IMPACT OF SOCIAL AND ENVIRONMENTAL FACTORS IN THE PROCUREMENT OF HEALTHCARE INFRASTRUCTURE

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Abstract: Construction investments contribute significantly to the development and growth of local and national economies, as well as adding social value. However, both the construction and operation of built facilities can have negative impacts on both the society and the environment. For example, healthcare infrastructures can consume large amounts of resources and energy, accommodate wide range of activities and attracts many visitors. In the UK, the NHS attends to the healthcare needs of over 50 million customers using its 1.2 million staff. The impact of NHS activities on the surrounding environment and local people is large and diverse. The identification and assessment of these issues is important in: providing better working environments and better services to the community; reducing environmental impact; achieving cost savings; and ultimately delivering best value from healthcare investments.

This paper discusses the importance of activities within the healthcare sector to sustainable economic growth and explores how the sector impacts on sustainable development, socially and environmentally. In achieving this, the paper identifies and highlights the impact of relevant social and environmental issues in the procurement of healthcare infrastructure using the project procurement life-cycle as its base, thus covering design, construction and operational phases.

Key words: Environmental, Healthcare, Procurement, Social, Sustainability.

1. INTRODUCTION

Construction investments contribute significantly to the development and growth of local and national economies, as well as adding social value. According to Roodman and Lenssen (1995), the construction industry directly or indirectly utilises around 40% of the material flow entering the world economy while Cooper and Curwell (1997) estimated that the UK construction industry uses about 6 tonnes of building materials annually for every member of the population. The extraction, processing and transportation of these materials create environmental impacts in the forms of noise, visual amenity, congestion, pollution, etc. Vale and Vale (1991) measured the UK energy consumption related to buildings and building construction services to be up to 66% (inclusive of mining and manufacturing of building materials, transport, construction and operation) of the total energy consumption. Bonini and Hanna (1997) quoted a similar level of energy consumption (54%) in the US construction industry. Construction also creates wastes at the construction and demolition stages. According to Levin (1997), the contribution of buildings to the total environmental burden ranges between 12 - 42% for the eight major environmental stressor categories: use of raw materials (30%), energy (42%), water (25%) and land (12%), and pollution emission such as atmospheric emissions (40%), water effluents (20%), solid waste (25%) and other releases (13%). Thus, construction generally affects communities and businesses as it makes heavy demands on the limited natural resources, and it can also lead to positive outcomes when planned successfully by raising the aesthetic profile of towns and cities.

In particular, healthcare infrastructures, such as hospitals and primary care trusts, support a wide range of activities, attract many visitors, use large amount of resources, and generate large amount of clinical and other wastes. The roles of healthcare facilities are not limited to the treatment of illnesses but are crucial to ensuring progress towards sustainability. They also improve people's wellbeing through promotion of healthier lifestyles by reducing factors that lead to ill-health and minimising environmental harm. The National Health Service (NHS) is the largest employer in the UK and one of the most complex property portfolios in Europe (NHS Estates, 1999). It is responsible for maintaining the health of the over 50 million population with an annual budget of around £40 billion, and provides working environment for over one million people in around 11,000 general practices. The NHS's proactive work to improve public health has a major social impact on individuals and communities by enhancing their quality of life. These impacts vary according to the size of the healthcare facility; for example, a large hospital can be a significant source of jobs and influence the associated local economy, while the main impacts of a smaller facility will be its relationship with the immediate neighbours and its catchment community.

