of Commerce (2008). The green market was 2% of non-residential construction starts in 2005; 10-12% in 2008; and will grow to 20-25% by 2013 (McGraw Hill Construction (2009). The role of

the built environment in the sustainability agenda has increased strongly during the past decade. For example in United States, the built environment accounts for 40% of the total energy consumption and over 38% of the total carbon dioxide emissions (e.g. USGBC, 2009). Consequently, the built environment and the real estate sector have an important role in climate change and in delivering a sustainable energy economy. It has also been suggested that real estate investors sometimes demand "green" features in buildings, but do not demand sustainable buildings because they have a lack of knowledge on their benefits (Keeping, 2000).

There are also statistics about cost of LEED certification. These studies show that costs for research, LEED documentation, registration and application costs constitutes only a minor part when compared to the construction budgets (determined by design choices) in contrast to what investors claim. Also the certification authorities promote themselves by saying that their certification increases the value of properties and also affects positively the image of the real estate company. However, this argument has not been proved through scientific researches yet.

2.5. Approaches

Under the light cast by the aforementioned facts, the available approaches concentrate on promotion of green technologies towards a sustainable future. Until the recent paradigm shift, it has been a mainstream way of thinking the industry and environment as being at odds due to conventional methods of extraction, manufacture and disposal whereby industry and growth are portrayed as destructive while environmentalism is conceived as obstacle. The problem here could be diagnosed as the fact that industrial revolution *per se* originally did not have a design, at all, as a whole but took shape gradually. It was purely driven by desire for acquisition of capital and efficient mass production to large amount of people. The broader picture was not considered although the genuine intentions were not bad. Doubtlessly, there are no limits in a world of abundance. Thus, the solution of the resultant environmental crisis after two centuries of mass-destruction at the peril of our habitat the ideal solution for our species would be to stop being so greedy and to consume less. Nonetheless, it was sufficient to find ways of coping without hindering the ongoing economic system.

However, the emerging movement promises to lay the foundations towards next step in industrial revolution. One of the promising approaches, called 'cradle to cradle' (McDonough & Braungart, 2002), which seems to achieve of conceiving the problem from a broader perspective, suggests the appropriation of the motto 'waste equals food' and introduces the notion of 'eco-effectiveness' rather than mere 'efficiency'. As pointed out above, tree, which has a crucial role in ecosystem, is taken as both a model and a metaphor of thinking. Moreover, ants, whose biomass is very small yet industrious production of which nourishes, plants, animals as well as soil, is also taken as an example of a new way of living in harmony with nature. Furthermore, other cultures that work within nutrient flows are also suggested as sources of inspiration.

The current research is limited to the energy performances of individual buildings, development of new techniques, systems or materials with better energy performance and environmental impacts of the building components and materials. There is a significant gap in studies which focus on the evolution, the most striking aspects, present needs and future trends of the subject of sustainable building and urban design despite few studies (Guedes *et al.*, 2006) on the integration of renewable energy systems at urban and building scale. Yilmaz & Keles (2004) stresses the role of cities (with references to Leitmann (1999)) and particularly of housing, which constitute 80% of the current urbanization (Oktay,2001), as an opportunity to reduce industrial and transport related pollution and the impact of urban areas

on nature with an accentuation on both 1995 EU summit in Rio de Janeiro with Agenda 21 as well as on the 6th Environment Action Programme that define sustainable development as qualitative and controlled, rather than ruthless, development with emphasis on preservation. The following section will introduce the current issues on the agenda of environmentally-sensitive building sector under the following headings; design aspects, building technologies, materials as well as certification and legislation which constitutes a key aspect in the institutionalization of this recent awareness and accompanying paradigm shift.

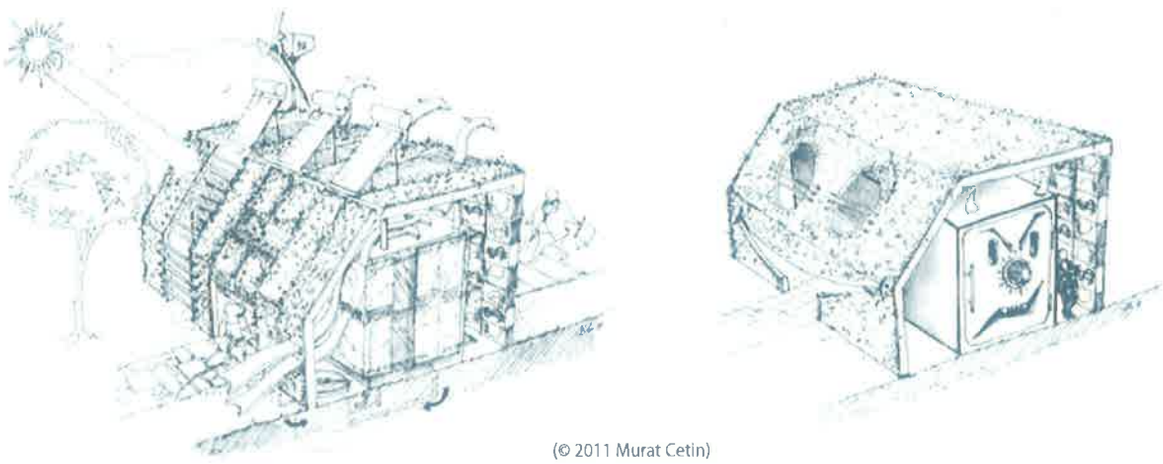
3. GREEN BUILDING INDUSTRY AND GREEN ARCHITECTURE

3.1. The Green Building as a Popular Trend of Global Culture

In this part of the chapter after all the aforementioned discussions, it is argued that 'green building' is a new industry rather than a cultural phenomenon yet. Although it is suggested as a remedy not only to cure the ills of the global corporate system that exploited both the nature and society at large so as to accumulate further capital but also to reconsider the position of humanity in regard to nature and other species, the notion of 'green building' has the tendency of falling into the trap of becoming another global, trendy instrument of capital accumulation at the peril of communal harmony which is the key factor for a sustainable way of living in nature. It seems that the main drives behind this paradigm shift are the formation and control of a new market through various disguises as the intrinsic conflicts, facts and figures raises questions regarding the ethics of this new movement until the emerging conflicts are resolved and this paradigm shift becomes a cultural phenomenon equally shared by all parties that are involved in the formation of physical environment (Figure 1).

Neither cities nor city buildings could themselves be sustainable, but they can significantly contribute to global environmental sustainability (Burnett, 2007). The reason why building sector adapting new strategies seems to be the need for (economic) survival in an age of extinction (in business) due to a serious crisis in fossil fuels (Sullivan, 2009). Nonetheless, this shift promises far beyond than mere survival. As a matter of fact, it turns out to be extremely profitable. According to figures, the extra initial cost (3-5 $ /ft^2) of building green guarantees a 50-65 $ /ft^2 in total 20-year net profit. It also has indirect benefits

Figure 1. Contemporary real-estate investments disguised as green buildings



(© 2011 Murat Cetin)

such as; the gain in productivity (6-26%), in retails sales (40% higher in day lit stores faster learning in schools, (20-26%) (Le Forestier, 2010). An upfront investment of 2% in green building design, on average, results in life cycle savings of 20% of the total construction costs – more than ten times the initial investment (Kats, G. (2003). Therefore, green construction practices (GCP) are mainly driven by managerial concerns rather than stakeholder pressures since clients are more concerned about immediate or short-term results instead of the potential benefits from improving environmental performance that may occur in the future (Shen and Tam, 2002). Therefore, clients put more attention to the analysis of project economic performance in project inception and design stages (Shen *et al.*, 2010).

The certification, which operates as a control device for this new mechanism, will be discussed below in regard to its role in establishing the new ground for the building sector in its transformation towards an environmentally sensitive status. LEED was initially created to reduce the environmental impacts of the built environment; however, there is no comprehensive evaluation of the overall impact of LEED that has been conducted so far. The findings are still both cautionary and encouraging. Overall, it is believed that LEED buildings are making a major impact in reducing the overall environmental footprint of individual structures. Nonetheless, significant further progress is still possible and indeed necessary on both the levels of individual building and market penetration if LEED is expected to contribute to reducing the environmental impact of buildings worldwide in a meaningful way (Watson, 2008). In fact, LEED cannot transform the market all by itself. LEED is a crucial part of the market transformation process that combines market pull with regulatory push. However, it currently operates as a control mechanism which eliminates the products unsuitable to satisfy the standards set for the new market and its industry.

