Chapter 12
Towards Sustainable Architecture: The Transformation of the Built Environment in İstanbul, Turkey

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But design, like sustainability, is a dynamic and living process. . . A design is sustainable, or it is not. If it is not sustainable, changes can be made to make it sustainable. If it is sustainable, by necessity it will be changing and evolving. Sustainability is not static – it is iteratively changing, based on evolving knowledge that connects science and design
(Williams 2007 *: 17)*.

Abstract Towards the end of the twentieth century, new consumerist lifestyles coupled with technological innovations and rising environmental consciousness have changed the concept in environmental and building designs. Conscientious developers and city governments see green building and environmental designs as a useful approach to counter the adverse effects of global warming, fossil energy consumption and nature destruction that have threatened ecological and human health. Today, sustainable architecture and green design have become an important agenda of the built environment. The aim of this study is to examine the efforts made towards constructing sustainable office buildings in İstanbul, Turkey. In İstanbul, due to its unique location and historical background, innovative, modern and sustainable buildings have been built in its newly developed central city area, such as Büyükdere Avenue. Using a chosen set of green building rating systems as criteria, assessment was focused on site-environment, energy-water, materials-resources and indoor environmental quality. High-rise office buildings selected for this survey were Metrocity Office Building, İşbank Headquarters and the Akbank Tower along Büyükdere Avenue. Results showed that standards achieved were low but they were symbolic of a self-initiated will in line with the international agenda towards urban ecological conservation.

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12.1 Introduction

Cities are not merely centres of wealth accumulation but also of consumption, waste generation and pollutants production. In the twenty-first century, as technology, globalization and urban growth advance further, cities will become the centre of our environmental future where urbanites are anticipated to be more distanced from nature spaces which are being destroyed to make room for high-rise blocks and concrete infrastructures. Indeed, by the year 2020, 75% of the population of Europe and 55% of the population of Asia will be living in cities, consuming relatively little land surface of the planet yet the bulk of its resources (Yeang 1999, Sassen 2008).

If we treat cities as living organisms and a complex yet organized entity that should be integrated functionally within the ecosystems as a whole, the concept of sustainable architecture, innovative designs to minimize the problems of resource-consuming and environment-polluting impact of concrete structures will be highly useful for a more sustainable future in urban living. Thus, the fundamental approach towards building a sustainable architecture is complex yet simple – it is essential to ally its design, operations and management as closely as possible to the functioning logics of nature.

Given that high-rise urban buildings consume huge amounts of construction materials, and non-renewable energy sources which in turn produce massive volumes of waste discharge into the environment, the latter's adverse effects and damages are not environmentally sustainable. Indeed, buildings consume more energy and release more carbon dioxide than vehicles. In the United States, for instance, buildings use up 37% of all energy resources and two-thirds of electricity – six times more than automobiles in energy consumption and carbon dioxide emissions (Goffman 2006). As such, it is necessary to design buildings with minimum consumption of non-renewable sources of energy in terms of heating, hot water, cooling, lighting, power, ventilation and other internal functions. Indeed, with careful consideration to the climatic features of the project site and through bioclimatic design principles using climate-responsive building configuration, appropriate building orientation, buildings' energy needs to make internal mechanical and electrical environmental systems operational can be reduced (Winchip 2007, Yeang 1999, Cooper et al. 2009).

In Turkey, the concept of sustainability has become an important key element for architectural discourse during the last 20 years. Innovative, modern and sustainable high-rise office buildings have been tested out especially in İstanbul, due to its unique location and historical background. Buildings in this city have become very early experimental examples of sustainable architecture in Turkey. The objective of this research is to showcase a few high-rise office buildings in İstanbul and to examine their level of sustainability based on identified design criteria in line with architectural sustainability. The selected examples are the Metrocity Office building, Isbank Headquarters and the Akbank Tower. They are compared and analyzed using the sustainable design criteria focused mainly on site-environment, energy–water, materials–resources and indoor environmental quality on the basis of green rating systems. Nevertheless, before investigating the particularly identified building examples of İstanbul placed under scrutiny, the issue of sustainable architecture is discussed in the broad context of environmental sustainability.

12.2 Environmental Sustainability and Sustainable Architecture

The concept of sustainability has become a rigorously discussed phenomenon throughout the world during the last 40 years. The importance of sustainability and environmental sustainable development, whose foundations were laid in 1972,[1] has increased and it has been used to integrate humans, nature and building environments in a harmonious manner (Keleş and Harmancı 1993). The public acceptance for the term "sustainability" came when the World Commission on Environment and Development (WCED), which the United Nations General Assembly charged with formulating an "agenda for the future", based its proposals mostly on environmental sustainable development. As revealed in WCED's 1987 report, often called the Brundtland Report, the concept, in contemplating and reflecting on the environmental consequences of economic, political and environmental applications of the world, queried the extent to which national and international communities had considered the interests of the future generations to ensure that they could continue to live in a sustainable way (WCED 1987, Perkins et al. 1999). This Report also identified common concerns that threaten our future, the role of the international economy, equity, poverty and environmental degradation (WCED 1987: 24).

