IDENTIFYING SUSTAINABILITY REQUIREMENTS IN THE REFURBISHMENT OF HOSPITALS: THE BUILT ESTATE, MODELS OF CARE, AND THE CHALLENGE OF ADAPTATION PLANNING

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***Abstract*—** Public spending across the United Kingdom is facing unprecedented challenges as a result of the economic downturn. Nowhere is this more keenly felt than the interface between the National Health Service (NHS) and the construction industry. Limited government investment is challenged by the ever-evolving demographics and technological changes which are driving the need for flexibility and progress throughout the NHS. In tandem with these financial and evolutionary challenges, the NHS bears a legal responsibility to reduce its Carbon Footprint significantly, in line with the requirements of the Climate Change Act. Additionally, the service is driven by the organisational and legal requirements of the wider sustainability drivers. The emphasis on construction within the NHS has focused predominantly in the area of new build within the last 10 years. This paper discusses the need to focus on the area of Refurbishment. The main aim of this paper is to present a contextual basis for an ongoing research study to develop a sustainable refurbishment model for hospitals. A comprehensive literature review has been employed as the methodology to discuss the current situation relative to organisational, financial, and sustainability factors. It is demonstrated that an understanding of the nature of refurbishment is required. Challenges specific to refurbishment, such as lack of as-built data and information on the state of the existing fabric and services, may have significant effects on the project in regard to time and cost. It is further demonstrated that the hospital facility has unique characteristics and Client expectations which do not affect a 'standard' commercial refurbishment.

***Keywords*—** **National Health Service (NHS), refurbishment, sustainability, management, climate change act, adaptation.**

I. INTRODUCTION

The healthcare sector in the United Kingdom is facing some of the toughest financial challenges since its inception. The economic challenges are timely in respect of the ambitious sustainability targets set out by Government, most notably in the area of carbon emission reduction. The link between reduced emissions and reduced costs through lower energy consumption seems clear, yet the energy requirements of the NHS as a whole are rising. One of the key areas in addressing this issue is the process of refurbishment. Refurbishment has been largely ignored in recent times in favour of new build; however, the economic situation has shifted this emphasis back onto the existing estate. Given the size of the existing portfolio, it is from the refurbishment of the existing estate where the design, construction, and operational solutions to the sustainability agenda must be found. The wider issue of adaptability is also gaining centre ground, and mirrors the pro-active and reactive nature of refurbishment itself. It is the main objective of this paper to present a clear understanding of the refurbishment process in the context of both the hospital and the issue of sustainability.

II. ECONOMIC CHALLENGES FOR THE NHS

The NHS, as a publicly funded institution is facing great challenges in light of the current UK economic downturn. Current predictions on financial pressures in England suggesting a 4% decrease in funding every year, over a period of 4 years [1] equating to a real cash figure reduction of

between 15 and 20 billion pounds. Scotland has a similar tale with the public sector watchdog identifying the NHS in Scotland as facing an "unprecedented squeeze" in its budgets and finances [2] It seems reasonable to assume that these predictions are indicative for the NHS as a whole. In appreciating the effects of such a major 'efficiency drive' on a national level, it is important to view the NHS in perspective of scale. This is most easily conveyed through basic statistics of the healthcare portfolio and the staffing levels. The portfolio of the NHS identifies it as the largest public sector body across the whole of Europe [3] Direct staff employment is correspondingly high, with an estimated 1.3 million people directly employed. [4] These figures take no account of the indirect employment figures related to areas such as infrastructure, retail, and supply chain. Overall, there is an extremely broad array of functions, departments, and business drivers which have evolved as essential to maintaining and supporting the service in its present form. This very evolution may be related to the core value of the NHS, which may be identified as the provision of care and services. It would be difficult to argue the point, that this is in fact the fundamental raison d'être of its very existence.

