STONE CLEANING: A VALUE ASSESSMENT

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Abstract

Buildings are an important record of a country's history and cultural heritage, and make an important contribution to modern cultural identity. Any intervention which changes their appearance, or the manner in which they contribute towards the living environment, should therefore be considered rigorously prior to such intervention being carried out. Stone cleaning has been applied widely to many buildings over a period of more than three decades, producing a varied range of results. This project is concerned with the development of a reliable methodology which can be employed as part of a decision making process, to help ensure that future stone cleaning takes full account of the implications for overall value (overall value is conceived of as the aggregate of financial, environmental and heritage values).

Stone cleaning has been completed in the past within an environment where although guidelines of best practice have been available, questions of the resultant value changes have been considered only indirectly through client preference, planning consideration and availability of finance. This project strove to explore the value system surrounding stone cleaning, and thus provide an assessment mechanism through which value can be considered in the future.

Assessment of the financial requirements and implications of stone cleaning indicates strongly that not only are short term gains in financial value uncertain, but that any longer term maintenance requirements as a result of cleaning will be likely to balance those gains. The environmental assessment methodology (using the contingent valuation method) has produced encouraging results, indicating that the level of bid is influenced by both the respondent knowledge of cleaning and the stone type. These provide powerful indicators for use in the overall assessment. Methodologies used previously to assess heritage value have been considered, and an approach developed through which the objective and subjective elements of the value assessment can be related.

The approach to overall assessment emanating from this research structures a series of assessments, ensuring that gains in the short term cannot override potential losses over the remaining life cycle. An ultimate aim of all stone cleaning is to enhance the built environment in some respects. The aim of this value assessment is to ensure that cleaning is completed only where an overall gain or benefit in value is attainable.

Declaration

The candidate has not, while registered for this Ph.D. submission, been registered for another award at a University during the research programme.

None of the original material in this thesis has been used in any other submission for an academic award. Acknowledgements for assistance received are given under the heading acknowledgements and any excepts from other work have been acknowledged by its source and author.

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Glossary of terms and abbreviations

Aesthetic Relating to a sense of beauty; artistic; as perceived by the senses.

Base date The date to which all financial costs and benefits have been calculated. For this thesis, the base date used for the financial modelling was March 1999.

Conservation A means by which groups can maintain their socio-cultural identity, as familiar objects indicating shared cultural values are more important than unfamiliar or foreign objects in creating a sense of place. The term "conservation" includes maintenance.

Contingent valuation method (CVM) An environmental valuation method, where respondents are typically provided with information about a hypothetical programme, and asked to provide information as to the economic sacrifice they would be prepared to make (willingness to pay) to ensure the programme went ahead. As an alternative, respondents can be asked to estimate the amount they would accept as compensation (willingness to accept compensation) for the loss of an existing environmental amenity.

Discount rate Costs occurring at different points in time require to be adjusted to allow for the effects of interest. The discount rate reflects that money has a time value, and is used to convert all costs to a common base date.

Environment A surrounding; external conditions influencing development or growth of people; living or working conditions.

Facade The exterior front or face of a building.

Hedonic Pricing An environmental valuation method, where an "indicator" of the subject under consideration is compared with an actual market. Characteristics of the subject itself and the market would typically be considered to identify significant variables.

Heritage "*Anything from the past that may be inherited, or handed down by tradition, in the sense of an inheritance being passed from one generation to another*" Fladmark (1994)

Intrinsic value Value which is inherent and essential to the point or object at issue. Value as an end in itself.

Life cycle costing (LCC) An economic assessment of an item, system of facility and competing design alternatives considering all significant costs of ownership over the economic life, expressed in terms of equivalent [pounds].

Maintenance Refers to the continuous protective care of the fabric, contents and setting of a place.

Patina A film or surface appearance developing on the surface of stone over long periods of exposure.

Objective Relating to an object; exterior to the mind; regarding what is actual, practical; uncoloured by one's own sensations or emotions.

Perceptual An awareness through the senses; knowledge from the mind; as seen, understood and discerned.

Repair To mend to a condition that is sound. Should be differentiated from "maintenance", as "repair" does not refer to a programme of continuous protective care.

Restoration The act or process of making good; reinstatement; renovation; possibly involving elements of reconstruction.

Short/ medium/ long term Within this thesis, "short term" means zero to five years following stone cleaning. "Medium term" means 5 to 20 years following cleaning, with "long term" referring to greater than 20 years after cleaning. These time scales are based on rates of re-soiling (which may become apparent towards the 5 year mark, or sooner for biological soiling), and emerging stone decay resulting from cleaning (which will be likely to occur over a period of 15 to 20 years).

Soiling - biological Refers to soiling as a result of natural algal or lichen growth. May be influenced by stone treatments, micro-climate, orientation or detailing, and is manifested in the emergence of crusts or tufts on the stone face.

Soiling - particulate Refers to soiling today consisting mainly of particulate elemental carbon from traffic emissions. Historical levels of pollution from heavy industry led to large areas of the urban environment becoming blackened through particulate soiling. Patterns of soiling are affected by micro-climate, orientation, detailing and levels of nearby vehicular traffic.

Stone cleaning The removal of soiling (either biological or particulate) from the stone face, thus exposing a lighter surface underneath, the aim being to produce aesthetically pleasing results. The exposed stone face can be damaged where the method used is either poorly specified, inappropriate to the stone itself or poorly applied.

Subjective Relating to a subject; derived from, existing in, one's own consciousness; introspective.