Similarly, the 1992 Rio Earth Summit organized by the United Nations alerted the alarming consumption of natural resources, the worrying rise in global warming and the rapid spectacular destruction of ecosystems. Participatory countries signed agreements that had been later translated into numerous regulatory measures affecting industry, transport, energy use and waste management. These measures were aimed at encouraging people in industrialized nations to conserve resources and to be aware of the potential consequences of their prevailing lifestyles. Indeed, global warming, land and sea degradation have been genuinely recognized as a consequence of human activities in their production methods, consumption patterns and choice of materials (Gauzin-Müller 2002, Ryder 2001, Wong et al. 2008). Soon after, came the debate and negotiations on similar issues that ended with the Kyoto Protocol of 1997 where participating nations designed more concrete measures including the reduction of greenhouse gas emissions. These measures have had wide-ranging implications in terms of land use, urban planning and especially architectural designs of city buildings.

Ten years after the Rio Summit in 2002, the United Nations sponsored another World Summit in Johannesburg. Global participants agreed to include the social issue of poverty eradication in the agenda as a basis of negotiation. Greater concern was also addressed over the broadened patterns of consumption and production, and as a result it was further appealed to protect and manage the natural resource-based economic, social, health-related activities so as to achieve a more sustainable lifestyle and living standards (Winchip 2007). Most recently in December 2009, the Conference of Parties (COP15) was held in Copenhagen, Denmark with an aim to establish an ambitious global climate agreement to begin from 2012 after the expiry of the Kyoto Protocol agreement.[2] Here, ministers and officials from 192 countries, together with a large number of civil society organizations, took part to exchange views and lay out principles for the new Agreement. Though the conference did not achieve a binding agreement or consensus for the post-Kyoto period, there was some "political accord" by approximately 25 parties including the United States and China. The accord was notable in that it required developed countries to commit new and additional resources, totalling US$30 billion for 2010–2012, including funds for forestry, to help developing countries. The 2020 goal is to cut deforestation by half (Light and Weiss 2009).

In principle, the Copenhagen Summit 2009 aimed to achieve the following targets (see United Nations Headquarters 2009):

(a) The most venerable and the poorest nations are assisted to adapt to the impacts of climate change;
(b) Substantial carbon emission reduction from industrialized countries;
(c) Developing countries to undertake nationally-appropriate mitigation actions with necessary international support;
(d) Financial and technological resources are significantly scaled up to meet the challenge of climate change; and
(e) To establish an equitable governance structure to ensure priorities of developing countries are recognized and financial auditing is transparent and effective.

Further negotiations have been planned for COP16 in Mexico, as there were unresolved issues from the Kyoto Protocol and a framework for long-term cooperative actions has yet to be established (UNFCCC 2009). All the above international negotiations have involved collective methods and measures to reduce emission of greenhouse gases, and consumption of fossil fuels, and use of green and renewable energy sources is encouraged. In this aspect, sustainable architecture has a great contributory role to play.

12.2.1 Sustainable Architecture

Sustainable architecture could be seen as a paradigm shift in conceptual thinking in architectural design history in recent decades. The shift has influenced values and professional practices of architects and landscape designers in their conceptualization, and reasoning about the relationship of the built environment and natural resources, energy use and the long-term future of living things (Williams 2007, Abley and Heartfield 2001). It is a key player in the environmental urban sustainable campaign due fundamentally to the rising energy consumption of buildings, particularly in urban places. In the 1990s, for example, buildings consumed globally 50%

of total energy and were responsible for 50% of the total ozone depletion; they had produced tremendously adverse environmental impacts. More significantly, modern buildings are heavily dependent on mechanical operations for heating, cooling, ventilation and lighting, using non-renewable forms of energy (Edwards 1999, Ryder 2001).

Arguably, structural designs of buildings, the ways buildings are serviced have all a direct influence over the volume of fossil fuels consumed leading to the quantity of carbon dioxide and other greenhouses gases released into the atmosphere. Such gases pollute the atmosphere, with potential damages to human and other biological health, and rise of global temperature. With an aim to counter buildings' adverse effects to the environment, sustainable architecture as a conceptual object may be defined as generally involving:

> environmentally conscious design techniques in the field of architecture. [It] is framed by the larger discussion of sustainability and the pressing economic and political issues of our world. In the broad context, sustainable architecture seeks to minimize the negative environmental impact of buildings by enhancing efficiency and moderation in the use of materials, energy, and development space. Most simply, the idea of sustainability, or ecological design, is to ensure that our actions and decisions today do not inhibit the opportunities of future generations (Wikipedia 2010).