Changing demographics and evolving models of care

At its most functional level, the health system and the hospitals within it must be measured against the issue of 'provision of care'. This itself, is a model framed within a broad spectrum of facility types. The property portfolio is vast, and must incorporate what is recognised as the 'standard acute' hospital, through to the far smaller, and often specialised clinics. In this context, no separation is made between the hospital, and the healthcare facility. This in turn is framed within the ever 'shifting sands' of service provision by process, and service provision by requirement. What must be understood by this statement is that the process, or method of service provision, is in itself a moving target. This is further compounded by the increased 'blurring of the lines' between the traditional roles of primary and secondary care [5] which supports the observation on the wide differentiation between healthcare facility and hospital types. The NHS is, ultimately, an over-arching term for a nationally distributed assemblage of Primary Care Trusts and Health Boards. In regard to the issue of service provision by requirement, it is now widely understood that there have been significant changes in demographics [6] which has seen an increasingly ageing population, and a range of medical conditions and diseases which are relatively new on a national level, attributable to such factors as strain resistance and re-emergence of previously controlled conditions [7] This observation must also be expanded to include the growing increase in numbers of people suffering from obesity and dietary related conditions, [8] and to the conditions which accompany an ageing population, that includes the need for growing requirements for high maintenance residential care and the increase of co-morbidities. [9] In design and construction terms, an additional perceived danger, especially in relation to new build projects, is that aspects of the built asset may be overtaken by changing requirements by the time the hospital is operating, or certainly before the envisaged end of life [8] This may not necessarily be solely as a result of demographics or service provision, but also as a result of technological or medical advancement, which could ostensibly render a facility or aspect of a facility obsolete. This is phrased well in Rechel et als observation that "form follows function" [8] and highlights the argument that a hospitals design is challenged by the need to address future events and trends, and its configuration should, in theory, be determined with this in mind. Given the economic challenges discussed earlier, and the nature of the design and construction process generally, this presents an uncomfortable interface between the NHS and the design and planning of its built assets.

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III. THE NHS AND THE SUSTAINABILITY AGENDA

The current status of the NHS in terms of sustainability is quite telling when it is appreciated that the NHS possesses Europe's largest property portfolio, and in consequence of this, is credited with 3% of total UK CO2 emissions [3] The scale of the portfolio has the knock on effect of identifying the NHS as the largest single contributor to climate change in the public sector [10] In numeric terms, the annual emissions are estimated at 21 million tonnes of carbon. [10] In its simplest terms, it should be understood that for these emissions to reach the end process of

atmospheric release, the energy or fuels at the root of the emission must be consumed in the first instance. This consumption in turn generates a real financial cost, which is estimated to be in excess of £400 million per annum [11] The connection between economic and environmental considerations, viewed in these simplistic terms seems unambiguous.

The issue of carbon reduction

It is against this backdrop that the NHS faces significant challenges in reducing its CO2 emissions across the entire organisation. To begin assessing these challenges, it is necessary to understand the current emissions produced by the service, and critically, to quantify the emissions by source. Identifying the areas of emission is key to this process and figures have been published recognising (in England) the breakdown of the carbon footprint as 22% in energy use, 18% in travel, and 60% as a result of procurement. [12] By comparison, Scotland's figures are calculated as 23% energy use, 25% travel, and 52% in procurement. [13] In reviewing these statistics against the required reductions, it is important to understand an added complexity to the issue which will add to the overall challenges already faced by the NHS. The nature of the investment and expansion to the NHS estate over recent years has resulted in an overall increase of CO2 emissions of 40%, measured against the 1990 baseline [3] This is despite the increased efficiencies achieved through strategic and operational reorganisation. This has the significant impact of requiring not only the reduction in emission production, but a trend reversal of the factors contributing to the overall footprint. This correspondingly high increase in CO2 emissions which seems to overtake and negate the real progress being made presents an almost 'Canute' type problem. This requires an understanding of the hospital in terms of real sustainability, but given the paradoxical challenges given above, what are the connections?

The hospital as a sustainable asset

The significant observation by Sheth et al [14] that that the majority of the existing healthcare built assets which will be utilised well into the 21st century have already been built, must direct the research to consider these factors in considering the procurement, design, and refurbishment of existing facilities. This observation is framed within the expectancy of future requirements from the NHS, as stated by the Chancellor of the Exchequer in his statement that all government departments and the NHS will (from April 2011) have a mandatory requirement to publish a sustainability report in their annual accounts. These are to include details of not only carbon emissions, but also waste management, and the use of finite resources [15] By the nature of the construction process, which will include the design and construction phases of refurbishment activity, these issues are especially relevant and have regulatory and management aspects which are unlikely to be found on a similar scale in any other industry and it is this more holistic methodology which is key to understanding and modelling an integrated approach. Remaining within the construction industry, the challenges of a sustainable asset are by no means unique to the hospital, and on the contrary, the built environment is being increasingly challenged across the board. However, issues such as the 24/7 requirement, the non-negotiable provision of care, and even the political sensitivities involved, place the hospital in a unique position. Rechel et al [8] provide a number of key themes in the construction and refurbishment of healthcare facilities (see Figure 1) These issues are inclusive of innovative design, therapeutic environment creation, response to future changes, the whole life cost analysis, and the carbon impact and rating.