Besides, the whole process has been so much promoted by the media and press who displayed a significant of change in its attitude that greening of our environment has become a trendy issue of the populist culture. However, this creates another type of conflict whereby any phenomenon that is so much popularized is bound to be appropriated by the corporate bodies. As a matter of fact, the shift in the position of the media, which is mainly driven by the large corporate groups today, supports the arguments voiced above. Consequently, the notions of; first, the popularity of the environmental issues s publicized through press and media, secondly, the formation of legislative bodies to control the market, and finally the emphasis on the managerial aspects of environmental concerns in the industry raises serious concerns regarding the future direction of this recent paradigm shift.

The recent shift towards greeing the building activity towards creation of a sustainable environment has also created a culture of its own. Yet, this culture is different in character than a shared consciousness of indigenous and native inhabitants of a public environment. Instead, it exhibits the characteristics of a new populist culture of 'green consumerism' (Mansvelt, 2010) although Pierce (2007) defines this as a 'green revolution' which is burgeoning. Mansvelt critically evaluates what green consumerism has become, but more critically, how it might evolve, addressing both limitations and possibilities for real and meaningful change. The available studies help us to define the nature of this process. The body of research through a high number of discussion and policy papers reflects the relative novelty of the topic and thus scarcity of actual market evidence (Falkenbach *et al.*, 2010). According to this observation, it seems that the research papers were categorized according to the drivers into three groups: papers discussing external drivers, corporate level drivers, and property level drivers. The in-depth research was focused on corporate and property level drivers. However, the issue needs to be tackled in a framework which covers

a broader context of process, issues, strategies and elements of green design. In that sense, three main principles of architectural design, which was established around two millennium ago by Roman architect Marcus Vitruvius Pollio, namely *commoditas*, *firmitas* and *venustas* seems to have been enhanced and enriched by the principle of *restitutitas* (restitution, restoration and reinstatement) where building contributes to its environment through passive design methods, energy production elements as well as insulation elements and materials (ERG, 1999).

This new culture finds its roots in the solid grounds of sensitive issues such as climate change and the poor conditions of developing countries. However, the pseudo-sensitivity and superficial awareness on these issues created through popular media channels neither, yet, guarantee implementation of the principles of sustainable living and building nor assure the prevention of compromises. Indeed, climate change, on the one hand, as a major threat to the sustenance of living on earth, is a consequence of the accumulated environmental pollution caused by the activities of human species. As discussed above with figures, construction activities, when compared with other industries, are considered to be the major contribution to environmental pollution (Ball, 2002; Hendrickson and Horvath, 2000; Morledge and Jackson, 2001; Tam *et al.*, 2004; Tam and Tam, 2008). Moreover, the environmental pollution caused by construction activities includes those related to noise, air, solid waste and water pollution, etc. (Majdalani *et al.*, 2006; Tam *et al.*, 2007).

On the other hand, the status of environmental concerns displays an even worse scenario for developing countries particularly in non-OECD countries (CIB & UNEP-IETC, 2002). Despite differences in climatic, cultural and economic contexts, there are many similarities between developed and developing countries regarding the environmental impacts of the building industry (John *et al.*, 2000). In these countries, it is generally perceived that internalization of environmental care practices translate into additional cost, thus reducing profits of the construction industry. Thus, the construction sector in the developing world is rather reactive to the issue. In result construction industry is substantially destroying the environment particularly in countries. For instance, in these countries, like China, every ten thousand square meters of construction area would produce 500e600 tons of solid wastes, while in developed countries, such as in U.S.A., the number of tons is about 180 (VANR, 2006;Wu, 2008; Li &Yao, 2009). Therefore, environment related problems are related to the fragile environments in these countries (Ngowi, 2001) (CIB & UNEP-IETC, 2002).

It is a crucial issue noteworthy of drawing attention that these developing countries, today, suffer from the disadvantages of modernist construction technologies imported from the developed countries at the beginning of the century although their genuine and traditional architecture was absolutely very sustainable through conventional and passive methods of utilizing energy. Indeed, success of a technology at a particular time also depends on its 'social' relevance and impact. The dominating economical system and its ramifications in the building technology have caused those societies, who are pushed to suffer from environmental conditions today, to lose the social ties with the way they built and shape their environment whereby they used to apply conventional methods and traditional techniques of vernacular architecture in dealing with climatic and geographical conditions (Daniels, 1999). However, modern urbanization endangers the cultural sustainability embedded in the urban-architectural heritage (Cetin, 2010). The conservation of the cultural aspects of sustainability requires more emphasis on passive methods (ERG, 1999) rather than promotion of green high technology products. For instance, buildings in the Iranian desert regions are constructed according to the specific climatic conditions and differ with those built in other climates (Amirkhani, 2010). Desert buildings are equipped with wind catch-

ers, arch-roofed air traps, water reservoirs with arched-domes and ice stores for the preservation of ice. The operation of modern coolers is similar to the Old Iranian air traps which were built at the entrance of the house over underground water reservoirs or ponds built inside the house to facilitate humidifying the hot dry air inside the houses. The great wind catchers of Iran epitomize zero carbon cooling technologies.

Nevertheless, significant compromises from the ideals of sustainable future are witnessed for sustaining the existing status quo in the building industry. Not only the conventional methods of passive utilization of energy-efficiency were given up, but also the target of zero impact on environment was compromised. The idea that as zero impact *per se* is practically unachievable to full extent, directed the efforts to reduce the impact level only to where it is either intolerable, or where the cost of its reduction is reasonable. This meant applying all available means to mitigate the environmental impacts and to improve the building's performance as long as these means do not entail additional costs, which would hamper the economic feasibility of the investment (VROM). Despite insufficient understanding of manager's key arguments or business logic for adopting corporate sustainability strategies (Salzmann *et al.*, 2005), the commitment of efforts and resources from contractors to meet the needs related to the reduction of environmental impacts is usually motivated by the influence exerted from environmental regulations of the governments and stakeholder demands. However, it has been found that managerial concern is the most important driver for the adoption of green practices (Qi *et al.*, 2010).

3.2. The Green Building as a Business Case for Sustainability

Construction, as one of man's activities, is acknowledged to have real and potential impacts on the environment and well being of the populations of the world (UNCHS, 1996; Spence &Mulligan, 1995). Therefore, the dialectics between ecocentrism and technocentrism, as well as the dichotomy between 'state versus market' or 'environmental protection versus development' of the 1970s, lost strength (Huber, 2000). Radical change or demodernization was no longer the main rhetoric in the field of environmental politics. The major discourse, on the contrary, gradually evolved in the direction that different interest groups began to understand the possibility of including environmental care through different practices, in an 'ecological modernization' process, through which both economy started to be ecologized and ecology started to be economized. Thus, the notion of 'environmental concern' started to loose its naive trait and grow to be a possibility of integrating into productivity and industrial systems more efficiently (MolAPJ, 1993; 1995). As a consequence of this transformation, the commoditization of green emerged as a strategy (Gensler, 2003) to make advantage of the possibility of including environmental care through different practices around the notions of; corporate sustainability, environmental performance, financial performance and corporate social responsibility. The business case for sustainability (BCS) has been approached in many different ways to prove or disprove the sound economic rationale for corporate sustainability management which could be defined as "a strategic and profit-driven corporate response to environmental and social issues caused through the organization's primary and secondary activities" (Salzmann *et al.*, 2005). The current research on the BCS seems to be divided into two categories: theoretical and empirical studies. The theoretical studies are based on frameworks that aim to explain the nature of the relationship among financial performances (FP), environmental (EP) or social performance (SP). The empirical studies, which also follow two different lines as instrumental and descriptive research, aim either to empirically test the relationships hypothesized in theoretical stud-

ies or to examine how companies and managers approach the BCS in practice respectively.

Nonetheless, construction sector is commonly known as a backward industry (Wei and Lin, 2004; Yitmen, 2007). Contractors have to respond to the challenges imposed by governmental regulations and pressures from project stakeholders (*e.g. community, ENGO {environmental nongovernment organization} and employees etc.*) (Sarkar, 2008; Robin and Poon, 2009). The studies reveal, however, they may adopt different responses according to the level of perceived pressures exerted by environmental regulations and project stakeholders (Shen and Tam, 2002). Clients, on the other hand, seem to put more emphasis on the analysis of projects' economic performance in project inception and design stages (Shen *et al.*, 2010). Similarly, contractors do so who will not voluntarily invest their limited assets to implement green construction technology or practices (GCP). Studies have shown the evidence that firms with larger size are more likely to implement GCPs (Zeng *et al.*, 2007; Li *et al.*, 2010) simply because large companies have more resource availability to devote to environmental management (Sharma, 2000), small firms may have more difficulties to adopt environmental friendly practices, because of lack of resources to do it (Barney, 1991).