Townscape The overall environment in which the majority of society lives and works

Travel cost method An environmental valuation method, where "indicators" of the subject under consideration are compared with the financial amounts and time spent by individuals in their travel to an area or site.

Value system Value, rather than being an object in itself, is often formed through the objective and subjective perceptions of the individual. The formation of a judgement will usually require that aspects of value be considered together. The value system refers to the combined recognition of objective, subjective and intrinsic values.

Willingness to pay (WTP) See "contingent valuation".

Willingness to accept compensation (WTA) See "contingent valuation".

Note: definitions contain excerpts from the following:

Chambers 20th Century Dictionary (1983), Richard Clay Ltd., Suffolk.

Fladmark, J.M. (1994) *The wealth of a nation*, Gilcomston Litho (Aberdeen) Ltd, ABERDEEN.

Hubbard, P. (1993) The value of conservation, *Town Planning Review*, 64 (4), 359-373.

ICOMOS (1981) Burra charter.

Kirk, S.J. and A. Dell'Isola (1995) *Life cycle costing for design professionals*, 2nd edition, McGraw-Hill, New York.

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1. *Introduction*

1.1 Background to the study

Buildings are an important record of a country's history and cultural heritage, and make an important contribution to modern cultural identity. Rodwell (1992) states,

> "...buildings, many of which are not historic in the sense of being Listed... collectively establish the distinctive urban grain and provide the backdrop to the living and working environments of the majority."

Any intervention that changes their appearance, or the manner in which they contribute towards the living environment, should therefore be considered rigorously prior to such intervention being carried out. Stone cleaning has been applied widely to many buildings over a period of more than three decades, producing a varied range of results. This project is concerned with the development of a reliable methodology which could be employed as part of a decision making process, to help ensure that future stone cleaning takes full account of the implications which it may hold for the overall value of the building. By concentrating on the value changes that can result from cleaning, it was felt that a methodology allowing an holistic assessment might be made possible.

Previous research has indicated that, in a large number of cases, stone cleaning has been harmful to the stone itself (Ashurst and Dimes 1990, Bluck and Porter 1991a and 1991b, Webster *et al.* 1991). Related research has also shown that the visual results of cleaning are often perceived in a complex, and not wholly positive manner (Andrew *et al.* 1994, Webster *et al.* 1991). In addition, current research (Young *et al.* 1999) would suggest that cleaning could lead to accelerated rates of decay, thus increasing the need for repair and maintenance work. A great deal of money is spent annually on the cleaning of stone building facades, yet research to date examining the non- physical effects of such work has been limited in both quality and scope.

Cleaning also has an effect on the environment in which the building itself is situated. Intersave (1995), a project completed by the Danish government recording the built environment states that,

> "the streets can be compared to rooms whose walls are the buildings on either side. In cities where the buildings form continuous rows, this conception is very clear".

Indeed, although stone cleaning might often be considered in relation to individual buildings or properties, the effects caused by cleaning a number of buildings is one of change to the wider built landscape. Therefore, value changes should similarly relate back to the wider built environment, in order that the overall effect is viewed in the correct context. This view is in agreement with recommendations presented in the literature (Andrew 1994, Young 1997, Webster *et al.* 1991).

If cleaning were to assist in the conservation process (or add to the heritage value of the building), this could in itself be regarded as a motivation towards its implementation. Conservation in relation to the built as opposed to natural environment must take account of the rationale underlying the manner in which buildings can have environmental and/or heritage value. If stone cleaning has a role to play in the conservation of local and national built heritage, the importance of terraces (owned usually by more than one party) as opposed to single buildings becomes evident (cleaning tends to be commissioned by the owners of individual properties, due in part to the mechanisms by which funding can be obtained). Conversely, if cleaning could threaten the continued life of parts of the built heritage, measures should be taken to avoid damage or loss to the terrace as a whole.

The effects of stone cleaning must be viewed within the context of a complex system of change, within which a wide range of effects can be observed. Methods of stone cleaning and their effects are introduced, so as to provide an understanding of the causes of change.

1.2 Stone cleaning (methods and effects)

1.2.1 Stone cleaning and approaches to building conservation

The effects of stone cleaning, whilst potentially physically damaging to stone, can also result in an increased level of visual attractiveness. Conservation of the built environment requires not only knowledge of decay processes, but also a desire and drive to preserve buildings. If stone cleaning can lead to positive perceptual changes, it is also possible that an awareness of buildings' needs will follow.

Bluck and Porter (1991a and b) describe how stone cleaning, whilst posing a risk of loss or damage to the condition of buildings if poorly implemented, may also reveal damage which has been taking place under the soiling layer, and therefore highlight where appropriate repair work should be carried out. It should be stated, however, that an experienced surveyor should be able to diagnose problems where stone has not been cleaned, the presence of soiling irrelevant[1]. Nevertheless, Bluck and Porter pose a number of questions relating to the rationale to be adopted, thus, *"before the cleaning programme is initiated there has to be a great deal of consideration given to the following points"*:

a. what are we cleaning?;
b. for what reason are we cleaning?;
c. how do we clean?.

These questions are both relevant and extremely important to the current project. Questions (a) and (c), in relation to stone type and cleaning methods have been investigated through laboratory and field analysis. Question (a) in relation to the relationship between buildings as a streetscape has not been explored in any great depth, however, and might have a bearing on the answer to question (b). The reasons for cleaning (i.e. a perceived and expected potential benefit) must be considered alongside the potential for loss. A possible visual benefit might be outweighed by a danger to the stone fabric. Although cleaning might often be considered for reasons other than conservation, the ability of the various cleaning methods to cause damage (and possibly decay) requires that a longer-term view be taken. The following goals of cleaning and conservation are suggested (Verhoef 1988).