The issue of perception and understanding of what sustainability means, and how to define it, become prominent in this context, to provide a frame of reference for the relationship between the hospital and sustainability. Gibsons model [16] consisting of the well known Venn Diagram showing the tripartite and integrated nature of sustainability is still valid. However, the hospital by the nature of it's unique characteristics (including the process of refurbishment), must have the flexibility within the model to address its specific needs and requirements. This leads the discussion into the area of refurbishment itself. Commonly perceived as a specialised and uncertain process, an understanding of its definitions and challenges is essential in building context to the debate.

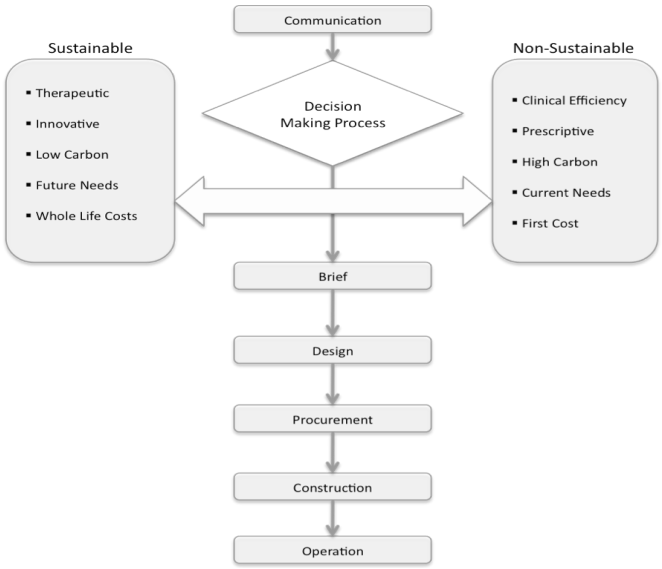

Fig.1 Key sustainability themes (adapted from ARUP Healthcare Design Group) Rechel et al. 2009 *Investing in Hospitals of the Future*. European Health Property Network. Pp.230

IV. DEFINING REFURBISHMENT

In the most basic of terms, a construction project is a well defined process with fairly well established participants and methodologies throughout. A fair definition of the nature of a project is proposed by Kerzner [17] in defining an undertaking of a temporary nature with a clear beginning and end point, and crucially, with a specific objective. This is echoed within the Project Management institutes [18] definition of:

"…a temporary endeavour undertaken to create a unique product or service. Temporary means that every project has a definite end. Unique means that the product or service is different in some distinguishing way from all similar products or services."

On a 'standard' construction project, the parameters of the project as an activity are fairly clearly defined, regardless of the choice of procurement path selected. Responsibilities and Risk are agreed for the design, the construction, the successful completion and handover, and to a limited degree, the initial operation of the asset. It is recognised that as the above definitions state, no two projects are the same, and this extremely simplistic view of the project life-cycle takes no account of the incredible technical and managerial complexity which are more common on any modern construction project. There seems little doubt, and clearly obviated by the term itself, that new build is not a difficult concept to grasp, or as defined by Riley and Cotgrave [19], a new build project could be:

"…any work that is starting from scratch…no part of the structure left on site."

Refocusing on refurbishment, the Collins English Dictionary [20] offers the following definition:

"To make neat, clean, or complete, as by renovating, re-equipping, or restoring"

Although succinct, and in general terms wholly accurate, such a definition is severely limited in scope in describing what Quah [21] refers to as an area which has evolved a contextually fluid and multi-faceted nature. This approach is supported by Mansfield [22] who recognised in excess of 20 differing terms that are used to describe the process, which it may be suggested with some confidence, are connected to the reasons for refurbishment. This in itself raises further questions for debate, which are wide ranging in their coverage. Given this approach of identifying the reasons to refurbish, the types of refurbishment may be inferred as fairly self explanatory, as in the findings of Aikivuori [23] who separated the activity into corrective, alteration, optimisation, pleasure driven, and opportunistic. These suggested drivers convey well the broad spectrum of motivations to undertake the refurbishment of a facility or structure, although they do lack the level of detail required to comprehensively understand the real technical or social motivations which initially catalyse the decision to refurbish. In light of this statement, Aikivuoris generic identifiers can be supported by the more detailed observations given by Hardcastle et al [24] in defining refurbishment as:

"…work which involves the structural alteration of buildings, the replacement of main services or finishes and/or the improvement of floor space, and also any redecoration and repair work."