Based on the aforementioned findings the following can be derived. Firstly, companies that aim improving their environmental performance through GCPs need managers with knowledge and concern for environmental issues. Secondly, incentives are required for green managers based on their environmental management performance so as to stimulate them in committing efforts and resources towards environmental initiatives and monitoring environmental behaviors at lower organizational levels. Thirdly, large contractors seem to have the ability to meet the challenges of environmental management requirements, which include investments in technology, human resources or certifications while this is not easy for middle and small size contractors. Therefore, the encouragement of merged large and middle size contractor's environmental strategies is considered an important strategy for successfully implementing green construction practices at all levels without excluding small scale business from the scene.

Whilst buildings are major contributors to environmental degradation they are, at the same time, important in sustaining businesses and the city economy and, given that city folk spend some 80–90% of their time indoors (Chau *et al.*, 2002), they can contribute positively to the quality of life. Therefore, GCPs constitute a significant potential in sustainable development (Cole, 2003). As discussed previously in relation to the conceptual diagram of 'sustainability triangle', the introduction of the component of 'ecology' into the equation of political and economical system would definitely contribute to the solution of intrinsic handicaps of the current system (Tan *et al.*, 2010). Therefore, the current paradigm shift presents a variety of reasons why we should build green in terms of business. Firstly, it saves money. Secondly, consumes less energy and fewer resources which directly influence the cost. Thirdly, inhabitants produce more which indirectly contributes to overall productivity. For instance, the cost per square foot for green buildings (i.e. seeking LEED Certification) falls into the existing range of costs for regular buildings (Langdon, 2007). An upfront investment of 2% in green building design, on average, results in life cycle savings of 20% of the total construction costs – more than ten times the initial investment (Kats, 2003). Besides, building sale prices for energy efficient buildings are more than 10% higher per square foot than conventional buildings (Miller *et al.*, 2007). As a matter of fact, construction and real estate professionals overestimate the costs of green building by 300% (WBCSD, 2008). However, perceived cost benefits of green building (McGraw Hill, 2006) are as follows; operating costs decrease 8-9%, building value increases 7.5%, return on investment improves 6.6%, occupancy ration increases

3.5%, and rent ratio increases 3%. Moreover, green buildings consume 26% less energy; they have 13% lower maintenance costs, 27% higher occupant satisfaction, and 33% less greenhouse gas emissions in comparison to the average commercial building (GSA Public Buildings Service, 2008). Green building also seems to stimulate the global economy by creating a demand for green jobs and workers that can contribute directly to creating a sustainable future. It is estimated that the US economy only could generate around two million green jobs within two years (PERICAP, 2008).Furthermore, researches proved a correlation between improved lighting design and a 27% reduction in the incidence of headaches, which accounts for 0.7% of overall employee health insurance cost at approximately annual $35 per employee (Aaras *et al.*, 1998). There are further studies which show the relationship between increased productivity and sustainable buildings (Heschong Mahone Group, 1999; McGraw Hill, 2007; Fisk, 2000). Therefore, as the recent stream of research proves, the entrepreneurship appears as a solution to, instead of the cause for, environmental degradation. Entrepreneurial innovation may "reform or revolutionize industries by exploiting an invention or an untried technological possibility" while improving the production of or creating a new product (Schumpeter, 1942). However, empirical tests of both Schumpeter's early theory of creative destruction and late theory of the need for large firms to provide innovation are yet inconclusive (Ahuja *et al.*,2008).

3.2.1. Incentives and Certification as Mechanisms of Market Control in Green Building

The governmental incentives play a crucial role in transformation of the nature of the industry. Moreover, incentives serve to reverse the traditional vision about the incompatibility between good business and the environment (Gallarotti, 1995). They could be in form of direct financial contributions or tax exemptions. The incentives clearly control the capital flow in the required direction. Similar to incentives, certification is also another mechanism which secures the implementation of the principles of green buildings. Regarding the aforementioned potential for entrepreneurial initiatives on green building, the notion of 'certification' plays a key role. Certification serves as an instrument to regulate the supply to reorganize the market. In this context, the discussion, here, considers the performance standards of green building eco-labels, as a certified grade (or rating) of performance achieved under a building environmental assessment method (BEAM), and the extent to which performance relates to the indicators for the sustainable city. BEAMs emerged in the early 1990s to provide some measure of the environmental performance of buildings, and now some 20 or so such tools are in use world-wide. Among these assessment methods, some are well-established, such as BREEAM (Baldwin *et al.*, 1990, 1998),HK-BEAM (HK-BEAM Society, 2004), and LEED (US Green Building Council, 1999, 2003) and some have been introduced relatively recently, e.g. CASBEE (Institute of Building Environment and Energy Conservation, 2003), and Green Star (Green Building Council of Australia, 2005). The outcome of a BEAM assessment is an eco-label, e.g. BREEAM-Excellent, HK-BEAM-Platinum, LEED-Gold, etc., based the sum of points (e.g. BREEAM) or credits obtained (e.g. LEED), or on a more complex calculation incorporating weighting factors (e.g. CASBEE). The BEAMs referenced here have developed independently as voluntary instruments to provide a catalyst for market transformation (Cole, 2003). They can be differentiated by; the life cycle stage(s) covered by certification; the environmental aspects (performance issues) covered and their categorization; the performance requirements (criteria, levels, standards, etc.); assessment methods demonstrating compliance; the scoring system that determines the final grade (eco-label). (Burnett, 2007).

LEED was created to reduce the environmental impacts of the built environment, but so far no comprehensive evaluation of the overall impact of LEED has been conducted although the findings are both encouraging and cautionary. Overall, it is agreed that LEED buildings are making a major impact in reducing the overall environmental footprint of individual structures. However, significant additional progress is possible and indeed necessary on both the individual building level and in terms of market penetration if LEED is to contribute in a meaningful way to reducing the environmental footprint of buildings in the U.S. and worldwide. To date, our calculations indicate that LEED Certified projects represent more than 6% of new commercial construction. It takes approximately two years from Registration to Certification, with an attrition rate of 25% to 30%. LEED NC continues to lead the way, with certified projects representing 5.8% of new construction starts and new registrations representing approximately 30% of the market (Watson, 2008). The environmental benefits of LEED are multi-dimensional. The followings summarizes few of these dimensions. For instance, it is estimated that approximately 400 million vehicle miles traveled (VMT) have been avoided by the occupants of LEED buildings between efficient location and the myriad of alternative transportation options supported by LEED. This figure is expected to grow to more than 4 billion vehicle miles by 2020. Also, water savings from LEED commercial buildings is expected to grow to more than 7% of all non-residential water use by 2020. LEED saves energy on many different levels. LEED buildings are known to consume approximately 25% less on average than comparable commercial buildings in terms of operational energy. These energy savings equal to more than 48.7 million tons of coal equivalent each year, representing approximately 78 million tons of carbon dioxide (CO2) avoided emissions by 2020. The most important impact of LEED on building industry has been to infest the entire industry with green building materials. Certified projects have specified a total of more than $10 billion of green materials, which could grow to a cumulative amount exceeding $100 billion by 2020. These figures support the arguments given at the beginning in regard to the business concerns exceeding environmental concerns. On another channel, indoor environmental quality emerges as the most important contributor to the productivity attributes of LEED. It is calculated that companies with employees working in LEED buildings realized annual productivity gains exceeding $170 million resulting from improved indoor environmental quality, a number that will grow to nearly $2 billion of annual productivity improvements by 2020. Moreover, reusing existing buildings is becoming a more common practice for LEED certified projects, with more than 12% of projects reporting major reuse of buildings and interior components. This equals to 37 million square feet in terms of square footage. This figure is estimated to exceed 400 million square feet by 2020. Furthermore, data show that nearly 60% of the C&D waste generated by LEED projects is diverted. Between the certified and "Built to LEED" projects, LEED buildings are estimated to have recycled or reused a cumulative total of 24 million tons of waste. These diversion figures mushroom to 200 million tons in 2015 and 325 million tons in 2020.

Doubtlessly, this level of savings can not be sufficient to reduce absolute energy demand from buildings worldwide simply because the growth in floor area is greater than the LEED-driven energy-use reduction, which results in continuing increases in total energy use. Therefore, a reasonable goal for the LEED system would be to aim at an *absolute* reduction in commercial energy consumption, or at least zero growth by 2015. Obviously, LEED cannot create a market transformation all by itself. As argued above, LEED is a vital part of the market transformation process that combines market pull with regulatory push. LEED was designed to lead the market by improving the performance of the top 25% of

buildings. Indeed, LEED will need to increase its rate of improvement, but additional measures are needed to support these improvements, as well as support and accelerate the uptake of LEED-like measures in the mass market. Market mechanisms in terms of technology incentives and energy prices that reflect true environmental and social costs may also be required to achieve these goals. Moreover, building codes will have to be updated in parallel with these incentives and certification standards. Also, changes in construction practices will need to be supported through training and market education about the benefits of investing in a low-carbon future. The market incentive programs described above could be very helpful in this regard.