[1] It should be noted that this project considered sandstone and granite buildings only. Where the material to be considered was limestone, it is possible that crusts removed through cleaning could uncover stone decay otherwise difficult to detect.

"cleaning, restoration and conservation of the facade are closely related to each other and are not to be considered separately.

Cleaning means, in the strict sense of the word that dirt is being removed from the facade without changing the surface texture of the surface material itself. The aim of restoring the facade is to bring the material properties, along with the outward appearance, back to it's initial state, so to enable the facade to perform it's functions effectively.

The purpose of conservation is to retard as much as possible the modification of the structure of the original or of the cleaned surface due to atmospheric influences."

Where cleaning can assist in the "restoration" of a facade back to that intended by the original design, whilst avoiding damage to the stone, an overall value gain might well result. However, where cleaning would be likely to leave stone open to attack from "atmospheric influences", or modify "the structure of the original", temporary visual value benefits (reduced over time by re- soiling) would not in themselves provide a strong rationale for proceeding.

Large-scale stone cleaning over the past few decades has meant a gradual but definite change in the appearance of many town centres in Scotland. The blackened city centre facades of Edinburgh and Glasgow, to cite two obvious examples, have been transformed by the re-emergence of the buff and red sandstone surfaces previously hidden below layers of soiling. Andrew (1992) describes how changes in the perception of visual character have been generally positive, but that the complexity of the facade (e.g. the extent of carving work) and the preservation of architectural continuity of terraced buildings are vital. Although the visual attractiveness was perceived by many as improved after cleaning, those town centres that could boast a previously homogenous visual character prior to cleaning had a visual harmony of their own. Feilden (1982) advocates that traditional buildings create a harmony that should be respected. Whether the pursuit of harmony is undertaken through architecture is debatable, although where cleaning leads to any disharmony in the cityscape, it should be seen that a certain amount of cultural and aesthetic value has been sacrificed.

Stone cleaning should be faithful at all times to the spirit of conserving the built heritage. It should be recognised that conservation approaches must regard all buildings as being part of a larger ever developing whole, and the preservation of heritage value should not be lost in the pursuit of commercial or town planning objectives.

The aims of conservation programmes must never lose sight of the rationale for their initial formulation, that being to preserve the built heritage. It is essential that a constant reappraisal of the cultural importance of a building, or area of buildings, be implemented, to ensure that methods of protection and conservation are appropriate. In addition, a greater understanding of the ways in which cultural values can be affected by the effects of cleaning must be reached, so as to ensure that an integrated decision making process can be followed. This will reduce problems encountered in the past through the improper use of certain cleaning methods, or inappropriate application.

It is essential that the importance of visual stimuli should not be overlooked. Stone cleaning of sandstone buildings can mark a dramatic change in the colour and light reflectivity of a stone facade and when applied to a number of buildings, changes in the perception of an area can be great. Evidence that degrees of soiling can increase the complexity and interest of a stone facade lend credence to the suggestion that cleaning which is visually implemented should also improve the visual interest passers by and residents of an area can derive from the buildings.

The visual value to be derived from the built environment can be assessed using a variety of methods. In relation to stone cleaning, a study was completed examining the effects of cleaning on the perceived visual value of (mainly sandstone) stone facades in Scotland (Webster *et al.* 1991, Andrew 1992).

The most immediately obvious effect of stone cleaning is the change in a buildings appearance. The aim of the cleaning process is to remove the soiling layer from the surface of the stone, exposing a, "clean", stone surface underneath, the newly exposed surface having a weathered patina, unlike freshly quarried stone. Cleaning methods have developed to cause the minimum damage to the stone itself and may leave a certain amount of the soiling layer intact on the building (Andrew *et al.* 1994).

Webster *et al.* (1991) indicated that soiling is a consistent means by which subjects conceptualise buildings. It was indicated also that where moderate[3] levels of soiling are present on a building, the building might, in certain circumstances, be construed as being "clean". Similarly, buildings which have been cleaned but where staining remains may be perceived as being "dirty". This would indicate that the cleaning process would not result in aesthetic gains in every case. That study, concentrating mainly on sandstone buildings, concluded that "*stone cleaning produces a positive change in evaluation, but ... the extent of the change in evaluation is very much dependant on the quality of the finish produced by the stone cleaning process*".

It was stated that "*large and significant differences found may in part be due to the examples selected, and that, in general, very soiled buildings were being compared to relatively recently cleaned ones*". When heavily soiled sandstone buildings are cleaned, the initial change in colour is dramatic, but lighter soiling levels, type of soiling and type of stone may temper the change.

Wherever stone cleaning work has been completed, the long-term maintenance costs associated with a building will be affected to some extent. Re-soiling of a stone facade will occur over time, after cleaning has been completed, and as a result a further cycle of cleaning might be considered in order that the desired, immediately post- cleaning, appearance of the stonework is maintained. The frequency of such an effect is difficult to generalise over a number of cases, as there is a great dependence on the actual environment within which each building is situated and the type and condition of stone used in its construction. The ongoing maintenance of stone surfaces requires an organised programme of work to maintain the appearance and condition of the stone at the immediate post-cleaning level. Although the associated financial costs to a building owner might accrue over a number of years, as opposed to immediately following the cleaning itself, their importance to a financial assessment remains.