This revisits the requirement to understand the hospital as a unique asset in comparison to other types of building. A comprehensive study undertaken by Kishk et al [37], presents the foundation of this difference as the relative complexity of the hospital design and function. A selected example to illustrate this 'uniqueness', was presented through the importance of consideration that is given to controlling and minimising the spread of infection. Targeting the finishes to the flooring systems, they develop the argument that the possible consequences of spillages or the use of ill considered chemicals in

different parts of the hospital complex, present potential challenges in respect of both initial selection and the planning of cleaning regimes. The selected finish therefore, must not only be resistant to infection through the use of cleaning agents, which themselves must be examined for the potential to affect physical health recovery rates and/or psychological well-being; the application of the new finish in a refurbishment project, and the continual application of cleaning agents must be accommodated in a 24/7 clinical environment. This is by no means an impossible task; but it is certainly a challenging one. This leads the discussion to consider the challenges of refurbishment, and the same challenges in the context of the healthcare setting.

The challenge of refurbishment

One of the most often cited challenges for refurbishment as opposed to new build, is the inherent uncertainty of the works themselves [21], [25], [26] and [27] This uncertainty is measured against the process as a whole, but it must be noted that the challenges faced in this aspect also have singular significance, respectively, to the design team, and to the contractor carrying out the works. Perhaps the most obvious example of this from the perspective of the designer, is the lack of information on the composition or co-ordination of the existing facility or structure. The literature supports the view that designers may be extremely reluctant to commit and engage with the decision making process when faced with the possibility of making mistakes on the basis of insufficient information [28] which in turn, feeds the perception [29] that "most of the time…" construction projects are hindered by lack of performance on the design process. This issue, which may even be perceived as a source of conflict between the design team and the contractor, is exacerbated by the common (and arguably reasonable) practice, of designers including contingency cost allocations within the design [30] This anticipates one of the refurbishment projects main challenges, which is the occurrence of large numbers of variation orders to the project, due to the 'unknown' nature of the facility or structure in question. Despite the technical challenges involved in the refurbishment process, especially in the area of existing services, and the space constraints of upgrading to modern standards and "matching up" [26] of the refurbishment output to the existing building conditions, a refurbishment project (and this point is of especial significance in relation the refurbishment of hospitals) may have to remain fully or partly operational throughout the project life-cycle. The most obvious impacts of this crucial point are in the area of health and safety, by means of re-routing, and interface with the public, and the potential costs added to the works to facilitate this. [19] On a 'standard' new build project there would very likely be a fully enclosed site-hoarding, and all persons entering the works area would undergo some form of induction or awareness safety training. When issues such as the potential for dangerous materials (i.e asbestos), the presence of noise and dust, or even the movement of vehicles and plant are taken into consideration, the unique approach required by all parties to the refurbishment process becomes more pronounced. In related terms, this is a highly topical debate which branches into the area of rationalisation, which is a key institutional driver for the NHS Asset Managers, driven from Government. In Scotland, for example, the identification and rectification of outstanding backlog maintenance issues, falls largely within the scope of the refurbishment process. In capital spending terms, this pre-allocates a percentage of the funding available to maintenance issues. This itself, is a challenge of economic sustainability. The remaining points to be understood for a rounded appreciation of refurbishment as a whole, are the earlier questions posed of 'when (or why) and also 'how' to refurbish. The answer to 'why' has already been touched upon in the earlier discussion on defining refurbishment, and it may be fair to say that different building types will have differing drivers to instigate the refurbishment process. Regardless of individual differences, an immediate and fairly summarised suggestion is offered by Markus [31], who states that...

"The overall purpose of refurbishment is to extend the beneficial use of an existing building by providing a cost effective alternative to redevelopment"

It may be argued however, that this explanation does not go far enough, and its logical simplicity ignores important detail in regard to both functional and economic aspects. Mansfield [22] specifically identifies depreciation as a main driver in the decision making process. His observations

address the connection between the reduction, or loss, in value of the properties investment value (in terms of both rental and capital), when compared to the value of a new property. He continues to identify that depreciation itself is a result of two further 'sub-effects', namely; physical deterioration, and obsolescence. There is validity in the proposition that the physical deterioration aspect of these factors is to a large degree predictable, but his view that the area of obsolescence is both 'unpredictable' and 'impossible to address' is questioned. Given the earlier discussions on the ever-shifting models of care and continual technological advancement associated with the hospital, it is argued that the hospital, of all built assets, must have obsolescence, and therefore adaptability, accepted as a fact and be addressed within the design accordingly.

