MEASURING THE OBSOLESCENCE OF OFFICE PROPERTY THROUGH USER-BASED APPRAISAL OF BUILDING QUALITY

JAMES PINDER AND SARA J. WILKINSON

School of Environment and Development, Sheffield Hallam University, Sheffield, United Kingdom

ABSTRACT

Buildings are constructed in circumstances of high uncertainty concerning their medium to long term lives. However, the act of construction is a commitment to physical permanency and spatial fixity. This, together with the fact that most buildings are durable, means that they have to function in changing political, economic, social and technological conditions. The result is that every building undergoes a process of obsolescence as it exhibits a diminishing capability to meet evolving user expectations through time. In recent decades, the process of building obsolescence has been particularly problematic for office property, as building life spans have become increasingly ephemeral (Gann, 2000). Technological advances and changing occupier needs have resulted in many office buildings being demolished after only 20 years life (Khalid, 1993). Furthermore, due to rapid innovation and development, future office buildings are likely to enjoy even shorter useful life spans. Such a trend is considered to represent a widespread inefficiency in the use of physical resources, the costs of which are borne by property owners, occupiers and non-users. The trend has implications for the way in which office buildings are designed and managed.

Previous studies into office property obsolescence have focused almost entirely upon the financial impact for the property owner (Baum, 1991; Khalid, 1993). However, the limitations of this traditional approach have become increasingly apparent (Pinder and Wilkinson, 2000). The research discussed in this paper suggests that building obsolescence in office property can be examined from the perspective of the building occupant. In so doing, the research explores the gap that develops between the expected and perceived utility of office property, the results of which will form the basis of a model for highlighting approaching problems of building obsolescence in public sector operational property. Such a model will be of practical worth in assisting facilities managers and designers to minimise the risk of building obsolescence. Both theoretical and methodological issues pertaining to the research undergo critical discussion in this paper, and the underlying aims and objectives are examined. The paper considers the first round of empirical research currently nearing completion, and before concluding, maps out the continuing programme of research.

KEYWORDS:

Building utility; employees, operational property; public sector; United Kingdom.

INTRODUCTION

Until recently it could be said that the lifespan of a building would be determined by the longevity of its fabric and that problems of obsolescence were relatively innocuous (Bowie, 1989). Today, most building types are increasingly prone to obsolescence because of the functional, economic and social requirements being placed on them by economic shifts, revolutionary technologies and emerging cultures (Chilton and Baldry, 1997). In the UK two reports have highlighted the nature and extent of the problem. Boyle and Harrison (2000) posited that many National Health Service (NHS) buildings currently under construction would become obsolete in several years time as developers fail to take account of user needs. The report predicted that this situation could leave the NHS with expensive buildings that become outdated within a few years, but for which it would still have to pay (Boyle and

Harrison, 2000). The Connaught Report (1997) questioned the suitability of the UK's stock of office buildings, estimating that a significant amount of the stock would fail to meet occupier requirements at the beginning of the new millennium; in other words, many office buildings would be obsolete. As an issue of current interest obsolescence cannot be ignored as tomorrow's problem (Khalid, 1993).

This paper considers research that is looking at the issue of obsolescence from the perspective of the building occupant. Initially the paper explores the concept of obsolescence, explaining how opinions vary according to the knowledge and viewpoint of the assessor. The paper discusses why building obsolescence in office property has come to the fore in recent years, and the implications that this obsolescence has had for those involved in the design, management and use of office buildings. The more specific focus of building obsolescence in public sector operational property portfolios is then examined, before discussing the need for a proactive approach to problems of building obsolescence in public sector office property to counteract the impact of organisational workplace dynamics. A framework for achieving this is posited, the overall aim of which is to enable facilities managers in public sector organisations to minimise the risk of building obsolescence in their operational portfolios; methodological issues and anticipated outcomes pertaining to this work are also discussed. Before concluding the paper reports on the current state of the research, outlining the ongoing programme of study.