Black (1977) discusses how the type of stone to be cleaned has an important bearing on the decision regarding which method should be used. A number of stone types have been cleaned in the past, with varying degrees of success. It must be borne in mind that even though "*a particular cleaning method may have achieved success on one type of stone, and*

[3] "Moderate" should here be taken to refer to soiling levels where the shape, colour and character of the underlying stone surface have not been entirely hidden by the soiling. Conversely, the term would also indicate that soiling is present.

even upon stone of like classification, does not imply suitability to stone of a like classification, and even upon stone of a like classification, does not imply suitability to stone of another locality. Initial success furthermore is not necessarily any criterion of ultimate effect".

This statement is true, although the practical repercussions are unclear. The cleaning method must be matched to the individual situation, in much the same way that all materials and methods should always be chosen to comply with the requirements of the project to hand. Black's point, although of great importance two decades ago, has been rather overshadowed by the establishment of clear guidelines for best practice (for example, and most notably, Andrew *et al.* 1994).

In relation to sandstone and other porous building stones, Black highlights how deterioration can be associated with water ingress into the stone. Cleaning methods which involve saturation of porous stones via pressure hosing risk carrying deposits into the stone itself. This in turn may lead to the formation of salts within the stone, giving rise in time to deterioration. Where cleaning were to be completed on a granite faced building, for instance, this particular problem would not occur.

A large number of buildings within the city centre of Glasgow were cleaned during the 1980s, and whether that work took proper account of the potential dangers of cleaning, in the pursuit of a short term aesthetic alteration must be questioned (Architects Journal 1991). Citing the City Chambers building as an example, the appearance of a, "*vigorous growth of green mould*", is referred to as being a possible result of the, "*excessive application of powerful chemicals*" (Architect's Journal 1991). Whilst a link between accelerated algal growth and the use of chemical cleaning agents has been established (Young 1997), the statement is extremely simplistic, in that the incidence of algal growth is determined by a complex set of variables, which may include the application of chemical cleaning agents.

Black concludes that prior to cleaning operations being carried out, the areas to be treated should be carefully inspected and that cleaning "*of necessity must be a slow and painstaking process if it is not to initiate further deterioration, and that is inconsistent with quick profit*". Such an approach was expanded upon and closely defined by Andrew *et al.* (1994), who produced a practitioners guide regarding the cleaning of sandstone buildings. The methodology suggested involves three stages, namely,

- preliminary examination of the site, stone type and selection of cleaning methods to be tested;
- the cleaning of selected test panels;
- analysis of test results.

The completion of this testing programme allows a decision to be made regarding the method to be used. This decision should be made in conjunction with full consideration of the likely aesthetic impact of cleaning the building and the evaluation of which steps to take should, "*always be approached on a damage limitation basis, if doubt persists, the option not to clean should be considered*".

It can be concluded that the proper selection of cleaning method appropriate to the situation to hand is essential.

As stated by Perks (1990), the tendency to clean stone buildings on the grounds that it is a "*safe and easy method of improving the townscape*" is flawed. Because sandstone is an extremely complex material, with considerable variation between quarries, the cleaning of sandstone surfaces is often not as simple and straightforward a task as may be assumed. Because soiling may be bonded into the stone, rather than being solely on the surface, cleaning of the stone can require the removal of a layer (or more) in order to achieve a suitably clean appearance. This could well hasten decay, as a fresh surface will be exposed to the elements.

Potential benefits from cleaning have in the past been assumed, with little effort to verify such benefits afterwards. Stone cleaning has also been shown to carry risks where work is poorly implemented, or inadequate consideration given to the long-term implications. Thus, an overall cost or benefit cannot be assumed in any case.

1.2.2 Stone cleaning methods

A number of cleaning methods are available for use, and have been analysed in some depth (Webster *et al.* 1991). Methods of cleaning can be grouped under two main headings, namely physical and chemical. Bluck and Porter (1991) describe how the buildings of Glasgow have been transformed from, "*black and grey soiled reminders of a heavy industrial past*", to brighter buildings, "*proudly proclaiming the future*". However, the cleaning has not been an unqualified success, with rapid biological re-soiling through the growth of algae, lichens and moss, and the suspected accelerated decay of cleaned stonework. This means that the whole approach to cleaning must be re- thought.

Problems arising from stone cleaning work can often also relate as much to the practitioners working practice as to the method itself, and a suggested method of working has been developed (Andrew *et al.* 1994).

Appendix 1 provides a summary of the major physical effects of various stone cleaning methods on sandstone and granite.

1.3 Hypothesis and aims

The *hypothesis* to be tested in this thesis is as follows.

> "By applying value assessment methodologies prior to the application of stone cleaning, more robust decisions can be made".

The project therefore explores the system of value changes and methodologies through which decision making in relation to stone cleaning could be improved. The *aims* are:

1. To investigate the potential effects of stone cleaning on aspects of overall value
2. To model those effects to facilitate robust value assessments
3. To establish an approach to overall value assessment, incorporating the developed models and ensuring that the whole value system is considered

These aims are clearly directed towards an overall value assessment, although a separate detailed consideration of parts of the value system was required. For that reason, the thesis both begins and ends by considering the overall value assessment, thus encouraging an holistic approach by the decision-maker.