Sustainable architecture is therefore a term used to describe an energy and ecologically conscious approach to the design of the built environment with the primary purpose of minimizing energy consumption and air pollution. Within sustainable architecture itself, building designs should be made compatible to fulfill the economic, social and environmental objectives of sustainability (Williams 2007: 13–16, Gissen 2003). Economic and social objectives of sustainability are equally crucial because buildings are meant to serve economic demand and social needs of human societies, without which buildings (commercial, residential, industrial, institutional, community etc) would not perform their intended functions and their demand is not summoned. Designers can be therefore in the position to use it as a powerful building process, and offer sustainable designs to function by adding environmental quality in the interest of the community. Green design is one of the sustainable design approaches.

12.2.2 Green Designs

Green designs are applicable to buildings to conserve energy, water and other material consumption and to protect the overall physical environment as well as building users. For the latter, creating a clean and green environment outdoor and a healthy building environment indoor implies the safeguarding of users' health and provision of a more productive working and living habitat. Health diseases inherent in problematic buildings include those related to the respiratory organs, asthma and allergy (Goffman 2006). In this sense, the green concept has a strong link to social and economic sustainability intertwined with environmental sustainability.

Green architecture or design indeed involves the approach that basically reduces energy, use of other resources and materials and regulates air flow into buildings targeted to deliver its intended outcome. Depending on local climatic conditions, temperate zones, for example, require forms of design that would capture well the passive solar light as against hot and humid tropic areas where solar exposure needs to be reduced to offer comfort. As widely acceptable, comfort contributes to health and productivity. The goals, inter alia, can be generally expressed in the following ways (Thomas 2003, Thomas and Ritchie 2009, Barnett and Browning 1999):

(a) Less demand for energy:
(b) Lower demand for space heating (for temperate zones), and cooling (for tropical zones) by using the orientation, form in relation to the solar and wind energy;
(c) Ensuring air ventilation is of a high quality, and materials within the building should not emit pollutants;
(d) Less hot and cold water consumption. It will be an advantage when waste hot water can be economically recovered;
(e) Optimal use of daylighting to cut down use of electrical energy; and
(f) Services that the building is able to put under its control should be energy-efficient, and materials used are environmentally friendly.

Today, national and city governments are increasingly conscientious of the importance of sustainable buildings for their cities, citizens and the environment as a whole. They have also passed legislations, regulations and environmental laws that require architects, engineers and designers to conceive and comply with sustainable architecture norms in both the building interior and exterior parts. Among the many international evaluation systems, four crucial green building rating systems have been used, namely (a) the BRE Environmental Assessment Method (BREEAM) in United Kingdom; (b) the Leaders in Energy and Environmental Design (LEED) in the United States; (c) the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) in Japan; and (d) the Green Star of the Green Building Council of Australia (GBCA) (WGBC 2010).

The above-cited systems have been used by many other countries as a reference, and with their own respective point grading system building approval certificates are issued. Despite certain differences, it is possible to identify four main categories out of these green building rating systems, with assessment criteria listed as follows:

(a) Site and Environment: assessing the relationship of the building to the existing topography and greenery application in the environment;
(b) Energy and Water: assessing energy consumption and saving capability, use of the most efficient methods to cut down energy and water consumption within buildings, as well as the efficient measures in the treatment of wastes and their storage;
(c) Indoor Environmental Quality: assessing the indoor air quality and the other comfort conditions like the heat efficiency, humidity ratio, natural ventilation etc; and

(d) Materials-Resources: assessing the sustainability value of building and service materials and how they would affect human beings, both physically and psychologically in the buildings.

The above four criteria of sustainable building design will be used in the assessment of the selected buildings in İstanbul below.

12.3 Sustainable Architecture in İstanbul, Turkey

In Turkey in general and in İstanbul in particular, urban-industrial growth first occurred during the 1950s, which saw massive numbers of rural migrants seeking urban-based jobs in emerging industries. This migration had a profound effect on the urban pattern and configuration characterized by unplanned land use and unhealthy living conditions. In poorly serviced spontaneous settlement areas filled up by migrants, it is not uncommon to witness serious degradation of the living environment.

With improved economic conditions and only after the 1980s that the city governments in Turkey have shown greater concern to the environmental problems of their urban habitat, and have become more aware of the sustainability concept. Concomitantly, the public has developed a greater consciousness and interest in environmental protection, and biodiversity. In city development programmes, urban sustainability issues and, for professional bodies and individuals, sustainable architecture, have started to gain momentum and capture greater attention. Turkey's association with sustainable architecture and green urbanism began in 1996 when İstanbul organized the Second UN Conference on human Settlements (Habitat II). This event helped not only put forward ways of applying sustainable principles in building designs but also adopted a specific approach to ensure urban groups were socially included in the decision-making process in that all urban residents have equal rights to the city. Such a concept of social inclusiveness of common people has helped lay the foundation of urban social sustainability and management of urban poverty in the country (Yılmaz 2008).