V. The Importance of Adaptability

Adaptability in this context is rapidly evolving into a key issue, especially in regard to the wider issue of climate change and mitigation strategies. As with refurbishment itself, adaptation has the dual approaches of reactive or pro-active. Figure 2 illustrates this duality, and identifies the commonalities between the drivers of the need to refurbish, and the definition of adaptation at each end of the spectrum.

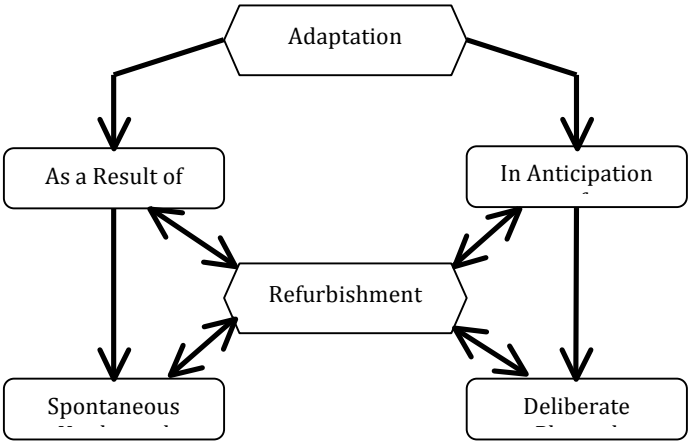

Fig. 2 Adaptation and Refurbishment shown as separate processes. The driver commonalities are shown addressing each end of the spectrum

The challenge of adaptation has been discussed throughout the literature, mainly in terms of commercial premises and the relationship with economic evaluation [32], [33] however, given the nature of the hospital as an 'essential' 24/7 functioning built asset, and the rapidity and constancy of the changes in care model, developments in pharmaceuticals, and evolving demographic; this is surprising. It is instructive to appreciate that the challenges discussed above, are predominantly focused on the hospital as a built asset, or on a *micro* scale, and yet the issue of adaptation in the context of healthcare, must also be considered from a *macro* level. At it's highest level, this is clearly identified within *The Stern Report* [34] which advises on the benefits (or necessities) of building adaptation and resilience into the current systems and infra-structure, to minimise the 'potential' economic impact on society as a whole. Aside from (but inextricably linked to) the economic impact of the (arguably) changing weather patterns and climatic conditions, Rudge and Kovats (in Roaf et al) [35] identify the physical 'real-life' health implications associated with a changing climate. It is argued however, that these health implications, which include the effects of heat and cold, and the identification of particularly vulnerable groups are not particular to the debated shifts in global temperature, but are, and have been constants affecting vulnerable groups on an ongoing basis. In terms of the challenges to the capacity and functionality of the hospital as an evolving, adapting asset, the *macro* scaled approach must be refocused and integrated to the *micro*, or human scale issues such as the ageing population, increased appearance of co-morbidities, as a result of advances in treatment and medication, and weighed against the political backdrop for healthcare services that seeks to shift the focus from secondary, and even primary care settings, into that of a community based system of care. These challenges take the discussion full circle, and place the hospital, and the healthcare estate, above all others, at the heart of debate regarding the necessity to plan for and build in, adaptability to the buildings form, orientation, and ultimately function. There is a clear link to the issue of resilience planning related to this issue, as resilience shares this dual driver approach (figure 2) of the capacity to come back from (recuperative), and the capacity to defend against (preventative) climate induced issues. A balanced and related strategy in asset planning and refurbishment against this backdrop will require an informed, flexible, and integrated decision making process. This is a daunting task when faced with the 'blank canvas' afforded to a new-build hospital, however, as the discussion has identified, the majority of the