Owing to the variety of activities undertaken, the cumulative impact of healthcare infrastructures on the society and environment are large and diverse. For example, Building Research Establishment reported in 1993 that energy consumption in UK hospitals results in an annual emission of around 7.5 million tonnes of CO_2 (BRE, 1993). In 2000, the Department of Environment, Transport and Regions reported that around 100,000 tonnes of clinical wastes with an additional 100,000 to 200,000 tonnes coming from other sources are generated in the UK predominantly GPs and dentists, nursing homes and private sources (DETR, 2000). A more detailed analysis in 2004 identified the quantity of waste generated by NHS as 384,698 tonnes, with 261,086 tonnes (68%) being domestic waste, 120,547 tonnes (31%) being clinical waste and 3,064 tonnes (1%) of special waste (Barratt *et al*., 2004). The previous major review of hospital waste was in 1997, and this demonstrated a composition of 47.04% clinical to 52.96% domestic waste (Audit Commission (AC), 1997). It is assumed that this reduction in the proportion of clinical waste generated (16% since 1997) is due to the adoption of more sustainable practices through segregation driven by initiatives such as those in "Health Waste Minimisation, A compendium of Good Practice" (NHS Estates, 2000). However, Woolridge *et al*. (2005) showed that the cost of domestic and clinical waste disposal has been increasing as are the tonnages of waste generated. They reported over 20% increase in the amount of total waste generated between 2001 and 2004.

Thus, in order to ensure better working environments and better service to the community, as well as reduce environmental impacts during the operation of healthcare infrastructure, there is need for the identification and integration of sustainability issues in the design and construction process. This paper aims at illustrating the importance of activities within the healthcare sector to sustainable economic growth and how the sector impacts on sustainable development, socially and environmentally. This will be achieved by identifying and highlighting the impact of relevant social and environmental issues on the procurement of healthcare infrastructures during the design, construction and operational phases.

2. WHAT IS SUSTAINABILITY?

The term 'sustainability' is often used interchangeably with 'sustainable development'. Sustainable Development is the achievement of a better quality of life through the efficient use of resources, in order to realise continued social progress while maintaining stable economic growth and caring for the environment. It has been defined in many ways by many authors. The following are the two most commonly cited definitions in the UK:

The United Nations World Commission on Environment and Development (UNWCED) (1987) define sustainable development as "…*development which meets the needs of the present without compromising the ability of future generations to meet their own needs*". This definition is popularly known as the Bruntland definition.

The Department of Environment, Transport and Regions (DETR) (1999) publication 'A Better Quality of Life' explained that "*at the heart of sustainable development is the simple idea of ensuring a better quality of life for everyone, now and for generations to come*". The publication lays out four key objectives that need to be met to bring about long-term improvements in people's quality of life:

a. social progress which recognises the needs of everyone;
b. effective protection of the environment;
c. prudent use of natural resources; and
d. maintenance of high and stable levels of economic growth and employment.

DETR (1999) further stressed that the health of the population is a key component of sustainable development. This view was echoed by the Director General of World Health Organisation, Gro Harlem Brundtland: "… *if people's health improves, they make real contribution to their nation's prosperity. In my judgement, good health is not only an important concern for individuals, it plays a central role in achieving sustainable economic growth and an effective use of resources*" (Brundtland, 2000).

In the context of construction, sustainability has been a growing trend and the opportunities for complete integration into the design and construction process is a great challenge for the industry. Hobson (2000) defined sustainable construction as "*a process by which a profitable and competitive industry delivers built assets (building structures, supporting infrastructure and immediate surroundings), which enhance the quality of life of people and offer customer satisfaction; provides flexibility and supports desirable natural and social environments; and maximise the efficient use of resources while minimising wastage*".

2.1 THE THREE PILLARS OF SUSTAINABILITY

All sustainability decisions involve balancing seemingly conflicting needs across what is known as 'The Three Pillars of Sustainability'. These pillars take account of the specific requirements and constraints of a particular project. The three pillars are:

1. Social sustainability

This identifies the needs of individuals and considers their well-being. In the context of construction, social sustainability covers a wide range of issues from health and safety, education and training through to social inclusion and poverty eradication. It is often the least considered area but it has the potential to bring the most benefits.

2. Economic sustainability
This focuses on the importance of stable economic growth. It means working within the capacity of the natural environment, adopting measures from fair and rewarding employment through to competitiveness and trade.