THE PROCESS OF OBSOLESCENCE

From the moment of construction buildings are subject to the process of physical deterioration and capital invested in them undergoes a gradual process of devaluation; as buildings age and decay they suffer from diminished utility and require a constant stream of capital investment (Bryson, 1997). Nevertheless, physical deterioration of buildings is largely a function of time and use, and can be controlled to some extent by selecting appropriate components and materials at the design stage, and by correct maintenance (Ashworth, 1999). Though effective maintenance policies are not the norm it is clear that building maintenance has begun to be approached in a more informed way; the increased use of planned maintenance programmes being a case in point (Chanter and Swallow, 1996). Furthermore, life cycle cost analysis has been developed to facilitate choice between alternative design options and to enable designers to take into consideration all costs that emerge during a building's physical life (Kishk and Al-Hajj, 1999). Physical deterioration should not, however, be confused with a building's decline in utility due to a failure to satisfy new needs created by changes in equipment, materials, style, laws and the many other forces that cause a building to lose desirability in the eyes of its user (Trowbridge, 1964). The impact of such factors is called obsolescence.

'Just what is obsolescence at any particular time is difficult to define, since any particular structure or environment can be found lacking in contemporary terms due to a variety of contributory factors' (Lichfield *et al.*, 1968; p.239). Whilst this may be so, the basic definition of obsolescence is reasonably clear: obsolescence is the process of becoming antiquated, old fashioned, outmoded, or out-of-date (Building Research Board, 1993). More specifically, obsolescence describes a relative decline in the utility of a building that does not result directly from physical usage, the action of the elements or the passage of time (Baum, 1991). Instead, obsolescence is caused by changes in peoples' needs and expectations regarding the use of a particular building (Lemer, 1996). Utility - the sense of usefulness, desirability or satisfaction - is central to the concept of obsolescence; if a building does not provide utility, it will be considered obsolete (Smith *et al*., 1998). However, there is no objective measure of utility for buildings and, if there was, it is unlikely that the changes over time would be represented by a straight line; the pattern of change would be more complex (Khalid, 1993).

The lack of an objective measure of building utility presents two problems. The first problem is that obsolescence is difficult to control. In contrast to the gradual process of physical deterioration obsolescence occurs at irregular and unpredictable intervals and is concerned with uncertain events, such as changes in fashion and technology, as well as innovation in the design and use of buildings (Ashworth, 1999). The range of variables and the unpredictability of some of these influences imply

that a general model of obsolescence is not feasible (Golton, 1989) and the scope for preventative action appears limited (Salway, 1986). The second problem is that obsolescence is a relative matter, which means that rational, consistent measures are very difficult to produce and are subjective (Raftery, 1991). This subjectivity derives from the fact that perceptions of obsolescence change relative to a particular situation or condition, and vary according to the viewpoint or interest of the observer; obsolescence is a function of human decision rather than a consequence of 'natural' forces (Cowan, 1970). Traditionally, the problem of measurement has been overcome by focusing upon the financial impact of obsolescence, by measuring obsolescence in terms of a real or nominal decrease in building value.

Authors such as Baum (1991) and Khalid (1993) have used the financial impact of obsolescence to measure the affect of obsolescence on the depreciation of office buildings in the investment property market. Whilst the limitations of the financial approach will become apparent later in this paper, it allows us to isolate two forms of obsolescence. *Building obsolescence* 'occurs when a building's stream of rental payments bears little relationship to the rental payments usually obtained from that location' (Bryson, 1997; p.1446). It is therefore concerned with buildings' physical characteristics, as determined by design and specification. *Locational obsolescence* occurs when buildings located within a particular area suffer from devaluation because the area is seen has less attractive by current or prospective occupiers (Bryson, 1997). Locational obsolescence results from changing expectations of infrastructure, communications and environmental conditions (Cowan, 1970; Lichfield *et al*., 1968). It is much more difficult for an individual building owner or user to remedy the causes of locational obsolescence, whereas building obsolescence can often be remedied by refurbishment (Debenham Tewson & Chinnocks, 1985). That is why this research is concerned solely with the issue of building obsolescence, with intrinsic rather than external characteristics.

THE IMPACT OF BUILDING OBSOLESCENCE on OFFICE PROPERTY

In the UK the timescales within which office buildings are designed, constructed and used have become increasingly ephemeral (Gann, 2000). Changing political, economic, social and technological conditions have caused modern organisations to become more dynamic, resulting in changing office facility needs over time. At the same time office buildings and their infrastructures have remained stereotypical, designed with the assumption that the needs of different organisations or of the same organisation do not differ significantly through time (Tu and Loftness, 1998). The failure of many office buildings to respond to these changing organisational needs is apparent as the rate of building obsolescence in office property has increased. Office building lifecycles have declined from between 40 and 50 years in the 1950's and 1960's to between 20 and 25 years in the 1990's; since then lifecycles have fallen, boosting the potential stock of redundant office buildings (Gann, 2000). The result is that building obsolescence is an important issue for building owners and occupiers, as many office properties have been refurbished or redeveloped long before reaching the end of their physical life because of the impact of building obsolescence (Khalid, 1993).