Value assessment methodologies have been developed over a number of decades, but have not been applied to date within the context of stone cleaning. In addition, assessments of financial, environmental and heritage value in relation to other subject matter have tended to be applied in isolation from one another, avoiding methodological problems but denying the benefits which would result from an overall consideration. This project provides an original contribution to knowledge by modelling the overall effects of cleaning on value for the first time, and by arriving at an approach through which the assessor can consider all aspects of the value system in a structured manner.

1.4 Value in the context of stone cleaning

It should be recognised that value can be considered from both objective and subjective points of view, and that one approach may not consider adequately the possible holistic value changes. The value mechanism developed through this thesis contains a number of smaller assessments, each of which contribute to the overall assessment, and which should in combination provide an assurance that the widest range of value is indeed considered and assessed.

The wholly objective approach to value assessment will be termed "financial assessment", and deal with the likely financial costs and benefits accruing from cleaning. Likewise, an assessment of subjective areas through the use of objective methodologies will be termed "environmental assessment". "Heritage assessment" will deal with the assessment of subjective areas of the value system, utilising assessment approaches appropriate to the data and subject matter. It is notable that the BSI (1998) state the "*underlying objectives* [of building conservation] *are cultural, economic and environmental*". Those objectives must be addressed and considered in relation to any alteration of the built environment.

Changes in physical condition, financial value, perceived environmental value and heritage value as a result of cleaning present an unclear situation. This project aimed to improve definition of the implications for value, providing a structure for the prediction of value changes prior to cleaning.

1.5 Thesis structure

This thesis is structured so as to present an holistic approach to value assessment, with as little fragmentation into discrete areas as possible.

Chapter two deals with concepts of value, both in a general sense, and also how they are related to this project. The underlying philosophy of value and value judgements is considered, prior to a preliminary investigation of the overall value system. Particular constituent areas of the system, which are to be considered later in the thesis, are identified.

Chapter three reviews literature of relevance to the study, including sections on financial, environmental and heritage value, and systems thinking. Methods of value assessment from the literature are identified and discussed.

Chapter four presents the development of methodologies for the assessment of financial, environmental (including aesthetic) and heritage value. Preparation of all assessment and data gathering mechanisms (i.e. rationale, design, format) is included in this chapter.

Chapter five presents the data gathered in relation to the financial value assessment, an analysis of that data, and any conclusions arising.

Chapter six presents data gathered through both an environmental valuation of stone cleaning and a study of the aesthetic effects of cleaning granite buildings. Data is analysed, notable findings identified and conclusions drawn.

Chapter seven presents the application of a heritage value assessment mechanism, developed from the literature, and presents the conclusions arising.

Chapter eight presents a conceptual model for the overall assessment of value, including conclusions arising.

Chapter nine presents overall conclusions and suggested further work arising from the project.

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2. *Value concepts and definitions*

2.1 Introduction

The concept of "value" embodies a range of issues pertinent to the built environment and the term "value" can assume different definitions depending upon a number of factors, including the method and aims of assessment. For the purpose of this thesis, and in order that a methodology can begin to examine properly the effects of stone cleaning on value, it is necessary that a certain amount of sub division is recognised within the overall definition of value. In practice, the overall value system operates as a complete and inter-dependant system where all parts are of mutual importance.

2.2 Philosophy of value

It is argued that value can be manifested in a variety of ways (e.g. financial, aesthetic, environmental), with the effects most easily established using a range of assessment techniques. It is possible to recognise how an accepted breakdown of discrete aspects of overall value stems directly from a definition of "value":

> **value** worth: a fair equivalent: intrinsic worth or goodness: recognition of such worth: that which renders anything useful or estimable: the degree of this quality: relative worth: high worth: esteem: efficacy: excellence: pride: precise meaning: the exact amount of a variable quantity in a particular case: (*plural*) moral principles: standards: (*verb*) to estimate the worth of: to rate at a price: to esteem: to prize

(Chambers 20th Century Dictionary, 1983)[1]

Concepts of value are often infused into decision-making processes through the formulation and application of value judgements. In the absence of an established method of evaluating and predicting the likely effects of stone cleaning on value, decisions have often been based largely on the decision maker formulating value judgements, based perhaps on past experience, or knowledge of research. The decision framework from which such judgements are formulated should be strengthened, so as to avoid unsound conclusions being reached in the future.

The definition presented suggests what might constitute value, and it is clear that both apparently objective and subjective approaches are central to the topic, thus causing difficulties with regard to assessment. Lamont (1955) identified that the problem may lie in the "*way the issue has been presented*", rather than in the issue of value *per se*. The objective/ subjective division directs that we may either regard value as being embodied in an object (e.g. a building), or that the very process of attributing value roots that value in the subject (e.g. an emotional response to the built environment).

Lamont argues that a more appropriate approach is to respect that while value may well be something in itself (i.e. an object), the assessment process completed through consideration of any object or subject attributes value within the mind of the assessor. The difference here is critical, as the attribution of value here described is in fact the process of valuation. Recognition of value being "*something in itself*" precludes neither objective nor subjective approaches, and the process of valuation "*does not presuppose the truth or falsity of either theory*".

Moore (1903) exemplifies the generation of a positive value judgement, where the "good" and "bad" are clearly separated with a preference for the former. This stance, whilst of philosophical interest, contributes little to the current study, as a complexity exists between "good" and "bad" in reality, with separation of the two often practically impossible. Lamont suggests that a "comparative value judgement" reflects that a choice enforced by circumstance will often be required, and that gains or losses in value must often be weighed against one another.