3. Environmental sustainability
This is most recognised of the three pillars. It is concerned with protecting and conserving both biodiversity and the environment, by reducing waste, preventing pollution and using water and other natural resources as efficiently as possible.

3. LIFECYCLE APPROACH

The project procurement lifecycle considers the whole life of a project from inception through to design and construction, operation and final re-use or disposal. It is a process which identifies where and when key decisions are to be made and determines the critical outputs that should be delivered at each stage of the project. Although there are many classifications regarding the various phases of a project procurement lifecycle, this article would consider only the main phases; design, construction and operational phases.

4. SUSTAINABILITY ISSUES AT DESIGN STAGE

Although the initial design cost of a building may represent only a fraction of its total construction cost, and even less of its lifetime operational cost, up to 80-90% of its lifecycle economic and ecological costs are usually sanctioned at this stage (Miles, 1972). Devoting sufficient time and resources to the design phase of a project can yield huge benefits in building quality and overall performance (Dell'Isola, 1997). It can also enable savings to be made in other aspects of the construction process, so that total construction time and cost are kept low. Key sustainable development issues that should be considered at the design stage of a healthcare infrastructure include the following.

4.1 Building and site layout

The building shape is the spatial attribute that defines the outline of the building. It informs the areas and sizes of the vertical components such as walls and associated finishes, windows, partitions and associated finishes, etc., as well as the perimeter detailing such as ground beams, fascias, and the eaves of roofs (Seeley, 1996). In general, Seeley asserts that "the simpler the plan shape, the lower its unit construction cost". The reason being that a building with a simple plan shape uses less external wall to enclose the same floor area and also for the fact that external wall is usually a cost significant element of a building. Thus, the building with the smallest perimeter for a given amount of accommodation offers the cheapest option as far as the enclosure elements are concerned (Ibrahim, 2003). However, Ferry and Brandon (1999) consequently argued that although circular shape provides the smallest perimeter in relation to area, it does not often provide the cheapest solution due to difficulty in setting out; high cost of achieving curved surfaces since non-right angled internal arrangements are generated, standard joinery and fittings based upon right angles will not fit against curved surfaces or acute-angled corners; and inefficient use of site space.

The key constraints influencing decisions on the outline of a building shape include the shape of the site (plot); functional requirements such as natural lighting and good views; and manner of use such as coordination of manufacturing processes, and the forms of machines and finished products in a factory building (Seeley, 1996). Thus, the aspects of building and site layout that has potential impact on the sustainability of healthcare facilities are:

a. low-rise construction (less than four floors) in order to reduce the need for vertical movements (which are energy intensive) and offer increased protection against heat loss through wind chill;
b. clustering of the buildings to reduce space requirement and connectivity (roads and paths) and increased protection against wind chill;
c. irregular building arrangement will ensure that high winds do not generate in corridors between buildings in consideration for care needs;
d. location of related services (having similar usage and service requirements) and departments together will reduce the amount of on-site transportation required and use of lifts;
e. where possible, separation of pedestrian and vehicular access routes will result in safer and more peaceful environment for pedestrians;
f. reduction in areas of hardstanding in order to minimise their contribution to surface water runoff;
g. minimising area covered with hardstanding or using porous pavement surfaces in order to downsize and reduce pressure placed on storm drains;
h. easy accessibility for deliveries and storage pending distribution throughout the facility;
i. ways of facilitating access of public transport and provision of disembarking point for public transport users;
j. building orientation to ensure the optimum use of solar energy;
k. using existing topography, trees (deciduous) or man-made windbreaks in protecting building surfaces from prevailing winds in order to reduce heat loss; and
l. provision of natural areas in order to increase health and wellbeing of staff and patients and reduce stress levels. Baines (2000) reported that hospital patients experience more rapid post-operative recoveries, require less medication and are more amenable if they have a view of green space from their beds.