The impact on office building ownership

Office buildings exist on two distinct but related levels (Bryson, 1997). They are seen as an investment class that competes with cash and securities for the allocation of institutional funds (Baum, 1991). Property investors regard office buildings as an investment medium that provides returns and benefits through the flow of rental income or capital appreciation (Bottom, 1996). However, these same investors shoulder the ultimate responsibility for problems of building obsolescence, which can serve to undermine a property's ability to show rental and capital growth in the long term (Salway, 1986). In the UK building obsolescence arose as a significant issue for investors in the 1980's, when it became clear that the life expectancy of office buildings was not as long as had been expected previously or implied within values and market valuations (Dixon *et al*., 1999). Since then technological advances and dramatic changes in occupier requirements mean that the financial impact of building obsolescence is more significant for office property than for any other

building type (Khalid, 1993). Connaught (1997) suggested that if the trend continued there would be a danger that UK office property would become less desirable against other forms of investment, its value base suspect and its worth to its owner diminished.

The impact on office building occupancy

Given the investment value of UK office property the financial impact of building obsolescence for the property owner has remained the focal point of concern for most property researchers. However, many office buildings are not investment property, but operational property that 'is utilised for the carrying out of an organisation's activities, is occupied by the organisation, and is not let in its entirety to a third party' (Avis *et al.*, 1993; p.29). The emphasis is not so much on the value of the office building as a commodity as with it's utility as a facility or resource. The level of utility provided by an office building will vary in time as it becomes subject to shifting political, economic, social and technological conditions, which lead to changing user expectations about the services and amenities an office building should provide (Ohemeng and Mole, 1996). If office building utility declines operational users may suffer from increased rates of churn[1], reduced productivity, higher employee turnover, increased staff absenteeism and rising health care costs related to on the job stress (Building Research Board, 1993). As operational user expectations may change over time there is a risk that office building utility will decline and occupancy costs will rise over acceptable levels.

This risk is of concern to UK public sector organisations with operational property portfolios. Public sector office buildings are valuable assets that can provide long and high-quality service if managed effectively. Public sector organisations have a responsibility to delay or minimise building obsolescence to optimise returns on public assets; failure to do so may impose significant costs on operational users of buildings, and ultimately, the public at large (Building Research Board, 1993). This responsibility often rests with the facilities management function since it is concerned with property matters that immediately affect operational users of buildings (Avis *et al.*, 1993). There is a need for facilities managers in public sector organisations to take a proactive approach to the management of building obsolescence so that irremediable problems are anticipated and the risk of unexpected occupancy costs reduced (Debenham Tewson & Chinnocks, 1985). Such an approach has been seen as problematical because of the practical difficulties of measuring and predicting building obsolescence (Bottom, 1996). The aim of this research is to enable facilities managers to overcome these practical difficulties and reduce the risk of building obsolescence in public sector office property.

PREDICTING BUILDING OBSOLESCENCE

The first objective of this research is to address the difficulties of predicting building obsolescence. To achieve this objective it is necessary draw on work by Bottom (1996), which demonstrated that it is possible to carry out predictive modelling of functional performance data to counteract the depreciation of investment property. Bottom gauged the opinions of senior managers from homogeneous groups of tenant organisations in the City of London regarding the suitability of their office accommodation; these results were then correlated with building design/quality data to form a decision-support model. The theoretical framework underlying this research is illustrated in Figure 1. Office buildings may be viewed as packages of resources, each one offering a different combination of resources according to its physical characteristics. The degree of utility afforded by these resources is a measure of the interaction between the building's physical characteristics and its operational users, attained at a cost to the occupier organisation. However, over time organisational workplace dynamics - a result of shifting political, economic, social and technological conditions - may change the interaction between the building and its operational users (Tu and Loftness, 1998); resource imbalances may develop and intensify over time, leading, first to stressful conditions, and

[1] Churn (rate) is defined by Brand (1994, p.168) as the 'percentage of an office's population that changes location in a year'. The cost of churn 'is often considered to be an unnecessary expense if the properties were better designed and managed' (Gibson, 2000; p.151).

ultimately to partial failures of a functional and financial kind (Nutt *et al*., 1976), as building utility declines and occupancy costs rise.