Legislation	Demographics	Changing models of care
Sustainability drivers	Planning issues/requirements	Funding
Political drivers	Technological advancement	Climate change
Social	**Environmental**	**Economic**
Therapeutic environment	Carbon emissions reduction	Life-Cycle Costs
Reduced risk of infection	Waste management	Whole Life Analysis
Thermal comfort	Reduce/Reuse/Recycle	Energy consumption
Fresh air provision	Climate change	Absenteeism
Natural daylight	Adaptability	CRC Energy Efficiency Scheme
Environmental control	Specification	BREEAM requirements
Privacy & Dignity	LZC technologies	LZC technologies
Acoustic quality	Transport	Transport
Adaptability	Volatile Organic Compounds	Room types
Transport	Room types	Procurement
Room types	Procurement	Staff retention
Procurement	Water use & consumption	Ageing population
View out		Co-morbidities
User group expectations		Changing health issues (obesity etc)
		Water use
		Waste management
		Specification

Table 1. Clinical/Client requirements in the context of sustainability. The higher level strategic drivers affecting all 3 component dimensions of the sustainability model are shown as over-arching factors

healthcare estate in use today, and figuratively speaking…tomorrow; is already built and functioning. This places the sustainability, and adaptability, challenge, largely at the feet of the refurbishment process and the practicalities of finding the 'best fit' as opposed to pursuit of the 'perfect fit'. The refurbishment process has been discussed in terms of its challenges and inherent risks, and yet this is still not the whole story. It may be argued that the success of the sustainability argument may, especially in the context of healthcare and the physical hospital, be part of the problem. Stringent legislation, and detailed and prescriptive assessment methodologies could be seen by practitioners as an additional layer of bureaucracy and cost on issues that, although positive, provide negligible gains to the efficacy of the provision of medical care. The final over-arching challenge for a successful refurbishment project of a healthcare related facility, is a reluctance from central government, and therefore, an inability from local government, to invest in publicly funded healthcare projects. In construction and planning terms, for the NHS as the Client, and the Design Team and consultants, these, of course, are no easy set of obstacles to overcome *even prior to the works being carried out*.

VI. THE CLIENTS REQUIREMENTS

Although this section is framed to address the Clients requirements, this issue can be approached from more than one direction. In the context of the study, this could as easily be referred to as 'clinical' or 'legislative and regulatory' requirements. In capturing all aspects of the sustainability issues related to the hospitals place in the public sector, the Director of the NHS Sustainable Development Unit, Dr David Pencheon, made special reference in his consultation response [36] on 'Healthy Lives, Healthy People' to the sixth of the NHS seven guiding principles with the reminder that:

"The NHS is committed to providing best value for taxpayers money and the most effective, fair and sustainable use of finite resources"

This is a major challenge for not just the NHS as the Client, but also the design teams and contractors in delivering and maintaining a built asset as multi-faceted and complicated as a 'standard' acute hospital. In the context of sustainability alone, these challenges are illustrated in Table 1, which separates many of the core sustainability considerations beneath the wider overarching drivers. What is clear from the factors within Table 1 is that there are multiple instances of a particular issue being grouped under more than one, or sometimes all of the three component parts of the sustainability model. This is a good indicator of the integrated nature of the hospital as a whole in regard to the issue of sustainability, and the integrated nature also, of the sustainability model itself. Although integration may be

considered in very positive terms, especially in regard to a team approach and the related synergies resulting from this; the hospital also presents unique challenges which have potentially the capacity to view integration as much a part of the problem as the solution. Perhaps the most basic example to demonstrate this point is the issue of Healthcare Associated Infection (HAI). Practically every factor within Table 1 must be considered against the prevention of HAI as a priority. It is recognised that a 'standard' commercial building has health related issues in regard to material selection, water supply etc, but the potential consequences and associated regulation and demand for best practice, place the hospital in a challenging and demanding league of its own.

VII. SUMMARY AND THE WAY AHEAD

It has been discussed that the NHS faces an uncomfortable paradox of increased functional demands and evolving models of care and technological advancements, against a background of extremely challenging economic circumstances. Major efficiency savings are framed against the legislative requirements for the organisation to adapt its assets and procedures to meet carbon reduction targets. Crucial to achieving these aims within the financial constraints, the area of refurbishment and adaptation of the existing estate has a key role to play. It is clear however, that refurbishment is in itself a specialised activity and must be understood by all parties. This is of especial significance in regard to the unique characteristics of a hospital.

The findings of this paper lay the foundation for a deeper and more focused direction of research as part of a full time PhD study. The research objective is to develop and test a multi-criteria decision support system which specifically targets the challenges associated with refurbishment projects in the healthcare sector.

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