4.2 Flexible and standardised design approaches

Because a huge amount of energy and resources is used in the construction of a building, insufficient flexibility in design may mean that the benefits of the investments may not be maximised if the building cannot adapt to changing requirements, or to alternative uses if it is no longer required for its originally planned use (Ferry and Brandon, 1999). The continuously evolving nature of healthcare needs, either as a result of feedback from performance indicators or demographics change, makes it important to ensure that a sufficient degree of flexibility in the infrastructure use be incorporated to assure that existing facilities can adapt to the changing requirements. The following factors should thus be taken into consideration:

a. designing some rooms slightly smaller or larger than is required in design specifications so that flexible interior layout can be achieved. For example, an office can be turned into a consulting room or a consulting room into an overnight room;
b. use of outer supporting frame in construction in order to eliminate the need for interior supports and thereby enabling re-design of the interior at a future date.

4.3 Integrated energy-efficient design approaches

Although traditional building styles take advantage of the use of sun as source of light and heat or use of walls and floor as heat sinks to reduce the size of internal temperature changes, the following technical innovations will enable higher performance and more sustainable healthcare buildings:

a. effective insulation will help in moderating internal environment and maintain comfortable temperature in either cold or hot weather. The areas where high levels of insulation can significantly improve performance are as follows (NHS Estates, 2001):
    i. windows, which accounts for around 20% of energy loss from a building, can be improved by using low emissive windows (double-glazed, with a surface coating that reflects heat back into a room);
    ii. walls, accounting for 8% of heat loss from a building, can be improved by using cavity insulation or thicker walls to provide thermal mass that absorbs heat during the day and releases it into the building at night; and
    iii. roof, which accounts for around 9% of heat loss from a building, can be improved through use of high insulation specification in the roof (to reduce energy use particularly on upper floors) in low-storey buildings.
b. use of passive solar design (PSD), involving the location of services in areas where they can achieve most benefit or are least affected by solar energy. This can reduce the need for artificial lighting, increase the quality of internal environment with more tranquil, natural and open atmosphere, and reduce the need for heating, cooling and ventilation services. Some important aspects of PSD include (NHS Estates, 2001):
    i. facing of the main façade to the south maximises heat and light gain;
    ii. siting of building to avoid overshading by another;
    iii. glazed areas to have external shading to reduce overheating and glare;
    iv. shallow planning of buildings, and deeper planned “light shelves” to be used to reflect light deeper into the building;
    v. use of operable windows, vents, and atria to increase natural ventilation;
    vi. circulation of hot air in the atria throughout the building to achieve solar heating during colder nights; and

vii. use of atria that is controllable with vents, blinds and shading.

c. the initial and operating costs of building services can be significantly reduced through the use extra insulation in windows, walls and roofs (as explained in section 4.3a above), necessitating the use of smaller plants;

d. use of whole-systems thinking, including whole-life costing to minimise the operational, maintenance and replacement costs over the facility lifetime and cost-effectiveness analysis such as the consideration of cost of increased insulation (windows, walls and roof) against heating and ventilation costs;

e. selection of building materials that require less energy to produce, are easier to recycle, require less transportation or use less non-renewable resources can significantly reduce the impact of buildings on the environment. CIRIA (1993) stated that the production of building materials in the UK accounts for around 10% of national energy consumption annually and thus the efficiency of different materials in use should be an influencing factor in its selection.

5. SUSTAINABILITY ISSUES AT CONSTRUCTION STAGE

Sustainable construction involves both the minimisation of environmental impacts of construction through specification and monitoring of construction activities and the maximisation of the social benefits that can be achieved from construction projects. Construction involves a large number of people and affects a locality in many ways. Similarly, although many of the environmental impacts arising from construction are predetermined by the design specification, management of site activities and materials sources can significantly reduce the impacts from these processes.