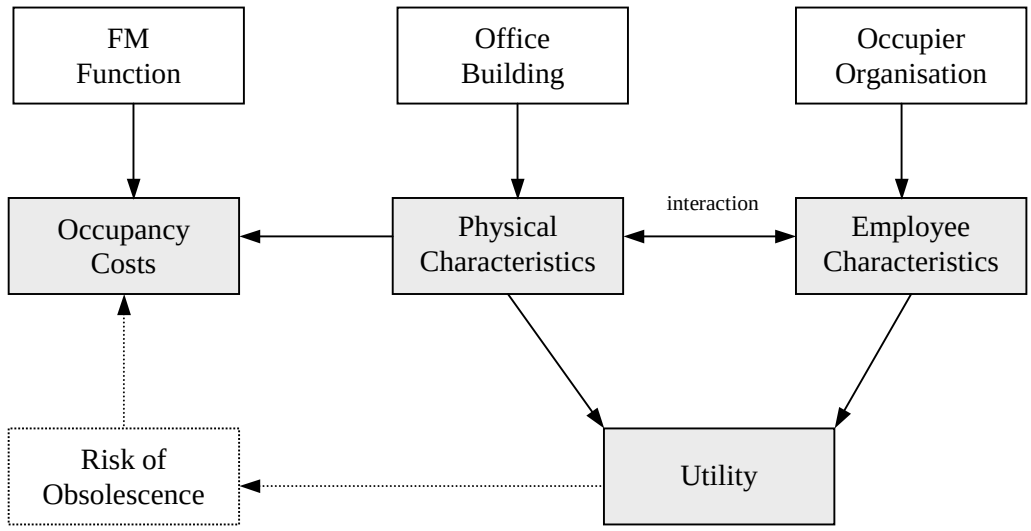

Figure 1: Theoretical framework (adapted from Bottom, 1996)

The operational users of public sector office buildings are composed of several groups, including occupants (employees who work in the building), senior managers or executives in the organisation (who may not necessarily work in the building) and visitors, including members of the public, who have business in the building (Gray and Tippett, 1992). This research focuses on the needs and expectations of the employees. The rationale is that in most public sector office buildings employees comprise the majority of occupants; hence their needs and expectations should take precedence (Douglas, 1996). It is recognised that employees are the most important assets in many organisations, public or private; as an organisation's investment in its employees often represents its greatest expenditure there is clearly an advantage in ensuring that office accommodation supports their activities (Chilton and Baldry, 1997). There is a substantial, growing body of literature that indicates that it is going to become ever more difficult for organisations to find and retain the right employees. Consequently, it is going to become increasingly important for facilities managers in the public sector to take account of employees' aspirations and priorities in respect of their office accommodation (Bradley and Osborne, 1999).

The needs and expectations of different employees may vary enormously, placing a wide variety of potential demands upon office property. Consequently, the minimum standard of office accommodation considered tolerable or yielding satisfactory utility will vary with each employee according to their objectives, the method of fulfilling those objectives and the resources available to them (Williams, 1985). The generic term 'office work' tends to conceal the critical differences that occur between different kinds of office work; in reality certain office activities place special demands on the physical environment in which they occur, which means that the functional, technical and social needs of specific groups of employees in combination may lead to a requirement for particular physical characteristics (Gray and Tippett, 1993). Thus, the composition and interaction of factors inducing building obsolescence will act differently on each employee in accordance with their specific characteristics; so whilst office accommodation may be unsuitable for one employee, it may yield a suitable level of utility to another (Williams, 1985). This research recognises this fact and aims to develop a model to highlight impending problems of building obsolescence in public sector operational property portfolios, one that will utilise office building characteristics to predict changes in office building utility and occupancy costs for homogeneous groups of employees, the latter being defined by function and work practice characteristics (Boyd and Jankovic, 1992).

MEASURING BUILDING OBSOLESCENCE

The second research objective is to address the difficulty of measuring office building utility as a means of determining the degree of building obsolescence affecting public sector operational property. Techniques such as Post-Occupancy Evaluation, ORBIT 2.1, Real Estate Norm, Serviceability and Building Quality Assessment have been developed to provide consistent, reliable measures of various facets of office building performance (Baird, 1996). However, none of these techniques appear suitable for measuring office building utility as defined in this research, and if they were, they are in the main expert-based techniques (Bottom, 1996). It has been suggested that in defining office building utility there is an element of subjectivity on the part of employees. Indeed, the assessment of the utility of an office building with regard to employee needs and expectations is a complex decision-making process that is strongly influenced by individual perceptions (Williams, 1985). At the same time, it is often difficult for individual employees to articulate their expectations and perceptions in language that can aid decision-makers (Gray and Tippett, 1993).