Although it may be the case that the apparent reliability of value judgements suffers when scrutinised to find a verifiable proof of their validity, it is also true that they represent a useful method of combining the results of objective and subjective analyses. Due to the nature of a number of established methods of value assessment (relating usually to only certain aspects of overall value), difficulties arise when attempting to formulate an overall "measurement" unit. Evolving and subjective public attitudes towards what might constitute "heritage" or "environment" make entirely objective assessments of parts of the value

[1] Note that definitions relating to music, mathematics and phonetics have been excluded from the above.

system difficult. One is forced, therefore, to rely on the value judgement to allow the possibility of holistic assessment.

That a move from objectivity to subjectivity might result in a reduced reliability must be addressed through the application of a judgement path well grounded in both logic and established knowledge. Where flawed value judgements are made, that flaw must lie surely in the poorly informed nature of a decision, and not in the concept of the value judgement itself. Value judgements are made by individuals, making the effective communication of information all the more vital.

It is argued that only certain aspects of the value system are directly measurable through the use of wholly objective methods. Other aspects present a situation where, due to their inherent nature, they may only be "assessed" through a study of the perception of their effects[2]. Value judgements are used for a wide range of assessments in everyday life, and should only be said to fail, or be unacceptable, where they are based on inaccurate or incomplete data, or are compiled in an illogical manner. Any attempt to derive an exact and infallible model of the value change resulting from cleaning is at once both laudable and yet hopelessly prone to rapid obsolescence.

Heath (1994) suggests that the underlying assumptions of value judgements must be stated more clearly, so as to make the path taken to arrive at that judgement more lucid. In addition, though, it is also desirable that a clear distinction between fact and value is recognised as being artificial for many real-life situations, where differences in subjective judgement will blur the boundary. Henderson and Poole (1991) recognise that "*normative analysis depends centrally upon value judgements*", and identify no logical difficulty in such an approach. Economists may attempt to examine "*objectively what will make society better*" (Colander 1993), but that clearly does not imply that all judgements need follow an objective path. For this study, it was essential that any lack of stringency was attended to whilst developing the methodology.

As more research is completed in the field of stone cleaning, and a greater number of buildings can be observed in a post-cleaning state, the complex network of cause and effect

[2] For example, a study of the aesthetic (i.e. visual) effects of stone cleaning requires that the methodology focus solely on the visual change, ignoring any other factors to ensure the results can be seen to represent just that one aspect, thus reducing complexity to the point that clarity is acceptable. However, the accurate "measurement" of visual change to the point that prediction of future changes in aesthetic value would be possible remains elusive.

which can be incorporated into a decision making network will inevitably continue to evolve. The point at which the conclusions of scientific research can be regarded as fact may only be reached after any reasonable doubt of their validity has been removed. Popper (1959), discussing the problem of induction in relation to scientific knowledge reminds that "*no matter how many instances of white swans we may have observed, this does not justify the conclusion that all swans are white*".

The importance of both causality (as embodied in scientific study) and freedom of choice in a value judgement is vital. Lamont (1955) reviews the Socratic postulate:

1. "that all men seek and choose what they regard as good, and what they regard as better rather than what they regard as worse;
2. that what is truly good is so independently of our desires and opinions - that "goodness" is in fact an objective property we may or may not truly apprehend; and
3. that virtuous action *means* action productive of good."

It is argued that points 2 and 3 seem inconsistent with the concept of a value judgement (Lamont 1955), where the attribution of value takes place in the mind, rather than in the object. For this project, it is clear that major aspects of the value system, namely environmental and heritage value will depend on the values ascribed by society, and may well differ between different groups, buildings, areas or cultures. The first point, that men choose what *they* regard as good, seems to contradict the second and is critical in this respect. Aspects of the value judgement, the value "assessment", will certainly appear to take an objective path (e.g. financial valuation), but in will fact contain an element of subjectivity in every case.