Major construction activities, such as the building of a new hospital or the renovation of existing healthcare centre, can have a significant impact on the local economy over the construction period, both directly through the creation of employment and indirectly through the procurement processes. Ways of maximising the social benefits of a healthcare infrastructure construction to the local communities include:

a. employing local people to work on-site and providing them with training opportunities;

b. using local suppliers for non-specialist services without undermining the delivery of value for money or contravening the rules and regulations governing public procurement;

c. working with local groups who may be able to make use of site waste materials or contribute to the development of the site; and

d. involvement of the local people in the planning and decision-making process in order to create sense of belonging.

The environmental aspects of construction processes relate to manufacture and transportation of construction materials, use of the materials on-site, ecological and nuisance impact in the vicinity of the construction site and pollution incidents. Ways of minimising environmental impacts during construction include:

e. re-using existing buildings will reduce the amount of energy and resources used for new buildings (manufacture and transportation of which account for around 12% of total UK industrial energy consumption (CIRIA (1993)). If new buildings are inevitable however, environmental impacts from material use can be minimised by management of the construction process and materials suppliers;

f. lean construction, which is concerned with ways of minimising waste and ensuring that all construction activities add value to the finished building, can be achieved in the following ways:
    i. bringing to site only those materials that will be needed immediately as stockpiling of materials on-site increases the likelihood of damage and waste of resources;
    ii. ensuring that delivery vehicles carry full loads when visiting the site thereby minimising transportation impacts and nuisance;
    iii. recycling of wastes through suppliers or specialists recyclers; and
    iv. on-site composting of organic wastes (paper, cardboard, wood, etc) and used to supplement topsoil in landscaping the finished site.
g. sustainable sourcing of building materials while ensuring that the value for money criteria are met;
h. taking appropriate steps to reduce local impacts of construction on both the environment and people as recommended by the Local Government Association (2003); and
i. use of risk assessment procedures to identify substances or activities that have potential to cause harm to the environment and estimate the likelihood of such an event occurring. Potential sources of pollution on a construction site include fuels and oils, construction materials, construction wastes, noise and light. Risk management procedures to minimise any incident include:
    i. secure storage of hazardous substance;
    ii. operating procedures for safe working with hazardous materials;
    iii. control over noise and light sources on-site.

6. SUSTAINABILITY ISSUES AT OPERATION PHASE

Sustainability issues during the operational phase of a healthcare infrastructure can be considered from the following perspectives (NHS Estates, 2001):

a. energy management;
b. waste management;
c. water management; and
d. transport.

6.1 Energy Management

Healthcare facilities use considerable amounts of energy on daily basis for a wide range of purposes such as heating, lighting, cooling, ventilation or powering appliances. A sustainable building must consider how it can minimise its energy use and source its energy requirements in the most cost-effective and environmentally beneficial manner. The benefits include financial savings, a more controllable and better quality internal environment, and reduced emissions of atmospheric pollutants arising from heat and power generation. Whether generated on-site or at a local power station, there are significant environmental and social costs associated with energy production such as:

a. emission of greenhouse gases, which contribute towards global climate change;

b. emission of particulate matter with associated chronic health impacts;
c. emission of oxides of sulphur and nitrogen, which contribute towards acidification; and
d. depletion of non-renewable resources.

The most effective way of reducing the impact of energy generation on-site is to reduce demand. Ways of minimising energy use and optimising energy sourcing include:

a. use of combined heat and power technologies, in which case the waste heat generated from on-site electricity production is used to provide heating;
b. use of natural sources of energy such as solar and wind, whenever possible;
c. use of heat recovery system, in which case the waste heat from hot water pipes or ventilation shafts are used to preheat the incoming ventilation air;
d. use of insulation to minimise heating requirements as detailed in section 4.3a
e. use of thermostatic radiator valves for wet central heating systems to minimise unnecessary heating and to increase local control and comfort;
f. insulation of pipework associated with the heating distribution system;
g. use of mechanical ventilation only when necessary, as this can account for up to 30% of electricity consumption in modern hospitals;
h. in addition to optimising cooling and ventilation equipment, minimise heat sources such as sterilizers, medical and laboratory equipment;
i. use of artificial lighting during the day by using PSD techniques detailed in section 4.3b;
j. using high efficiency fluorescent tubes rather than traditional filament bulbs to achieve huge energy savings and significant reduction in cooling load; and
k. use of dimming systems that adjust the level of artificial light according to the level of natural light, or occupancy sensing systems or timed lighting controls.