The deviation of existing utility from required utility involves two problems: first to identify, and secondly to measure the difference in utility (Aikivuori, 1996). Market research techniques are espoused as a means of overcoming these problems (Beeston, 1984). This research aims to use market research techniques to develop a multi-item instrument for measuring the utility of public sector office buildings; the instrument will be used to elicit the opinions of employees regarding the suitability of their office accommodation. To ensure a valid and reliable instrument, this research will use Churchill's (1979) procedure for developing multi-item measures of marketing constructs, summarised in Table 1. The first step in the procedure entails specifying the domain of the building utility construct; this involves delineating the boundaries of the construct by means of a comprehensive literature review. A literature review suggests that the concept of *building quality* can serve as an effective proxy for building utility, a premise supported by many authors (Baum, 1991; Bruhns *et al.*, 1991; Gray and Tippett, 1993; Khalid, 1993; Bottom, 1996; Bryson, 1997).

Table 1: Procedure for developing multi-item instruments (adapted from Churchill, 1979, p.66)

No.	Description	Coefficient or Technique
1	Specify domain of construct	Literature search
2	Generate sample of items	Literature search, experience survey, insight stimulating
3	Collect data	survey, critical incidents, focus groups
4	Purify measure	Coefficient alpha, factor analysis
5	Collect data	
6	Assess reliability	Coefficient alpha, split-half reliability
7	Assess validity	Multitrait-multi method matrix, criterion validity
8	Develop norms	Average and other statistics summarising distribution of score

The word 'quality is elusive and can be defined in many ways' (Baum, 1994, p.43). The *Concise Oxford Dictionary* (Pearsall, 1999; p.1170) defines quality as being 'a distinctive attribute or characteristic', 'the degree of excellence of a thing', or 'the relative nature of a thing'. For the purpose of this research building quality is taken as being the 'measure of the extent to which the building meets the requirements of its owners and users' (Gray and Tippett, 1993; p.1). Flanagan (1984) argued likewise, defining building quality as the degree to which the building performs the function for which it is required. Having defined the domain of the construct, step 2 of the procedure involves undertaking exploratory qualitative research in order to generate items that capture the domain. In this research focus groups are used to elicit the views of a sample of employees from a public sector organisation; items generated from the focus groups form the basis of the quantitative stage of the research procedure. The first part of the quantitative stage (step 3) involves collecting data for statistical analysis; two competing measurement models, both derived from the service

quality marketing literature, are being utilised in this research: a perceptions-expectations model and a perceptions only model.

The perceptions-expectations measurement model is based upon the gap analysis approach developed in marketing by Parasuraman *et al* (1985), whose research explored the concept of service quality. Parasuraman *et al* (1985) developed the gap analysis approach to identify and measure gaps in service quality. Their work resulted in a marketing instrument called SERVQUAL (Parasuraman *et al.,* 1988). A significant feature of the SERVQUAL instrument is that gap scores are computed for each item and sub-item of the construct; the expectations of the respondent for each statement are recorded first, followed by the respondents perceptions for each statement (Hoxley, 2000). The approach is based on the notion that customers judge the quality of a service by comparing the service they perceive with the service they expect. Thus, if a customer perceives a poorer service than they expected, they will feel that they have received a low quality service; this difference, between perceived service and expected service, is described as a quality 'gap' (Parasuraman *et al*., 1988). The application of this measurement model in this research will produce an instrument capable of identifying building quality gaps; a negative score for any particular item or sub-item of the building quality construct will indicate a quality deficiency and hence building obsolescence. It would therefore be analogous to the 'supply-demand' approach used by Bruhns *et al* (1991) and Bottom (1996).