Indeed, the Second UN Conference on Human Settlements (Habitat II) of 1996 had reaffirmed the importance of the building sector by specifically identifying buildings to meet the needs of humans in the environmental, aesthetic, functional, security and ecological domains. According to Turkey's 8th Development Plan, the provision of environmental quality and building healthy communities in urban areas have been given high priority, and clean water, air and sustainable urban life are considered key elements of quality of life to be sought after (DPT 2001). Supplementary to this higher order development pursuit, a series of related regulations, laws and building codes were passed legislatively and came into force in 2002. The most important regulations of these are the Renewable Energy Sources Law, Energy Efficiency Law, Buildings Thermal Insulation Regulation, Building Materials Regulation and TSE 825-Thermal Insulation Requirements for Buildings.

These regulations and laws focused on the reduction of energy consumption and provided incentives to the use of renewable energy sources (DPT 2010).

Early examples of sustainable architecture are most commonly seen in İstanbul because it is a metropolitan area with a population of almost 13 million.[3] Also İstanbul has a significant role to play in this aspect, not only because of its historical and cultural background, but also due to its unique location that hosts the headquarters of many national and international companies. İstanbul is at the crossroads between Europe and Asia, and has a vast metropolitan area that accommodates the latest innovations of buildings and combines the old with the new.

12.3.1 Selected Buildings with Sustainable Architecture in İstanbul

As the financial and industrial centre of Turkey, it is symbolic and characteristically imperative that İstanbul's new built-up areas should respond and comply with the most-up-to-date building norms of sustainability demands, whether for corporate or residential communities. In site selection, the sustainability approach requires that new buildings be near the business district and accessible to the main transportation centres. Büyükdere Avenue is a perfect choice with its prime land characteristics. This avenue is located in a newly developed district and does not have any significant historical and cultural identity.

As early as the 1980s, land in this area was the least expensive which provided for unlimited renewal opportunities. Consequently, all of the prestigious high-rise office buildings for financial corporations were constructed there, replacing the small-scale residential settlements and factories with high-rise office and shopping blocks (Mimdap, 2007a).[4] Buildings constructed then in the 1980s had no legal obligations to comply with construction and design criteria on the basis of sustainable architecture. Generally landowners and architects constructed freely according to their own design principles and perceptions. Not surprisingly, the sharp increase in the number of buildings on this avenue has caused a lack of infrastructure, crowdedness, pollution and traffic jams. With the adoption of the green building criteria and with the İstanbul Building code revised many times (last revision was done in 2007), construction of environmentally friendly buildings has finally become a legal obligation[5] (IBB 2010).

İstanbul possesses buildings constructed by both national and multinational companies to reflect their corporate identities and they have become objects of prestige. However, even though the green design criteria were adopted in the 1990s, this new approach of development control for high-rise office buildings has not been effective, as buildings now standing amidst a disorganized pattern along Büyükdere Avenue clearly reflect. The sustainable design criteria for high-rise buildings as a means of development guidance have only started to see its effectiveness after the Building Code revision in 2007, thanks to the rising awareness of the architects involved in the building designs. For the purpose of this study, three building samples situated along the Büyükdere Avenue which have adopted sustainable design methods are selected for evaluation, namely the Metrocity Office Building, Isbank

Headquarters and the Akbank Tower (see Fig. 12.1). Each of these three buildings is discussed in turn.

12.3.1.1 The Metrocity Office Building

It is a complex of mixed use, consisting of a shopping centre, office and apartments, designed by architects Sami Sisa and Doğan Tekeli and built between 1997 and 2003. The first two storeys of the office building were designed as a shopping centre. The other two blocks are apartment units. The office block was designed facing the avenue after considering the orientation of the land plot which overlooks Büyükdere Avenue with a broad view (Boyut 2001). At the centre of the Metrocity Complex is a subway station, the most important facility provided for its users for easy access in a city such as İstanbul, known for its traffic congestion. The Metrocity Office Building has a total of 23 storeys and a height of 118 m. The floor area of each storey covers 750 m^2 and approximately 30–35 people work on each storey (Uluğ 2003).

12.3.1.2 The Isbank Headquarters

The banking headquarters was first designed by Doğan Tekeli and its construction was undertaken by Swanke Hayden Cornell Architects from 1996 to 2000. The decision to have the building facade facing the Büyükdere Avenue with its main entrance at the corner of the Bosphorus Bridge was to ensure that the building could be visible from all directions and that two tower blocks could be erected side by side parallel

Fig. 12.1 Overview of high-rise office buildings in İstanbul. *Source*: Mynet (2008)

to the bridge. This is solved with high blocks standing on a three-story horizontal mass. This horizontal mass houses the bank headquarters, provides a main entrance, and a central and exhibition hall. At the ground floor, there is a small shopping centre and a cafeteria which opens to a green garden facing the Büyükdere Avenue. The Isbank Headquarters building has 46 storeys, a height of 181 m, and a standard normal floor area of 1,407 m^2 (Boyut 2001).