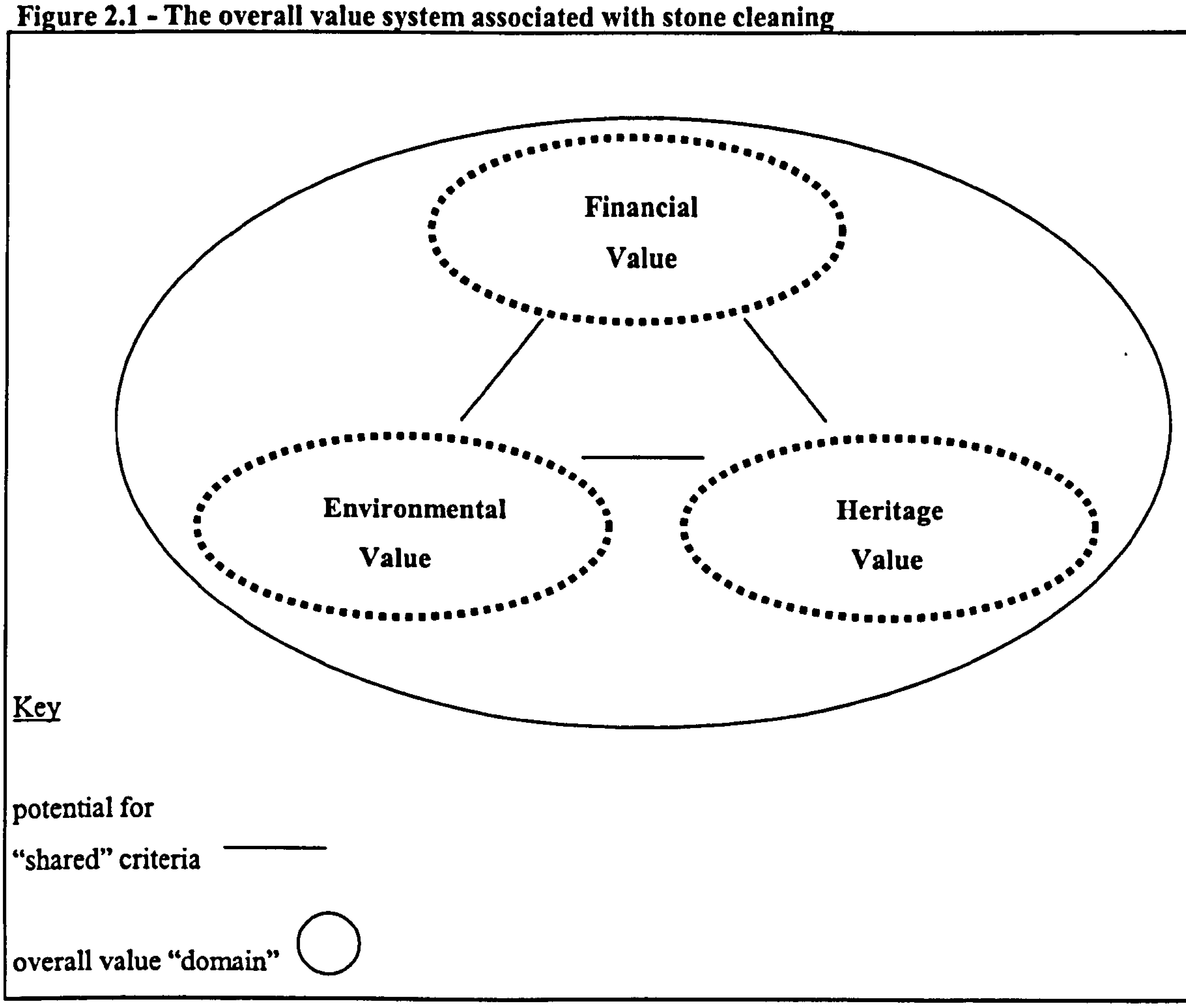
In attempting to explain what approach will be taken toward the value judgement, the requirement for freedom of choice must be complementary with the doctrine of causation in scientific discovery. The example cited by Popper, above, illustrates how the establishment of a causal connection does not in itself offer proof as to a necessary, inevitable connection. Lamont expands on this point, stating that "*causality is not the creation or production of one 'thing' by another...but between events occurring in things*". It can be argued, therefore, that the approach taken in this project follows a causal (i.e. scientific) approach, in that likely or observed causal relationships between the effects of cleaning stone and an associated value system have been identified and modelled. The concepts of causality and "absolute proof" rest together uneasily, yet an understanding of causality establishes a firm support for the theory or value judgement. Lamont suggests that value judgements rest in a theory of opportunity costs. "*While virtuous or dutiful action means action from respect for personality, we shall do what we believe to be our duty only if the assessment of the relative opportunity costs indicates the doing of the duty as the line of action with the least opportunity cost*". In other words, a value judgement requires by it's very nature the consideration of good and bad aspects of a given situation, and should only result in a positive judgement where that consideration is positive. The logical and rigorous application of a decision production methodology can be as important, if not more so, than any conclusions reached.

It is clear from the literature, and from consideration of the value system to be considered, that any failure to make effective use of value judgements can be due often to inadequate planning of the decision process. In the absence of a rigorous value judgement methodology, there is a danger that important information, or links between areas of information, would not be considered, leading to incorrect or inappropriate judgements and conclusions.

2.3 Value System

Stone cleaning has the potential to influence both objective and subjective aspects of value. Stone cleaning methods can be grouped under a number of headings, with each capable of producing certain outcomes in addition to the removal of soiling (a list of these effects is provided in Appendix 1). It is clear that a wide range of physical effects can lead to an equally wide range of value changes. The system of value change is illustrated in figure 2.1. It should be noted that relationships exist across all areas of the value system, suggesting that an holistic (rather than fragmented or specialised) approach to value assessment might be appropriate[3].

Figure 2.1 - The overall value system associated with stone cleaning



As illustrated, the system is complex because there are a number of potentially shared criteria between sub-groupings. These are important from a conceptual perspective but not

[3] It is clear that an understanding of the importance and relevance of each constituent part of the overall system is essential. The ability of many of the physical and other effects of cleaning to influence more than one aspect of

necessarily from a value assessment perspective. This can be considered in two ways, namely the aim of the assessment, and the nature of the overlapping value sections. Note that the value "domain" is shown to reflect the fact that financial, environmental and heritage represent aspects of a common overall system. Whilst the holistic range of objective and subjective values are covered by the three sub-systems selected, it is possible that the domain could be sub-divided along different lines.