3.2.2. Aspects of Profitability in Green Building

As argued above, greening of the construction market seems to have made an enormously positive impact on the real estate markets (Kuei-Feng, 2010). Nonetheless, the adoption of sustainable principles, however, has been slowed by a lack of evidence relating to the financial benefits and uneven distribution of costs and benefits between owners (investors) and occupiers (Falkenbach, 2010). There are various studies whereby green building (GB) market in relation to the general building market is reviewed and the business rationales of stakeholders to invest in the GB market have been investigated from the perspective of building designers (Chan *et al.*, 2009).

Various studies elucidate the subject of sustainable development and attempt to place it in a corporate context, not necessarily in the form of the "golden rules of industrial sustainability" but in an analysis and subsequent discussion of the way mainstream economists have handled the environment (Ulhoi, 1996). Another stream of studies (e.g. Dangelico & Pontrandolfo, 2010) develops a Green Option Matrices (GOM), which characterizes and categorizes green products and practices along different dimensions. This matrix is then used to analyze the different features of green products as well as related green practices developed by a sample of companies belonging to the Dow Jones Sustainability World Index (DJSWI). On another channel, various studies concentrate on the methods of how to adopt the "green accounting" standards (Stanojevic, 2010) that translate socially and environmentally responsible behavior into monetary terms, the only language businesses understand, particularly having considered the role of the managers in adopting the green building approaches in building industry as discussed above.

3.2.3. Problems of Profitability in Green Building

The aforementioned studies put forward a series of problems and obstacles in regard to the implementation of strategies so as to transform the construction industry through green building practices. The studies show that these problems are mainly related (and thus limited) to perceptions and prejudgments about the topic. For instance, obstacles and potentials are primarily conditioned by contractor's awareness towards the concept (Sakr, 2010) (ZainulAbidin, 2010; Ruikar *et al.*, 2006). Also the lack of basic self-evaluation approaches and methods, such as life cycle assessment (LCA) (Ortiz *et al.*, 2009) or performance measurement indicators (PMIs), in the construction industry (Tam *et al.*, 2006), prepares the grounds for this type of unawareness at management level. Also, the construction process is usually fragmented, involving several parties with different objectives. Hence, often, none of them normally assumes direct responsibility for protecting the environment. The concept of supply chain management (SCM) is now commonly applied in business for the mutual benefit of enterprises in the supply chain. A basic principle of SCM is `integration'. However, SCM is not well known in the construction industry (Ofori, 2000).

Once these perceptual barriers are eliminated, the potential areas of profitability will be clearly revealed for the building industry.

3.2.4. Areas of Profitability in Green Building

Under the light cast by above discussions, six major areas emerge in the field of green building; architectural design, construction technology, building material, certification and legislation, performance assessment and human resources. These areas represent the potential areas of research and investment. Here, these aspects are introduced, yet, not discussed below in detail since it is beyond the scope of this book and that of this particular chapter which intends to introduce the concepts regarding green buildings and its relation to the subject of green business. It is of prime interest, here, to elucidate the relation of the notion of green building to business studies particularly from the perspective of technology. Therefore, each aspect will be introduced in terms of its relation to the use of technology towards the accomplishment of a green business case within construction, building industries and real-estate sectors.

Firstly, in regard to architectural design aspect of green building, one of the most significant issues is the thorough analysis of the existing context in which the building is to be built in terms of utilization of available resources so as to minimize the impacts of the building into the context. Therefore, in the first place, green design is actually a state of mind specifically set to understand and work with environment rather than imposing any idea, process, material or technology onto it. In addition to climatic and passive design principles to benefit from alternative energy sources, principles of recycling are considered as essential components of an architectural design approach. Green building design necessitates the introduction of connectivity instead of fragmentation, and of integrated paradigm which requires a systems approach. When built environment is seen as in terms of stocks, flows and patterns the importance of integrated systems in building design increases because the impact of different parameters on each other are usually hard to predict (Santamauris, 2001). Integrated design strategy, which is a process by which all design variables that affect each other are tackled together and resolved in optimal manner, is essential in designing green buildings. Holistic design, which conceives entire building as a whole aims at integrating different aspects into the early stages of design. In such an approach, non-linear and parallel collaboration is required rather than linear consequence of collaboration (Lewis, 2004). Then, seemingly conflicting aspects of design would be synchronized towards a sustainable product that is in harmony with the processes and particularly the lifecycles of nature.

In regard to technological aspect of green construction, the first point to be raised is the choice or adaptation of the appropriate method and techniques for construction because the conventional construction technologies developed during the industrial era had proved to be extremely harmful to environment as explained through figures above (Kobes, 2005). On the other hand, the traditional methods and techniques of construction systems that are observed in vernacular architecture seem to have a much deeper concern for environment (Parres, 2007). Unlike traditional methods and techniques, the industrial modes of construction are based on mass-production, domination and exploitation of nature, and high energy consuming materials and processes such as material transportation, material processing, material fabrication etc. (Duncan, 2008). For instance, the use of prefabrication offers significant advantages, yet appropriate criteria for applicability assessments to a given building have been found to be deficient. Decisions to use prefabrication are still largely based on anecdotal evidence or simply cost-based evaluation when comparing various construction methods. Holistic criteria are needed to assist with the selection of an appropriate construction method in concrete

buildings during early project stages. Following a thorough literature review and comprehensive comparisons between prefabrication and on-site construction method, various sustainable performance criteria (SPC) based on the requirements of different project stakeholders could be identified (Chen *et al.*, 2010). Energy and resource efficiencies are both critical to achieve sustainability in building design and construction. Embodied energy is a measure of the energy required to produce, install, and maintain materials, while technical metabolism enhances the recyclability of the building design. In fact, almost all types of materials could be recycled. However, the technical metabolism of the materials depends on the existence of a market for these recycled materials, the regional recycling capacities, the total energy used to recycle, and the knowledge of the workers and designers about material recycling on a construction project (Lerner, 1998). Another important and related issue is the transportation energy used for recycling construction wastes and the actual rate of recycling of these projects. The recyclability of construction wastes and the energy required for transporting the wastes are affected by regional variables (Chong & Hermreck, 2010).

In regard to building material aspect of green building, which appears to be the most emphasized among the others, the role of materials used in the constructions is undeniably significant in terms of their impact on the environment. The sustainable characteristics of materials are thoroughly studied and appropriate technologies are developed for the production of more sustainable materials since their scale is currently compatible with the prevailing production thus economic system. In that regard, they represent a more manageable aspect of the building industry towards its sustainable future. Moreover, materials are directly related to the circulation in the market. Thus, materials provide the quickest economic return of any investment made in the field of green building and in the area of sustainable environment. Therefore, it seems the whole issue of green building and sustainable architectural design is reduced to the conversion of individual materials into the standards determined by the certification procedures of the environmental concern, which will constitute another aspect. In today's construction market, the phrase "environmentally friendly product" is arbitrarily used to describe an array of items. In reality, in fact, environmentally friendly products are those that do not harm the space that humans occupy and do not have any adverse impact on the ecology or environment during their harvesting, manufacturing, transportation, installation, curing, drying, and duration of use. Particularly, the adhesives, membranes and sealants play an important role in this regard because they are often used in adhering or complementing many finishes (Mintie, 2010).Despite the current emphasis on the material aspect of the issue, a real assessment of the environmental impacts of materials is still somewhat *terra incognito* in the green building movement. It is one of the most complex areas to evaluate from an impacts perspective and essentially impossible to determine "savings" (Watson, 2008).