12.3.1.3 The Sabancı Centre

The Sabancı Centre has two tower blocks, designed and constructed by Haluk Tümay and Ayhan Böke between 1988 and 1993. The Sabancı Centre comprises the 39 floor Akbank Tower, housing the central headquarters of Akbank, and another 34-floor Sabancı Holding Tower which houses the central and administrative headquarters of the Hacı Ömer Sabancı Holding and the Sabancı Group corporations (Sabancı, 1993) (see Fig. 12.2).

12.3.2 Comparison of the Buildings Using Sustainable Design Criteria

The three above-cited sets of buildings were designed by architects with different perceptions of design and were built at different times. With no legal obligations in Turkey 15–20 years ago, they applied certain green building standards to their projects. Some of the standards and technologies used were generally below the international norms at that time. It is however worthy of evaluating and comparing their applications using the four main criteria listed below.

Fig. 12.2 Metrocity, İşbank Headquarters, Sabancı Towers. *Source*: Mimdap (2007b) (Photo on *Left*). Photos (*centre* and *right*) by Selin Mutdoğan

12.3.2.1 Site-Environment

This criterion examines the building's relationship with its natural environment and green areas, in consideration of its site location, its position with surrounding buildings, as well as climatic and topographic characteristics. Besides, natural energy sources, such as solar and wind energy, should be exploited to decrease fossil-based energy consumption. On the other hand, the social relationship between humans and their environment in terms of human mobility and existing architectural heritage should also be considered (Karataş 2004).

The building sites of the three high-rise buildings on Büyükdere Avenue under study have no architectural heritage and valuable green areas, such as parks or orchards. This could have been an advantage because there were no physical restrictions in land use planning. Indeed, the developers had used this "freedom of expression" to design their own green areas in relation to the surrounding buildings constructed in recent years, within an architectural and design unity. Although an overall unity was created with the other buildings, the floor plans and form of the facades of the three buildings are different from each other. While the İşbank Headquarters and Sabancı Towers were designed as squares with a service core in the centre, the Metrocity office building is in the form of a quarter circle and the service core is oriented towards the north and west.

Climatic conditions affect the formation of the building envelope and materials used. Dark-coloured glass reflecting heat and light has been used for these three buildings; it is widely used in the İstanbul city region which has humid, windy and very hot summers. A panel system has been used for the wall cladding at the İşbank Headquarters (İşbankası Kuleleri 2006). The modular-sized panel system is significantly different from the other systems in that it is semi-finished at a local factory site, then transported to and completed at the building site. The building facade of the Sabancı Towers has been designed taking into account its intended function, aesthetics, safety and flexibility. The exterior surface of the building has been covered with a semi-panel system – the first example of this kind of utilization in Turkey. Reflective blue glass has been used on the outer facade and granite coating has been used on the concrete surfaces (Sabancı Center 1993) (see Table 12.1).

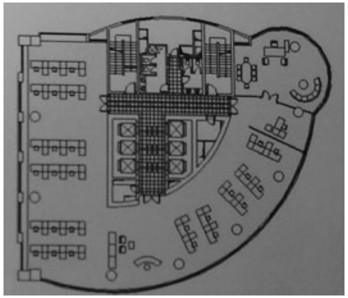
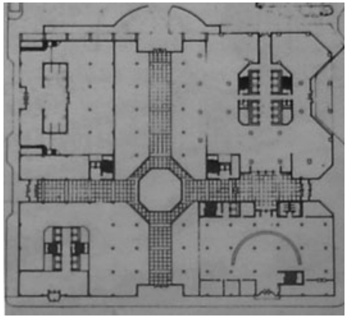
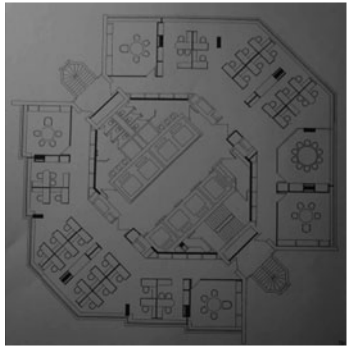
In the design of the facades and entrances of the three buildings, harmonization with the built-up environment, the building users and the established natural environment was given due consideration. To make up for the lack of green areas on the shell, an artificial natural setting was created at the main entrance and along the common spaces of different storeys. The entrance to the Metrocity office building and shopping centre looks onto Büyükdere Avenue. The subway station, a small pool and green areas were designed in this area (Fig. 12.3). Furthermore, the roof of the shopping centre is designed as a green roof.