6.2 Waste Management

Healthcare facilities are a major source of both clinical and municipal wastes. With a disposal cost of between £180 and £320 per tonne, disposing these wastes costs the NHS Trusts around £34 million to £60 million a year (Audit Commission (AU), 1997). The budget for waste disposal in a typical 600 bed UK General Hospital is in excess of £225,000 per annum (Woolridge *et al.,* 2005). Thus, reducing the amount of waste arising from healthcare operations has become increasingly important in order to reduce unnecessary expenditure, while ensuring compliance to legislation.

Audit Commission (1997) recommends the following ways of reducing, re-using and cycling wastes:

a. reversing the growing tendency to use disposable equipment by re-introducing more re-usable equipment;
b. careful categorisation and segregation of the waste to ensure that household waste is not mixed with the clinical waste;
c. use of gas rather than coal as a source of fuel can eliminate the need to dispose coal ash to landfill; and
d. removal of recyclables or re-usables from waste stream and selling them to dealers.

6.3 Water Management

Water management involves reduction of overall level of water consumption and the recycling of grey-water. Greywater is water that has been used for a domestic purpose such as bathing, showering or hand-washing. Good water management can reduce costs if careful management practices are put in place which reduces water usage and encourage the re-use of grey-water for secondary purposes that do not require water of drinking-quality, such as WC flushing. However, the re-use of grey-water has its drawbacks as it could be a source of potential health risk and thus on-site partial treatment would be necessary.

6.4 Transport

Ease of access to hospital sites is essential to ensure access to healthcare for the whole society. Thus, healthcare infrastructures should be sited at a location with the greatest accessibility to the majority of the members of the society. However, access by car in particular is unsustainable and the increasing road traffic causes:

a. congestion, delays, unreliable journeys and road casualties;
b. emission of pollutants, affecting local air quality and community health;
c. emissions of carbon dioxide contributing to global warming;
d. noise and negative visual impacts; and
e. reduced levels of physical activity in the population related to a greater reliance on the car, and increased stress levels whilst driving, resulting in poorer health.

7. CONCLUSION

Procurement of constructed facilities have impact on the environment and also plays significant economic and social role, such as provision of employment, procuring of goods and services, investing in capital infrastructure, and (in some areas) contributing to the research and development process. The variety of activities undertaken within the facilities has necessitated the consideration of their economic, social and environmental impacts on both individuals and the communities they serve. Thus, NHS is significant not only because of the number of people it employs, but also indirectly through the consumption patterns of its employees, which contribute to local economies. One regional study (Yorkshire Forward, 2003) suggests that the greatest impact of rising health spending on the local economy was through employees' spending patterns, rather than through increasing NHS demand for goods and services. As a buyer of goods and services, the NHS can minimise its environmental impact by greening its supply chain and strengthening the local economy by opening its contracts to local small and medium-sized enterprises (SMEs). Similarly, substituting local supplies of goods and services currently sourced elsewhere could help build niche markets. Other economic prospects could come from allying the NHS with universities and businesses to commercialise research into new products and services.

This paper identified the inter-related sustainable development issues that require careful consideration when formulating strategy for establishing a healthcare infrastructure and also suggested ways of sustaining them. It has identified the key design issues for ensuring a sustainable healthcare infrastructure in terms of building and site layout, flexible and standardised design approaches, and integrated energy-efficient design approaches. The paper further highlighted the social and environmental impacts on people and environment as a result of construction and operation of healthcare infrastructure.

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