In regard to certification and legislation aspect of green building, it is fair to suggest that it is directly associated with the material aspects of green building. The current paradigm shift have manifested itself very quickly in the market and certification, as discussed in previous sections, have emerged as a mechanism to regulate and control the market in terms of the standards and specifications regarding the building sector towards a sustainable life in the future. New sustainability requirements and changing priorities in construction management have stimulated the emerging green specifications to a faster pace of development. Various studies have been conducted to determine primary factors leading to the success in preparing green specifications. A comprehensive set of variables concerning sustainable construction were identified (Lam *et al.*, 2010) based on extensive construction management literature. During the recent and fast paradigm shift towards a

green building industry, some manufacturers have quickly labeled their products green, sustainable or eco-friendly whereas the other have been slow to establish the ground rules for what constitutes a green product eventually leading the accusations of one another with 'green-washing' their products in a context where definitive benchmark against which specifiers, architects and others engaged with the built environment could measure sustainability claims of a product in the market. Regarding this need for a benchmark clearly specified green standards are offered via the Leadership in Energy and Environmental Design (LEED) certification. The certification process involves an analysis of a product's environmental impacts over its entire life cycle, which encompasses everything from identifying the source and content of raw materials through product development, distribution, use, and end-of-life recycling potential or disposal. The procedures follow American National Standards Institute (ANSI) protocols and rely on the continued involvement of manufacturers and other stakeholders to ensure collaboration and transparency (Nelson, 2010). As a matter of fact, the certification authorities promote themselves by claiming that their certification increases the value of properties and also affects positively the image of the real estate company. However, whether this has been proven by a comprehensive surveys and scientific researches remains unclear (Falkenbach, 2010). Moreover, having considering the fact that energy-efficient and renewable technologies in buildings are becoming more commonplace as businesses "go green" and the emergent upswing in sustainable construction activities, it is of interest to understand how these technologies are applied within the framework of a sustainable building code, as well as how green building design and construction are related and integrated to existing regulations as well as issues of safety (Stevenson & Nichols, 2010).

In regard to performance assessment aspect of green building, which is also related to the certification processes, the following points can be highlighted. First of all, assessment constitutes a prerequisite in order to be able to establish the grounds for standards regarding the green building practices for a sustainable future. In that regard, the notions of environmental performance assessment (EPA) and performance measurement indicators (PMI), as its primary instrument, play the leading roles. Various methods of evaluation are adopted for studying different characteristics of buildings ranging from their energy-efficiency or energy consumption to their impact on the environment. As mentioned above, in order to implement EPA, PMIs that show the environmental performance outcome are required, which, however, seem to be lacking in the construction industry. Along with the purpose of filling this gap, several structured surveys, whereby key output indicators - such as; "regulatory compliance", "auditing activities" and "resources consumption" - are identified, have been conducted (Tam *et al.*, 2006). Along a parallel path, various researches, in which energy and water consumption practices are assessed, investigates the existing building stocks with the ultimate aim of establishing guidelines for delivering sustainable residential buildings in the near future using simulation software packages (e.g. Taleb & Sharples, 2011). These assessment and evaluation efforts are not only economically but also legally significant. Particularly considering the fact that governments are gradually beginning to mandate LEED standards, the role and responsibility of developing appropriate and reliable methods of assessment becomes highly valuable for the actors in the building industry. Moreover, the endeavors not only to address emerging green opportunities but also assuring their positions seem to be vital for all parties which indirectly makes an impact on contracts (Sobelsohn, 2010). Thus, reliable assessment and evaluation procedures gain a higher status which can be associated with the contracts.

Finally, in regard to employment aspect of green building, the potential and additional capacity for new jobs created by green business in

building and construction industries as well as real-estate sector presents a new dimension in the current paradigm shift towards a sustainable future. The workforce of this sector consists of not only architects and engineers but also contractors, subcontractors, inspectors, and many others from all parts of industry (Barsuk, 2009). Thus, the ongoing shift is affecting the nature of all parties in the sector. For example, the experts who are directly specialized in the areas that are related to the fields of environment, energy and chemistry are holding more advantageous positions. Furthermore, the professionals who have special training about the environmental aspects of their own areas are also moving to better positions. Moreover, potential of contribution that design can make to improve environmental performance is recently being recognized. Not to mention, the importance of creating an environmentally sensitive image for a company to survive within the ongoing paradigm shift is also highly related to the employment of skilled designers. In other words, the power of design has started not only to highlight but also to increase the responsibility of designer. Along this path, many leading architects demonstrate an understanding of environmental priorities in, mainly, showcase buildings but majority of new buildings remain untouched by environmental concerns like energy efficiency or avoidance of toxic materials. Business, on the other hand, well realizes that long term commercial success depends on acceptable environmental performance. Along this purpose, business requires a special workforce who is well-equipped in solving issues like resource depletion, pollution or industrial accidents which are being disruptive, and thus, costly (Mackenzie, 1997). Therefore, the creation of jobs as well as areas of expertise (*i.e. green collar jobs as described by Barsuk* (2009)) seems to add a further layer to the multifaceted benefits of green businesses.

3.2.5. Opportunities of Profitability in Green Building

Businesses always anticipate upcoming constraints to turn risks into opportunities. By the same token, construction industry and real-estate sectors have successfully managed to turn not only the a-century-old dichotomy between industrial and environmental concern into a business opportunity but also the recent chain of economic crisis and real-estate recession into business leap. Indeed, environmental issues represent a tremendous entrepreneurial opportunity (York & Venkataraman, 2010) through creative destruction of unsustainable businesses and paradigms. The recent flow of capital funding to the "clean tech" sector is clear evidence of this phenomenon (Pernick and Wilder, 2007). Similar examples are easily found in building market characterized by environmental challenges because market equilibrium in our conventional methods of production is reached to some extent (Casson, 1982). Thus, the environmental pressures have coincided with a time which is ripe for innovation (Kuckertz & Wagner, 2010). Also, failing to address these green opportunities seems to be too costly for all parties (Sobelsohn, 2010). Environmental dilemmas are addressed through not only the power of the market to communicate information and motivate the right individuals to bring those innovations about but also the process of continual discovery fostered by free market competition, solutions. The realm of environmental degradation offers one of the clearest examples of how businesses can produce economic and societal value when social responsibility is perceived as "building shared value" rather than managing risk (Porter and Kramer, 2006). Thus, this recent green shift creates diverse opportunities in variety of sectors ranging from advertising to insurance sector (Sclafane, 2010). At the end of the day, however, sustainable cities are cities that provide a livable and healthy environment for their inhabitants and meet their needs without impairing the capacity

of the local regional and global environmental systems to satisfy the needs of future generations. Therefore, this paradigm shift should be conceived as an opportunity not only for business but for all inhabitants of this planet.

4. CONCLUSION

This chapter was an attempt to draw readers' attention to the recent paradigm shift as a response to the fact that human species have so much transformed their relationships in the last two centuries, and therefore, gradually lost their genuine connection with the complex flows and cycles of the nature until recently it was discovered that the way nature is tried to be controlled, changed and dominated the nature eventually turned against us. The way systems of production and consumption were organized proved to be incompatible with the dynamics of nature and caused a constant state of crisis which manifests itself in every field, building industry being no exception. It became the leading sector in the recent attempts to transform its production technologies and processes from environmentally destructive solutions to ecological, sustainable and environmentally friendly approaches. This chapter, therefore, elucidates the fields of architectural design and building sector in terms of green issues in business and the role of information and building technologies through analysis of recent developments in both theory and practice. Throughout the chapter, it is argued that the current flux of shift in the whole segments of the industry and its market towards green architecture and building, in form of a '*green madness*' is both conditioned and imposed by the dynamics and motives in '*green business*'. Thus, it is also argued that the current paradigm shift may appear as strategies for re-organizing the building and real estate markets. Along this framework, the chapter firstly reviewed the definitions, its evolution of green technologies in building sector, its aims, criteria as well as the facts and figures that formed the arguments of this chapter. Then, the notion of green building was discussed both as a popular trend and as a business case. Finally, business dimensions of green building were elaborated through an analysis of incentives, mechanisms, aspects, areas, problems and opportunities of profitability in the sector.

Consequently, it is concluded that the present time appears right for environmental issues to present a tremendous entrepreneurial opportunity since the market seems to have already reached equilibrium and needs another leap in this latest phase of its evolution. In this context, solutions that can help solve the sustainability riddle appear more likely to emerge with the process of continual discovery fostered by free market competition. It is shown here various ways of financial benefits to the firms that employ environment-friendly building practices. The involvement and commitment of different actors was mandatory to achieve sustainability goals in the building sector, however, a more homogenized sustainable building policy is needed. These policies are mainly public and government directed in Europe while they are market driven USA.

Although the individual solutions found in showcase buildings have not yet become totally embedded in the daily routines of construction activities, these endeavors show that sustainability issues could become more pragmatic and thus be implemented more voluntarily, proactively and on large-scale by the market should the actors involved with the production of the built environment - such as the governments, the construction industry, and the companies that occupy commercial spaces and dwellers of housing units - work in cooperation. Moreover, sustainable building policy framework may offer certain advantages by fostering the environmental self-regulation of the construction sector through a combination of 'constraining' and 'enabling' policies, including an energy performance standard, packages for sustainable building, covenants, and advisory systems. Currently, however, environmental strategy

consists largely of piecemeal projects aimed at controlling or preventing pollution and has hardly featured in the firms' strategies. It might create a competitive advantage for the firm if environmental improvement is brought to the firm's strategy level. However, this requires use of environment-friendly practices in the whole life-cycle of the building so as to create a fit among them.