The Isbank Headquarters, for security reasons, has a few entrances from different directions. The bank skyscrapers have a transport service system for both vertical movements and linking with the outside world, and a spacious car park. There is also greenery landscaping at the section overlooking the shopping centre entrance

Table 12.1 Comparison of three buildings using sustainable "site-environment" design criteria

Criteria	Metrocity office building	İşbank headquarters	Sabancı towers
Relation with outside environment	Connected with the main road axis	No connection with exterior	No connection with exterior
Entrance	Extroverted because of shopping mall	2 main entrances with security. Intraverted because of the security	2 main entrances with security. Intraverted because of the security
Building form			

Table 12.1 (continued)

Criteria	Metrocity office building	İşbank headquarters	Sabancı towers
Typical floor plan			
Orientation	South-East Service core at North and West	Uniform facade Service core in the middle	Uniform facade Service core in the middle
Density	30–35 people for each floor (23 floors)	65–75 people for each floor (46 floors)	38–48 people for each floor (33 floors)
Parking capacity	350	2900 (for all 3 towers)	600
Public transportation	Metro station within the tower	Very close to metro station	Very close to metro station
Open spaces and green areas	A pool and green area in front of shopping mall; a small roof garden designed for staff	A small recreation area for staff	Very small green spots designed in car parking area
Facades	Dark coloured glass	Dark coloured glass, panel system	Reflective blue glass, semi-panel system

Source: Morhayim 2003, Aydemir et al. (1992), Tekeli and Sisa (2003), and Tekeli (1999)
Note: Photos by Selin Mutdoğan

Fig. 12.3 Entrance of the Metrocity (Photos by Selin Mutdoğan)

of the complex and at the main entrance of the business towers. This green area, which covers the car parking entrance, has different species of plants (Fig. 12.4).

Similarly, the Sabancı Centre has green areas and gardens designed by landscape architects around the office blocks. All three buildings are located very close to the subway stations for easy access to public transport.

Fig. 12.4 Entrance and recreational areas of the İşbank headquarters (Photos by Selin Mutdoğan)

12.3.2.2 Energy and Water

For attaining sustainability, wise energy and water consumption has been given high priority in today's world, especially as buildings, as discussed earlier, consume 50% of total energy sources. High-rise buildings are targeted as they are a great consumer of energy as well as an emitter of pollutants and wastes. By green energy norms, buildings housing large numbers of workers and having an intense usage of equipment should be equipped with automated systems to ensure a well-coordinated operation and to provide maximum efficiency of all systems. Heating, air conditioning, ventilation, humidification, water purifying, heat recovery systems, fire detection, warning systems, stair pressure systems, lighting, security, garden irrigation, Uninterruptible Power Supply (UPS), generator and elevator systems available in the buildings can be centrally controlled with the automated systems to ensure the most efficient use of energy.

Unfortunately all three buildings under study have been equipped with traditional HVAC systems. Seen as high technology, the Freon gases (Freon 22 – Freon 134A – Freon 11) released by the buildings are harmful to the ozone layer, though the HVAC systems used in buildings are connected to the automated system for the most efficient operation. All three buildings have their own fan coil units. The Metrocity uses VRV (Variable Refrigerant volume), the Isbank uses 4 fan coils and VAV (Variable Air Volume) and the Sabancı uses parapet front heating systems and VAV (Aydemir et al. 1992, Karabey 2003, Morhayim 2003).

Theoretically, energy efficient equipment is preferred for lighting fixtures. All batteries should have photocell systems in order to save fresh water. The outdoor air is directly used for cooling the building and waste heat from the building is recovered (heat recovery) during the seasonal transition periods. The İşbank Headquarters and Metrocity Office building use stored storm waters for garden irrigation. In the treatment of waste waters, black water[6] is sent directly to the local drainage system and gray water in the whole building is filtered (Morhayim 2003, Pamir 2001).

The annual CO_2 emission amounts and energy consumption are measured at the İşbank Headquarters and Sabancı Centre, but not at the Metrocity Office Building. According to the survey data (Pamir 2001), the İşbank Headquarters consumes 120 kmw/m^2 of electricity per year. The Sabancı Towers has a total energy consumption of 161 kmw/m^2 per year. The energy consumption of buildings must be under 150–250 kwh/m^2 per year to pass an energy-efficient evaluation (Morhayim 2003). It appears that both buildings have met the target (Table 12.2).

The envelope, besides determining the outer appearance of the building and reflecting the institutional identity of the companies using the buildings as their office, is also effective in ensuring indoor comfort. Heat loss in buildings usually occurs at the shell. Hence, this is an important factor that tends to increase energy consumption. The surfaces at the connection points of the facade coating should be designed so as to prevent air leakage. Care should be taken in the fullness and emptiness rate on the facade to avoid heat loss and the northern side should be closed to the outer environment as much as possible (Williams 2007). These factors have been considered in the three buildings analyzed and the service cores

Table 12.2 Comparison of the three buildings using sustainable "energy-water" design criteria