Although gap analysis has received widespread application the use of gap scores has recently become the subject of much debate. Several authors (Boulding et al., 1993; Brown et al., 1993; Cronin and Taylor, 1994) have rejected the gap based model, arguing that an instrument based upon a perceptions only measurement model out-performs an instrument derived from a gap-based measurement model (Hoxley, 2000). It has been suggested that by wording statements so that expectations and perceptions are measured in the same statement it is possible to achieve increased efficiency over gap-based instruments**.** The effect is to reduce the number of items that must be measured by half, whilst still retaining validity and reliability (Cronin and Taylor, 1992). The rationale behind the use of two competing measurement models in this research is that it will enable the researcher to select the most efficient, valid and reliable instrument, using steps 4 through to 8 of the procedure shown in Table 1. Both instruments are being developed as part of an empirical study currently nearing completion. The empirical study is being undertaken with a large UK public sector organisation, involving nearly one thousand of its employees and a number of office buildings from its operational property portfolio. The instrument developed as part of this initial empirical study will be used in the main round of empirical research, which will involve analysing several hundred office buildings from the organisation's property portfolio and will be used to construct the model discussed earlier in this paper.

ANTICIPATED OUTCOMES

In the UK there has been much discussion in the property investment market about the problems of building obsolescence and its affect on property values (Debenham Tewson & Chinnocks, 1985). However, building obsolescence also impacts upon operational users of office buildings. Taking account of building obsolescence is vital in all property types and crucial in office property (Downs, 1995). There is a substantial, growing body of literature and empirical research that shows that office accommodation can enhance or deplete the productivity, health and well-being of employees; if building obsolescence is not addressed employee productivity and morale may drop, and the total costs of business increase (Gray and Tippett, 1993). To maximise operational property utilisation factors causing building obsolescence should be identified and managed, trends that threaten undesirable outcomes should be understood and controlled (Pugh, 1991; Aikivuori, 1996). The first step towards maximising office building utility is awareness of the problems of change and the possibilities of accommodating change, which means focusing on individual buildings or portfolios (Building Research Board, 1993). The model being developed in this research will facilitate

awareness by identifying impending problems of building obsolescence in public sector operational property.

This research will assist facilities managers in public sector organisations who are expected to respond to dynamic employee needs with inflexible buildings and facilities (Chilton and Baldry, 1997). The model developed in this research will enable facilities managers to minimise the risk of building obsolescence in operational property portfolios. It will allow facilities managers to determine whether their buildings have physical characteristics that are currently, or prospectively, not meeting the needs or expectations of employees, or employee groups, enabling the establishment of proactive strategies for combating sources of building obsolescence (Bottom, 1996). By applying the model over time facilities managers will be able to determine rates of building obsolescence for particular physical characteristics (Bottom, 1996). Such information will facilitate property portfolio review, acquisition or disposal (Douglas, 1996). This research will assist those involved in the design and refurbishment of operational property. To reduce the risk of future building obsolescence in office buildings systematic feedback on the operation of existing buildings is essential (Preiser, 1995). Over the years building designers have found that certain physical characteristics are consistently better suited to managing building obsolescence; the model being developed in this research will allow designers to develop broader insights into design configurations that are better suited to avoiding or delaying building obsolescence (Building Research Board, 1993).

CONCLUSION

Clearly, building obsolescence has become an important issue in the UK property market, as changing political, economic, social and technological conditions have served to reduce the functional life spans of many office buildings. However, whilst the financial impact of building obsolescence for property owners is relatively clear-cut, for operational users of office property the consequences are often more subtle, as declining utility results in increased occupancy costs and reduced productivity. This declining utility is a problem for the many public sector organisations in the UK with operational property portfolios. Public sector organisations have a responsibility to minimise the risk of office building obsolescence, as failure to do so may mean significant costs for operational users and the public at large. Nevertheless, a proactive approach has traditionally been considered difficult because of the practical difficulties of measuring and predicting building obsolescence. This research aims to help facilities managers in public sector organisations to overcome these practical difficulties. The first research objective is to develop a model that will allow facilities managers in public sector organisations to reduce the risk of building obsolescence in their operational property portfolios. This model will utilise office building characteristics to predict changes in building utility and occupancy costs for homogeneous groups of employees, the latter being defined by function and work practices.

The second research objective is to develop a rigorous measure of office building utility, one that is based upon the opinions of employees regarding the suitability of their office accommodation. Market research techniques are espoused as a useful means of eliciting information from employees and this research is currently using one such technique to develop a multi-item instrument for measuring office building utility. Two competing measurement models are being used to develop this instrument: one based upon employee expectations and perceptions, and the other based solely upon employee perceptions. The use of two competing measurement models will allow the researcher to select the most efficient, valid and reliable instrument for use in the main round of empirical research. Taken as a whole this research is of significance to those involved in the management of public sector operational property, since it will enable them to adopt a more proactive approach to problems of building obsolescence. It is also of importance to those involved in the design and refurbishment of operational property, since it will provide increased awareness about which physical characteristics or design configurations are most suited to avoiding or delaying problems of building obsolescence.