The aforementioned facts show the importance of the role that managers play in the adoption of green construction practices. However, the emphasis should be distributed equally to the lower levels of the organizations. This demand is shown by the raising potential for employment created by requirement for the fields of expertise in green building. It also seems that large scale corporations of contractors have the ability to face the challenges derived from environmental management requirements, which include investments in technology, human resources or certifications whereas this is not easy for middle and small size contractors. The disadvantages of small scale businesses as primary actors of building activity over the world should be eliminated with further incentives and legislative procedures. Moreover, environment related problems are related to the fragile environments in developing countries whose disadvantages should also be eliminated for a real and globally sustainable future.

In sum, it is fair to suggest that early human generations intuitively recognized the importance of utilizing the resources provided by nature carefully and had practical experience of the fact that humans are dependent on the earth's life-support systems for survival. The contemporary societies, on the other hand, often use science and technology to conquer nature without establishing the consequences of such a conquest. Today's paradigm shift towards a sustainable way of living and producing in future, however, seems to be very promising in terms of its humane ramifications should the emphasis on the economic potentials of green buildings is counterbalanced with social concerns.

REFERENCES

Aaras, A. (1998). Musculoskeletal, visual and psychosocial stress in VDU operators before and after multidisciplinary ergonomic interventions. *Applied Ergonomics*, *4*(2), 335–354. doi:10.1016/S0003-6870(97)00079-3

Ahuja, G., Lampert, C. M., & Tandon, V. (2008). Moving beyond Schumpeter: Management research on the determinants of technological innovation. *The Academy of Management Annals*, *2*, 1–98. doi:10.1080/19416520802211446

Akbari, H. (2005). *Energy saving potentials and air quality benefits of urban heat island mitigation*. Lawrence Berkeley National Laboratory.

Amirkhani, A., Ehsan, Z., Amin, S., & Masoud, K. (2010). Wind catchers: Remarkable example of Iranian sustainable architecture. *Journal of Sustainable Development*, *3*(2), 89–97.

Anink, D., Boonstra, C., & Mak, J. (1996). *Handbook of sustainable building*. London, UK: James & James Science Publishers.

ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers). (2001). *Standard 140-2001. Standard method of test for the evaluation of building energy analysis, computer programs*.

ASTM International. (2001). *Standard terminology for sustainability relative to the performance of buildings*. *E (Norwalk, Conn.)*, 2114–01.

Baldwin, R., Leach, S. J., Doggart, J., & Attenborough, M. (1990). *BREEAM 1/90: An environmental assessment for new office designs*. Garston, UK: Building Research Establishments.

Baldwin, R., Yates, A., Howard, N., & Rao, S. (1998). *BREEAM 98 for offices*. Garston, UK: Building Research Establishments.

Ball, J. (2002). Can ISO 14000 and eco-labeling turn the construction industry green? *Building and Environment*, *37*(4), 421–428. doi:10.1016/S0360-1323(01)00031-2

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1),99–120.doi:10.1177/014920639101700108

Barsuk, P. (2009). Green collar jobs on the rise. *Contract (New York, N.Y.)*, *50*(9), 34.

Blassingame, L. (1998). Sustainable cities: Oxymoron, utopia, or inevitability. *The Social Science Journal*, *35*(1), 1–13. doi:10.1016/S0362-3319(98)90055-6

Buildings Energy Databook (BED). (2006). *US Department of Energy and annual energy review 2007.*

Burnett, J. (2007). City buildings—Eco-labels and shades of green! *Landscape and Urban Planning*, *83*, 29–38. doi:10.1016/j.landurbplan.2007.09.003

Casson, M. (1982). *The entrepreneur: An economic theory*. Northampton, MA: Edward Elgar Publishing Limited.

Cetin, M. (2010). Dynamics of ever-expanding modern urbanism and endangered cultural sustainability of urban heritage in middle eastern cities. *Proceedings of ICSAUD 2010*, Penang, Malaysia, (pp. 411-421).

Chan, E. H. W., Qian, Q. K., & Lam, P. T. I. (2009). The market for green building in developed Asian cities: The perspectives of building designers. *Energy Policy*, *37*, 3061–3070. doi:10.1016/j.enpol.2009.03.057

Chau, C. K., Tu, E. Y., Chan, D. W. T., & Burnett, J. (2002). Estimating the total exposure to air pollutants for different population age groups in Hong Kong. *Environment International*, *27*, 617–630. doi:10.1016/S0160-4120(01)00120-9

Chen, Y., Okudan, G. E., & Riley, D. R. (2010). Sustainable performance criteria for construction method selection in concrete buildings. *Automation in Construction*, *19*, 235–244. doi:10.1016/j.autcon.2009.10.004

Chong, W. K., & Hermreck, C. (2010). Understanding transportation energy and technical metabolism of construction waste recycling. *Resources, Conservation and Recycling*, *54*, 579–590. doi:10.1016/j.resconrec.2009.10.015

CIB & UNEP-IETC. (2002). *Agenda 21 for sustainable construction in developing countries. A discussion document.* Pretoria, South Africa: CSIR Building and Construction Technology. Cole, R. J. (2003). Building environmental assessment methods: A measure of success. *The Future of Sustainable Construction, Special Issue,* 1–8.

Costanza, R., & Daly, H. E. (1992). Natural capital and sustainable development. *Conservation Biology*, *6*(1), 37–46. doi:10.1046/j.1523-1739.1992.610037.x

Cushman & Wakefield. (2009a). *Modern retail space in Poland*. Retrieved from http://www.cushwake.com/cwglobal/jsp/newsDetail.jsp?Country=GB&Language=EN&repId=c32700011p

Cushman & Wakefield. (2009b). *Modern office space in Poland.* Retrieved from http://www.cushwake.com/cwglobal/jsp/localHome.jsp?Country=1900176&Language=EN&_requestid=1150342

Cushman & Wakefield. (2009c). *Modern industrial space in Poland*. Retrieved from http://www.cushwake.com/cwglobal/jsp/localHome.jsp?Country=1900176&Language=EN&_requestid=1150342

Dangelico, R. M., & Pontrandolfo, P. (2010). From green product definitions and classifications to the green option matrix. *Journal of Cleaner Production*, *18*, 1608–1628. doi:10.1016/j.jclepro.2010.07.007

Daniels, K. (1999). *The technology of ecological building; Basic principles, measures, examples and ideas*. Boston, MA: Birkhauser Verlag.

De Landa, M. (1997). *A thousand years of non-linear history*. New York, NY: Zone Books.

Department of Agriculture. (n.d.). *Major uses of land in the United States, 2002/EIB-14*, (Economic Research Service/USDA). Retrieved from http://www.ers.usda.gov/Publications/EIB14

Department of Commerce. (2008). *Annual value of construction put in place.* DOE/EIA-0384. (2008). *Energy Information Administration, U.S. Department of Energy, June 2008.* Retrieved from http://www.eia.doe.gov/aer/pdf/aer.pdf.

Dimson, B. (1996). Principles and challenges of sustainable design and construction. *Industry and Environment*, *19*, 2.

Duncan, M. (2008). Green beginnings. *Contract (New York, N.Y.)*, *49*, 2.

Edwards, B. (1996). *Towards sustainable architecture, European directives & building design*. Oxford, UK: Butterworth Architecture Legal Series.

Edwards, B. (1998). *Green buildings pay*. London, UK: E&FN Spon. doi:10.4324/9780203235904

Energy Information Administration (EIA). (2008). *Assumptions to the annual energy outlook.*

Environmental Information Administration (EIA). (2008). *EIA annual energy outlook.*

ERG. (1999). *A green Vitruvius: Principles and practice of sustainable architectural design*. London, UK: James & James.

Falkenbach, H., Lindholm, A., & Schleich, H. (2010). Environmental sustainability: Drivers for the real estate investor. *Journal of Real Estate Literature*, *18*(2), 203–223.

Fisk, W. (2000). Health and productivity gains from better indoor environments and their relationship with building energy efficiency. *Annual Review of Energy and the Environment*, *25*, 537–566. doi:10.1146/annurev.energy.25.1.537

Frobeen, A. (2006). Socially sustainable. *The Canadian Architect*, *51*, 4.