Criteria	Metrocity office building	İşbank headquarters	Sabancı towers
Automation system for energy usage	Yes	Yes	Yes
Energy source for heating	Natural gas	Natural gas	Natural gas
Amount of CO_2 emission/year	Not measured	Measured	Measured
Amount of energy consumption/m^2	Not measured	120 kwh/m^2/year (just electricity)	161 kwh/m^2/year
Energy efficieny of lighting fixtures	Yes	Yes	Yes
Usage of gases harmful to ozone layer	Freon 22	Freon 134A	Freon 22 Freon 11
HVAC system	VRV	4 Fan coils, VAV	Paraphet front heater, VAV
Free-cooling in offices	No	Yes	Yes
Heat-recovery	No	Yes	Yes
Usage of storm water	Stored	Using garden irrigation	No
Usage of grey water	filtered	filtered	filtered
Usage of black water	No- Directly delivered to central sewer system	No- Directly delivered to central sewer system	No- Directly delivered to central sewer system

Source: Morhayim (2003) and Pamir (2001)
Note: HVAC = Heating, Ventilation and Air Conditioning; VRV= Variable Refrigerant Volume; VAV= Variable Air Volume

have been designed in the middle and northern parts of the building plan. The three buildings being investigated have used the best possible green technology in Turkey, and they can be served as pioneer examples for future reference on sustainability assessment.

12.3.2.3 Indoor Environmental Quality

Office workers spend a significant part of their working hours inside the buildings. As such, how the materials used in the buildings influence the ambient air; their impact on the human health, psychology, and comfort levels are very important. The impact is even more crucial if the buildings are high-rise and have no direct contact with the outside of the structure.

In an earlier study conducted by building owners and architecture firms of two buildings, questionnaires were prepared to survey the potential building users at the design stage. Their opinions were used as guidance for the design of a healthier indoor environment for the İşbank Headquarters and Sabancı Towers (Sabancı Center 1993, Tekeli 1999). This method could not be used at the Metrocity because of the rental contract restriction. The offices were sold after the completion of the building (Uluğ 2003). Special care was taken in the selection of materials in compliance with sustainable design criteria such as the indoor air quality (IAQ materials). For fire safety, materials not dispersing poisonous gases have been chosen.

To minimize the negative impact of low indoor air quality on workers, sensors measuring the indoor air quality in the three buildings have been used. However, according to the tests taken while the building was under construction, the indoor air quality at the İşbank and the Sabancı Towers passed marginally the standards (Morhayim 2003).

Another critical element of evaluating indoor environmental quality (IEQ) is to ensure that the building design allows adequate daylight to enter the office workplace. In the three buildings being examined, the focus of the service area is located in the central part of the building. Therefore, the design plan would need to make sure that the workers there can make use of natural light and natural air conditioning, where available. The orientation of the windows has helped perform such functions. A wide window opening on the façade of the İşbank building provides substantial amount of daylight into the building. Strip windows have been used at the Metrocity and Sabancı Towers which also enjoy a very broad angle of landscape view and high-quality natural light (Karabey 2003, Sabancı Center 1993).

The three office buildings have "flexible" office plan layouts. This means their office spaces have been designed to obtain the greatest possible window view and daylight penetration. Such design functions have been achieved at the Metrocity Building, especially by using local materials. Moreover, three different types of "Workstations" have been specially designed at the Sabancı Towers to achieve the most efficient operation of the energy distribution system (Tümay 1994). Indeed, the Isbank has been designed as an intelligent building, which consumes energy in the most rational manner and provides users with the maximum comfort. A computer-controlled system has been established to keep air quality, air conditioning (indoor heating and cooling conditions) at a high level of performance, supported by waste recycling and an open office system (Table 12.3).

12.3.2.4 Materials and Resources

By sustainable design, it is necessary that materials used do not have negative environmental consequences, even if values of aesthetics and costs have to be compromised. When selecting the materials, the following points have to be considered (Yeang 2006: 376):

- Materials are reusable and recyclable and dematerialization[7] principle is observed;
- Materials have a high potential for continuous reuse and recycling at the end of its useful life span;
- Materials have low energy impact;
- Locally produced materials are given priority of use; and
- Materials have no or negligibly low toxicity harmful to humans and the ecosystems.

Table 12.3 Comparison of the three buildings using sustainable "indoor environmental quality" design criteria

Criteria	Metrocity office building	İşbank headquarters	Sabancı towers
Precautions for healthy indoor environment	Yes	Yes (especially human-environment relation considered)	Yes
Based on questionnaire survey	No (rent)	Yes	Yes
– Natural ventilation	Yes	No	No
– Percentage of natural lighting	100%	85%	100%
– Facades with reflecting glass	Yes	Yes	Yes
– Low-e glass	Yes	Yes	Yes
– Heat sensor installed indoor	Yes	Yes	Yes
– Sensor for indoor air quality	Yes	Yes	Yes
– Measuring CO_2 indoor	Measurements with permission from office owners only	Yes	No
– Green areas indoor	No	No	No
– Indoor social facilities	Shopping centre Sport centre Restaurant	Concert hall Art gallery Shopping centre Cinema	Concert hall Art gallery Sport centre Restaurant

Source: Morhayim (2003), Sabancı Center (1993), and Tümay (1994)

In examining the three selected buildings under study, it is found that materials were largely chosen according to their quality for fire resistance since fire safety regulations were rigorously in force. Local materials were mostly used for furnishings and as finished products in Sabancı Towers. No recyclable materials were used, though preferred under the concept of sustainability. For the three buildings under study, architects had not considered about the reuse of construction waste in case of building demolition in the future. Using re-used and recycled construction waste and materials means extension of their life span (see Table 12.4). More recently, it has been reported that some local developers have used recyclable and sustainable materials, though to a limited extent.