REFERENCES

Aikivuori, A. (1996) Periods and Demand for Private Sector Housing Refurbishment, *Construction Management and Economics*, **14**, 3-12.

Ashworth, A. (1999) *Cost Studies of Buildings*, 3rd edn, Longman, New York.

Avis, M., Braham, R., Crosby, N., French, N., Gane, D., Gibson, V.A., Temple, M., and Whitman, A. (1993) *Property Management Performance Monitoring*, GTI and Oxford Brookes University, Oxford.

Baird, G. (ed) (1996) *Building Evaluation Techniques*, McGraw-Hill, London.

Baum, A. (1991) *Property Investment Depreciation and Obsolescence*, Routledge.

Baum, A. (1994) Quality and Property Performance, *Journal of Property Valuation and Investment,* **12** (1), 31-46.

Beeston, D. (1984) The Measurement of Quality and Its Cost, In Brandon, P.S. and Powell, J.A. (eds), *Quality and Profit in Building Design*, E & FN Spon, London.

Bottom, C.W. (1996) *Determination of the Functional Performance of Office Accommodation: Building Quality and Tenant Characteristics*, D.Phil, University of Ulster.

Boulding, W., Kalra, A., Staelin, R. and Zeithaml, V.A. (1993) A Dynamic Process Model of Service Quality: From Expectations to Behavioural Intentions, *Journal of Marketing Research,* **30**, February, 7-27.

Bowie, N. (1989) Depreciation in Commercial Buildings, *Estates Gazette,* 19 August.

Boyd, D. and Jankovic, L. (1992) Building IQ – Rating the Intelligent Building, *The Intelligent Buildings and Management Conference*, Uxbridge.

Boyle, S. and Harrison, A. (2000) Private Finance and Service Development, In Appleby, J. and Harrison, A. (eds), *Health Care UK*, Autumn, King's Fund, London.

Bradley, S. and Osborne, P. (1999) The Working Environment: Catalyst or Constraint? *Journal of Corporate Real Estate*, **1** (2) 178-190.

Brand, S. (1994) *How Buildings Learn*, Phoenix Illustrated, London.

Brown, T.J., Churchill, G.A., and Peter, J.P. (1993) Improving the Measurement of Service Quality, *Journal of Retailing*, **69** (1), 7-27.

Bruhns, H., Isaacs, N., Baird, G., and Kernohan, D. (1991) *Building Quality Assessment*, Centre for Building Performance Research, Victoria University of Wellington, New Zealand.

Bryson, J.R. (1997) Obsolescence and the Process of Creative Reconstruction, *Urban Studies*, **34** (9), 1439-1458.

Building Research Board (1993) *The Fourth Dimension in Building: Strategies for Minimizing Obsolescence,* National Academy Press, Washington D.C.

Chanter, B. and Swallow, P. (1996) *Building Maintenance Management*, Blackwell Science, Oxford.

Chilton, J.J. and Baldry, D. (1997) The Effects of Integrated Workplaces Strategies on Commercial Office Space, *Facilities*, **15** (7/8), 187-194.

Churchill, G.A. (1979) A Paradigm for Developing Better Marketing Constructs, *Journal of Marketing Research*, **16**, February, 64-73.

Cowan, P. (1970) *Obsolescence in the Built Environment*, Joint Unit for Planning Research, London.

Connaught (1997) *The Connaught Report: Refurbishment in the Office Sector 1997/8*, The Royal Institution of Chartered Surveyors, London.

Cronin, J.J. and Taylor, S.A. (1992) Measuring Service Quality: A Reexamination and Extension, *Journal of Marketing*, **56**, July, 55-68.

Cronin, J.J. and Taylor, S.A. (1994) SERVPERF Versus SERVQUAL: Reconciling Performance-based and Perceptions-Minus-Expectations Measurement of Service Quality, *Journal of Marketing*, **58**, January, 125-131.

Debenham Tewson & Chinnocks (1985) *Obsolescence - Its Effect on the Valuation of Property Investments*, Debenham Tewson & Chinnocks, London.