Gallarotti, G. M. (1995). It pays to be green: The managerial incentive structure and environmentally sound strategies. *The Columbia Journal of World Business*, 38–57. doi:10.1016/0022-5428(95)90004-7

Gensler, M. A. (2003). Enhancing momentum for sustainable design. *Contract (New York, N.Y.)*, *45*(4), 74.

Gies, E. (2008). Green building goes mainstream: A wide-angle view of sustainable materials. *World Watch*, *21*, 4.

Girardet, H. (2000). *Cities, people, planet*. Liverpool (UK) Schumacher Lectures, Urban Sustainability. April. Retrieved from http://www.schumacher.org.uk/transcrips/schumlec00 Liv CitiesPeoplePlanet HerbertGirardet.pdf.

Goodland, R. (1995). The concept of environmental sustainability. *Annual Review of Ecology and Systematics*, *26*, 1–24. doi:10.1146/annurev.es.26.110195.000245

GSA Public Buildings Service. (2008). *Assessing green building performance: A post occupancy evaluation of 12 GSA buildings*.

Guedes, M. C., Pinheiro, M., & Alves, L. M. (2009). Sustainable architecture and urban design in Portugal: An overview. *Renewable Energy*, *34*, 1999–2006. doi:10.1016/j.renene.2009.02.014

Hancock, T. (2002). Indicators of environmental health in the urban setting. *Canadian Journal of Public Health*, *93*, 45–51.

Hanie, O., Ahmad, J. A., Aryan, A., & Mohammad Reza, L. (2010). Understanding the importance of sustainable buildings in occupants environmental health and comfort. *Journal of Sustainable Development, 3*(2), 194–200.

Hendrickson, C., & Horvath, A. (2000). Resource use and environmental emissions of U.S. construction sectors. *Journal of Construction Engineering and Management, 126*(1), 38–44. doi:10.1061/(ASCE)0733-9364(2000)126:1(38)

Heschong Mahone Group. (1999). *Skylighting and retail sales: An investigation into the relationship between daylighting and human performance.*

Heschong Mahone Group. (1999). *Daylighting in schools: An investigation into the relationship between daylighting and human performance.*

HK-BEAM Society. (2004). *HK-BEAM 4/04: New buildings*. Retrieved from http://www.hk-beam.org.hk/

Huber, J. (2000). Towards industrial ecology: Sustainable development as a concept of ecological modernisation. *Journal of Environmental Policy and Planning, 2*, 269–285.

Kats, G. (2003). *The costs and financial benefits of green buildings: A report to California's sustainable building task force.*

Keeping, M. (2000). *What about the demand? Do investors want 'sustainable buildings'?* RICS Research Foundation. The Cutting Edge 2000. Retrieved from http://www.rics.org/NR/rdonlyres /B10EB127-AB3A-41B9-BA35-2416B057AC63/0/what about the demand 20000101.pdf

Kilbert, C. J., & Grosskopf, K. (2005). *Radical sustainable construction: Envisioning next-generation green buildings.* Retrieved from http://www.treeo.ufl.edu/rsc06/WhitePaper-RSC06.pdf

Kobes, J. M. (2005). From gray to green. *Lighting Design + Application, 35*, 8.

Kuckertz, A., & Wagner, M. (2010). The influence of sustainability orientation on entrepreneurial intentions — Investigating the role of business experience. *Journal of Business Venturing, 25*, 524–539. doi:10.1016/j.jbusvent.2009.09.001

Kuei-Feng, C., & Po-Cheng, C. (2010). Measuring the influence of the greening design of the building environment on the urban real estate market in Taiwan. *Building and Environment, 45*, 2057–2067. doi:10.1016/j.buildenv.2010.02.013

Lam, P. T. I., Chan, E. H. W., Poon, C. S., Chau, C. K., & Chun, K. P. (2010). Factors affecting the implementation of green specifications in construction. *Journal of Environmental Management, 91*, 654–661. doi:10.1016/j.jenvman.2009.09.029

Langdon, D. (2007). *Cost of green revisited: Reexamining the feasibility and cost impact of sustainable design in the light of increased market adoption.*

Le Forestier, C. (2010). *EP-IMCO hearing public procurement – Meeting the new challenges.* 27/1/2010, FIEC contribution to the European Parliament's own initiative report.

Lehmann, S. (2008). Sustainability on the urban scale: Green urbanism – New models for urban growth and neighbourhoods. In Droege, P. (Ed.), *Urban energy transition: From fossil fuels to renewable power*. Oxford, UK: Elsevier. doi:10.1016/B978-0-08-045341-5.00018-9

Leitmann, J. (1999). *Sustaining cities*. New York, NY: McGraw-Hill.

Lenssen, N., & Roodman, D. M. (1995). *Worldwatch paper 124: A building revolution: How ecology and health concerns are transforming construction.* Worldwatch paper no. 124 Worldwatch Institute.

Lerner, S. (1998). Buildings made from waste materials. *The Futurist, 32*, 4.

Lewis, M. (2004). Integrated design for sustainable buildings. *ASHRAE Journal*, *46*(9), S22.

Li, B., & Yao, R. (2009). Urbanisation and its impact on building energy consumption and efficiency in China. *Renewable Energy*, *34*, 1994–1998. doi:10.1016/j.renene.2009.02.015

Li, X. D., Zhu, Y. M., & Zhang, Z. H. (2010). An LCA-based environmental impact assessment model for construction process. *Building and Environment*, *45*(3), 766–775. doi:10.1016/j.buildenv.2009.08.010

Mackenzie, D. (1997). *Green design: Design for the environment*. London, UK: Laurence King.

Mansvelt, J. (2010). *Green consumerism*. New York, NY: Sage.

MCD. C-Series Reports. (1995). *Manufacturing and construction division.* Census Bureau, U.S. Department of Commerce.

McDonough, W. (1992). *The Hannover principles: Design for sustainability*. New York, NY: W. McDonough Architects McGraw Hill Construction. (2009). *Green outlook 2009: Trends driving change.*

McDonough, W., & Braungart, M. (2002). *Cradle to cradle: Remaking the way we make things*. New York, NY: North Point Press.

McGraw Hill Construction. (2006). *Green building SmartMarket report.*

McGraw-Hill Construction. (2007). *Greening of corporate America SmartMarket report*.

McGraw-Hill Construction. (2008). *Key trends in the European and U.S. construction marketplace: SmartMarket report*.

Melchert, L. (2007). The Dutch sustainable building policy: A model for developing countries? *Building and Environment*, *42*, 893–901. doi:10.1016/j.buildenv.2005.10.007

Mendler, S., & Odell, W. (2000). *The HOK guidebook to sustainable design*. New York, NY: John Wiley and Sons.

Miller, N., Spivey, J., & Florance, A. (2007). *Does green pay off?* Mintie, A. (2010). Adhesives & sealants industry. *Sustainable Building Options, 21*(3).

Mol A. P. J. (1995). *The refinement of production*. Utrecht, The Netherlands: van Arkel.

Mol, A. P. J., & Spaargaren, G. (1993). Environment, modernity and the risk-society. The apocalyptic horizon of environmental reform. *International Sociology*, *8*(4), 431–459. doi:10.1177/026858093008004003

Morledge, R., & Jackson, F. R. (2001). Reducing environmental pollution caused by construction plant. *Environmental Management and Health*, *53*(6), 270–280.

National Dubo Centrum (The Netherlands). (2000). *Sustainable building: Frameworks for the future*. Rotterdam, The Netherlands: National Dubo Centrum.

Nelson, C. (2010). Setting a green building product standard. *Ceramic Industry*, *4*(3), 15–16.

Ngowi, A. B. (2001). Creating competitive advantage by using environment friendly building processes. *Building and Environment*, *36*, 291–298. doi:10.1016/S0360-1323(00)00006-8

Office of Solid Waste. (2003). *Municipal solid waste in the United States: 2007 facts and figures*. U.S. Environmental Protection Agency. Retrieved from http://www.epa.gov/epawaste/nonhaz/municipal/msw99.htm

Ofori, G. (2000). Greening the construction supply chain in Singapore. *European Journal of Purchasing & Supply Management*, *6*, 195–206. doi:10.1016/S0969-7012(00)00015-0

Oktay, D. (2001). Green spaces and ecological quality of housing. *Ekistics*, *65*, 391–393.

Ortiz, O., Castells, F., & Sonnemann, G. (2009). Sustainability in the construction industry: A review of recent developments based on LCA. *Construction & Building Materials*, *2*, 28–39. doi:10.1016/j.conbuildmat.2007.11.012

Parris, T. M. (2007). Green buildings. *Environment*, *49*, 1. doi:10.3200/ENVT.49.1.3-7

Peirce, N. (2007). Sustainable cities. *The American Prospect*, *18*(1), A6.