12.4 Conclusion

Cities are centres of buildings, physical infrastructure and movements of economic activities of all kinds, the outcome of which produces tremendous amounts of waste harmful to the environment. The issue of common survival and long-term sustainability has called for concerted global efforts to save the Earth from being further degraded. Buildings, being a key culprit of carbon emission, have captured increasingly attention that sustainable architecture and green design are indispensable towards the ultimate end of controlling global warming and air pollution. On the top of financial and technological capabilities, moral responsibility is badly needed

Table 12.4 Comparison of 3 buildings using sustainable "material and resources" design criteria

Criteria	Metrocity office building	İşbank headquarters	Sabancı towers
PVC materials	Yes (fire resistancy)	No	Yes (fire resistancy)
Non-toxic materials	Galvanized materials used	Tested (especially for fire resistancy)	Yes (fire resistancy)
Source of materials used	Local	Local	Local
Usage of recycled materials	No	No	No
Usage of re-used materials	Not installed by tenants nor owners	Yes	Yes
Wastes (recycling and reuse)	Separate storage systems	Separate storage systems	Recycling (cooperating with another company)
Reuse of waste of construction materials in case of building demolition	No	No	No

Source: Morhayim (2003), Karabey (2003), and Sabancı Center (1993)

first, from developed countries, followed by developing countries which are fast industrializing and large consumers of raw materials as well as finished products. This is the key challenge towards a new international equitable management of the world's resources and environment on the basis of shared responsibility.

Turkey is a developing country but its pace of urbanization and the growth of its metropolitan centres are hardly any different from other high-growth developing countries. Over the last two decades, there have been efforts to set up examples of sustainable buildings in İstanbul. Unfortunately, none of them use renewable energy. However, pressure to adopt up-to-date norms to build sustainable buildings is being mounted. In the near future and as public awareness is enhanced and cost is reduced with the help of more advanced and innovative technology, green legislations will be put in place for implementation and enforcement. This study has demonstrated that the three modern buildings in İstanbul being surveyed have achieved little in sustainable design based on the criteria used to measure their annual carbon emission amounts and the energy consumption per square metre of floor area. Nevertheless, for Turkey, such low achievement should be evaluated as a good starting point.

Today, there are more advanced green technologies being adopted in other Turkish cities than the three buildings studied. Some of these buildings use geothermal energy, a cogeneration system or have double facades of higher standards. In Ankara and Erzurum, the Redevco Turkey opened two shopping centres in 2009 named respectively Gordion Shopping Centre in Ankara and Erzurumlu Forum in Erzurum. These two projects were awarded a BREEAM Certificate (rated "Very Good") – the first BREEAM-certified projects in the country. Up to now Siemens Office Building in İstanbul has been awarded a LEED certificate (rated "GOLD"). Also, Unilever and Philips Offices were awarded a LEED certificate for their renovation works in interior designs. Besides, some national organizations such as the

Association of Environmentally-Friendly Green Buildings (ÇEDBİK) are trying to create Turkey's own green building rating system. Results have been encouraging and one could claim such a self-initiated spirit will move Turkey a step forward in line with the international agenda towards urban ecological conservation.

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Notes

1. The first global environment summit was the UN Conference on the Human Environment in Stockholm, Sweden in 1972.
2. The Kyoto Protocol did not demand carbon reductions from developing countries. The Copenhagen Summit wants major polluting developing countries such as China, India, South Africa and Brazil to be binded to emission reductions. Both China and India had agreed to cut respectively 13 and 19% below business-as-usual carbon emissions from 2005 levels by 2020 (Light and Weiss 2009).
3. According to the Population Census of Turkey conducted in 2009, İstanbul's population was 12.915 million.
4. These opinions were discussed at a symposium entitled "Büyükdere Caddesi ve Mimarlik" (Büyükdere Avenue and Architecture) at the Taksim Campus of the Beykent University on 9 January 2008.
5. Without a comprehensive set of "Green Building Code" in Turkey, some companies use LEED or BREEAM to obtain a green building certificate.
6. Wastewater from toilets and urinals, which contains pathogens must be neutralized before water can be safely reused. After neutralization, black water is typically used for non-potable purposes, such as flushing or irrigation (Gissen 2003: 183).
7. Dematerialization means using fewer materials and less energy to produce goods and services. This idea fits in well with new technologies (Yeang 2006).

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