Dixon, T.J., Crosby, N. and Law, V.K. (1999) A Critical Review of Methodologies for Measuring Rental Depreciation Applied to UK Commercial Real Estate, *Journal of Property Research*, **16** (2) 153-180.

Douglas, J. (1996) Building Performance and Its Relevance to Facilities Management, *Facilities*, **14** (3/4), 23-32.

Downs, A. (1995) The Hidden Impacts of Obsolescence, *National Real Estate Investor*, August, 18-20.

Flanagan, R. (1984) Life Cycle Costing – A Means for Evaluating Quality, In P.S. and Powell, J.A. (eds), *Quality and Profit in Building Design*, E & FN Spon, London.

Gann, D.M. (2000) *Building Innovation: Complex Structures in a Changing World*, Thomas Telford.

Gibson, V.A. (2000) Property Portfolio Dynamics: The Flexible Management of Inflexible Assets, *Facilities*, **18** (3/4), 150-154.

Golton, B.L. (1989) Perspectives of Building Obsolescence, in *Land and Property Development: New Directions*, transactions of the Land and Property Development Conference held at St Hilda's College, Oxford, 14-16 September, Grover, R. (ed).

Gray, J. and Tippett, H. (1992) *Office Space: A Primer for Managers*, Center for Building Performance Research, Victoria University of Wellington, New Zealand.

Gray, J. and Tippett, H. (1993) *Building Quality Assessment: A Prerequisite to Economic Analysis*, Center for Building Performance Research, Victoria University of Wellington, New Zealand.

Hoxley, M. (2000) Measuring UK Construction Professional Service Quality: The What, How, When and Who, *International Journal of Quality and Reliability Management*, **17** (4/5), 511-526.

Khalid, G. (1993) *Hedonic Price Estimation of the Financial Impact of Obsolescence on Commercial Office Buildings*, PhD, University of Reading.

Kishk, M. and Al-Hajj, A. (1999) An Integrated Framework for Life Cycle Costing in Buildings, *In the COBRA conference proceedings*, The Royal Institution of Chartered Surveyors.

Lemer, A.C. (1996) Infrastructure Obsolescence and Design Service Life, *Journal of Infrastructure Systems*, **2** (4), 153-161.

Lichfield, N. & Associates (1968) Economics of Conservation, In Esher, L.B. (ed), *York: A Study in Conservation*, HMSO, London.

Nutt, B., Walker, B., Holliday, S., and Sears, D. (1976) *Obsolescence in Housing: Theory and Applications*, Saxon House and Lexington Books, Farnborough.

Ohemeng, F.A. and Mole, T. (1996) Value-Focused Approach to Built Asset Renewal and Replacement Decisions, *In the COBRA conference proceedings*, The Royal Institution of Chartered Surveyors.

Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1985) A Conceptual Model of Service Quality and Its Implications for Future Research, *Journal of Marketing*, **49**, 41-50.

Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1988) SERVQUAL: A Multiple-Item Scale for Measuring Consumer Perceptions of Service Quality, *Journal of Retailing*, **64** (1), 12-40.

Pearsall, J. (ed) (1999) *The Concise Oxford Dictionary*, 10th edn, Oxford University Press, Oxford.

Pinder, J. and Wilkinson, S. J. (2000) The Obsolescence of Office Property: A New Research Agenda, *In Proceedings 16th Annual Conference of the Association of Researchers in Construction Management*, 6-8th September, Glasgow.

Preiser, W.F.E. (1995) Post-Occupancy Evaluation: How to Make Buildings Work Better, *Facilities*, **13** (11), 19-28.

Pugh, C. (1991) The Refurbishment of Shopping Centres, *Property Management*, **10** (1), 38-46.

Raftery, J. (1991) *Principles of Building Economics: An Introduction*, BSP Professional, Oxford.

Salway, F. (1986) *Depreciation of Commercial Property*, College of Estate Management, Reading.

Smith, M., Whitelegg, J. and Williams, N. (1998) *Greening the Built Environment*, Earthscan, London.

Trowbridge, C.R. (1964) Deterioration, *Appraisal Journal*, January, 91-96.

Tu, K. and Loftness, V. (1998) The Effects of Organisational Workplace Dynamics and Building Infrastructure Flexibility on Environmental and Technical Quality in Offices, *Journal of Corporate Real Estate*, **1** (1), 46-63.

Williams, A.M. (1985) *Obsolescence and Re-use: A Study of Multi-Storey Industrial Buildings*, School of Land and Building Studies, Leicester Polytechnic.