Pernick, R., & Wilder, C. (2007). *The clean tech revolution: The next big growth and investment opportunity*. New York, NY: Harper Collins Publishers.

Pivo, G., Fisher, J. D. (2009). *Investment returns from responsible property investments: Energy efficient, Transit-oriented and Urban Regeneration Office Properties in the US from 1998-2008.*

Political Economy Research Institute & Center for American Progress. (2008). *Green recovery: A program to create good jobs and start building a low-carbon economy.*

Porter, M. E., & Van der Linde, C. (1995). Green and competitive: Ending the stalemate. *Harvard Business Review*, *73*(5), 120–134.

Press, L. M. S. (2005). *Transnational buildings in local environments*. Aldershot, UK: Ashgate Press.

Qi, G. Y., Shen, L. Y., & Jorge, O. J. (2010). The drivers for contractors' green innovation: An industry perspective. *Journal of Cleaner Production*, *18*, 1358–1365. doi:10.1016/j.jclepro.2010.04.017

Qi, G. Y., Shen, L. Y., Zeng, S. X., & Jorge, O. J. (2010). The drivers for contractors' green innovation: An industry perspective. *Journal of Cleaner Production*, *18*, 1358–1365. doi:10.1016/j.jclepro.2010.04.017

Robin, C. P. Y., & Poon, C. S. (2009). Cultural shift towards sustainability in the construction industry of Hong Kong. *Journal of Environmental Management*, *90*(11), 3616–3628. doi:10.1016/j.jenvman.2009.06.017

Ruikar, K., Anumba, C. J., & Carrillo, P. M. (2006). An e-readiness assessment application for construction companies. *Automation in Construction*, *15*, 98–110. doi:10.1016/j.autcon.2005.02.009

Sakr, D. A., Sherif, A., & El-Haggar, S. M. (2010). Environmental management systems' awareness: An investigation of top 50 contractors in Egypt. *Journal of Cleaner Production*, *18*, 210–218. doi:10.1016/j.jclepro.2009.09.021

Salzmann, O. (2007). *Corporate sustainability management in the energy sector: Drivers, practices and outcome*. Berlin, Germany: Fakultat Wirtschaft und Management, Technische Universitat Berlin.

Salzmann, O., Ionescu-Somers, A., & Steger, U. (2005). The business case for corporate sustainability. *European Management Journal*, *23*(1), 27–36. doi:10.1016/j.emj.2004.12.007

Santamauris, M. (2001). *Energy and climate in the built environment*. London, UK: James & James.

Sarkar, R. (2008). Public policy and corporate environmental behavior: A broader view. *Corporate Social Responsibility and Environmental Management*, *15*(5), 281–297. doi:10.1002/csr.167

Schumpeter, J. A. (1942). *Capitalism, socialism and democracy* (6th ed.). Abingdon, UK: Routledge.

Sclafane, S. (2010, January 11). Argo brokerage tackles architect, design risks with green-building endorsement. *P & C*, *114*(2), 17.

Sharma, S. (2000). Managerial interpretations and organizational context as predictors of corporate choice of environmental strategy. *Academy of Management Journal*, *43*(4), 681–697. doi:10.2307/1556361

Shen, L., Tan, Y., & Yao, H. (2010). *Sustainable construction practice and contractors' competitiveness: A preliminary study.* Habitat International.

Shen, L. Y., & Tam, W. Y. V. (2002). Implementation of environmental management in the Hong Kong construction industry. *International Journal of Project Management*, *20*(7), 535–543. doi:10.1016/S0263-7863(01)00054-0

Sinha, R. (2009). Green building: A step towards sustainable architecture. *The IUP Journal of Infrastructure, 7*(2).

Sobelsohn, R. J. (2010). Legal green. *Contract (New York, N.Y.)*, *51*(3), 34.

Spence, R., & Mulligan, H. (1995). Sustainable development and the construction industry. *Habitat International*, *19*(3), 279–299. doi:10.1016/0197-3975(94)00071-9

Stanojevic, M., Vranes, S., & Gokalp, I. (2010). Green accounting for greener energy. *Renewable & Sustainable Energy Reviews*, *14*, 2473–2491. doi:10.1016/j.rser.2010.06.020

Stevenson, K., & Nichols, D. (2010). Next-generation building codes: Addressing public safety and sustainable construction. *Firehouse, 103*(5).

Streimikiene, D., & Girdzijauskas, S. (2009). Assessment of post-Kyoto climate change mitigation regimes impact on sustainable development. *Renewable & Sustainable Energy Reviews*, *13*, 129–141. doi:10.1016/j.rser.2007.07.002

Sullivan, J. (2009). Survival of the fittest. *Builder*, *4*(2), 86–98.

Taleb, H. M., & Sharples, S. (2011). Developing sustainable residential buildings in Saudi Arabia: A case study. *Applied Energy*, *88*, 383–391. doi:10.1016/j.apenergy.2010.07.029

Tam, C. M., Tam, W. Y. V., & Tsui, W. S. (2004). Green construction assessment for environmental management in the construction industry of Hong Kong. *International Journal of Project Management*, *22*(7), 563–571. doi:10.1016/j.ijproman.2004.03.001

Tam, V. W. Y., Tam, C. M., Zeng, S. X., & Chan, K. K. (2006). Environmental performance measurement indicators in construction. *Building and Environment*, *41*, 164–173. doi:10.1016/j.buildenv.2005.01.009

Tam, W. Y. V., & Tam, C. M. (2008). Waste reduction through incentives: A case study. *Building Research and Information*, *36*(1), 37–43. doi:10.1080/09613210701417003

Tan, Y., Shen, L., & Yao, H. (2010). Sustainable construction practice and contractors' competitiveness: A preliminary study. *Habitat International*, *30*, 1–6.

Ulhoi, J. P., Madsen, H., & Hildebrandt, S. (1996). Green new world: A corporate environmental business perspective. *Scandinavian Journal of Management*, *12*(3), 243–254. doi:10.1016/0956-5221(96)00007-3

UNCHS. (1996). *The habitat agenda: Goals, principles, commitments and global plan of action.* 3-14 June, Istanbul, Turkey.

UNEP (United Nations Environmental Programme). (1996). The construction industry and the environment. *United Nations Environmental Programme Review, 19*(6).

US EPA ENERGY STAR program. (n.d.). Retrieved from http://www.energystar.gov/index.cfm?c=thermostats.pr thermostats

U.S. Geological Survey. (2000). *2000 data.*

US Green Building Council. (1999). *Report on green building facts*.

US Green Building Council. (2003). *Report on green building facts*.

US Green Building Council. (2009). *Report on green building facts.*

Vale, B., & Vale, R. (1991). *Green architecture: Design for a sustainable future*. London, UK: Thames and Hudson.

VANR (Vermont Agency of Natural Resources). (2006). *Appendix 2: Strategies – Construction waste and demolition debris (C&D).* Retrieved from www.anr.state.vt.us/dec/wastediv/R3/WP-planning/Appendix2.pdf

VROM (Ministry of Housing, Spatial Planning and the Environment, the Netherlands). (n.d.). *Sustainable building in the Netherlands, national package*. The Hague, The Netherlands: VROM.

Watson, R. (2008). *Green building impact report*. Greener World Media.

Wei, X. Y., & Lin, Z. Y. (2004). Present status and development of construction industry in China. *Journal of the Harbin Institute of Technology*, *36*(1), 124–128.

Williams, D. E. (2007). *Sustainable design: Ecology, architecture and planning*. New Jersey: Wiley.

World Business Council for Sustainable Development. (2008). *Energy efficiency in buildings.*

Wu, H. J. (2008). Popularize green construction and promoting the development of construction industry. *Construction and Architecture*, *23*(1), 10–15.

Yilmaz, M., & Keles, R. (2004). Sustainable housing design and the natural environment. *Ekistics*, *71*, 427–429.

Yitmen, I. (2007). The challenge of change for innovation in construction: A North Cyprus perspective. *Building and Environment*, *42*(3), 1319–1328. doi:10.1016/j.buildenv.2005.10.032

York, J. G., & Venkataraman, S. (2010). The entrepreneur–environment nexus: Uncertainty, innovation, and allocation. *Journal of Business Venturing*, *25*, 449–463. doi:10.1016/j.jbusvent.2009.07.007

Zainul Abidin, N. (2010). Investigating the awareness and application of sustainable construction concept by Malaysian developers. *Habitat International*, *34*, 421–426. doi:10.1016/j.habitatint.2009.11.011