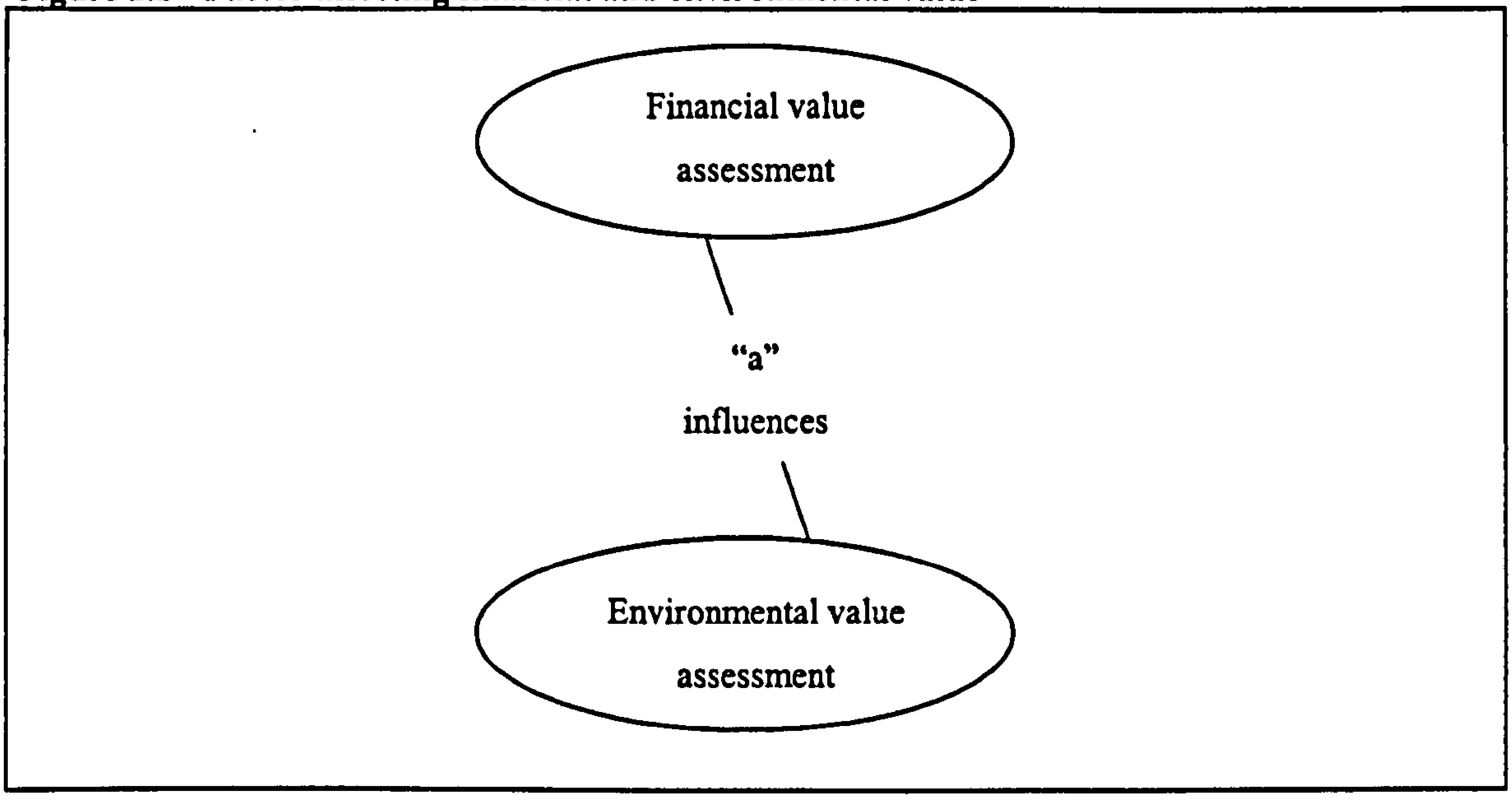
The aim of the assessment is not to arrive at a measured "value", but rather to ensure that decisions made as to whether or not to clean are properly informed and reliable. Were the aim to be an objective "measurement" of value, the danger of value elements being "double counted" as part of more than one assessment would be important. This project, however, is concerned with ensuring all criterions are considered, rather than "measuring" their effects.

The assessor, who may be an occupant, building owner or a wider community, ascribes value to an object. Value assessment is not, therefore, concerned with value as an object, but with value as it is ascribed by the assessor. The aspects of value within the overall system identified here recognise simply that both objective and subjective approaches to assessment exist, but should be regarded as complementary, leading to holistic assessments.

If we assume that the link between financial and environmental value is called "a", we can then consider the implications of that link for measurement or assessment purposes. The link "a", it should be understood, does not explicitly represent variables to be assessed, but rather areas of influence. For example, assessments could be completed for the financial and environmental value effects of cleaning on a given building. In that assessment, factors would have to be considered which were influencing both financial and environmental value, but not heritage value. This is illustrated in figure 2.2.

value means that an isolated assessment of (for example) financial value, would fail to truly represent the overall value change.

Figure 2.2 - Factor affecting financial and environmental value



Assessments of financial and environmental value could progress, and the results used as the preliminary stage of a cost/ benefit study. The importance of factor "a" concerns the manner in which those assessments are progressed, rather than being an element of value in itself. For example, the choice of cleaning method will influence financial cost, but will also have a bearing on the physical and aesthetic effects. It can be appreciated that the effects, not the method itself, are being assessed, allowing for the two assessments to be completed in relative isolation. Indeed, a great number of factors (e.g. location, stone type, building size) will impact not just one but two or all three areas of value. This does not make the assessment any less reliable, but on the contrary ensures that each assessment properly considers all pertinent facts. The range of variables to be assessed, and the manner in which the decision process should progress, is considered in the methodology sections of chapters five through seven.

A number of value assessment and modelling methods exist, but these tend to focus on parts of the overall system. The reason for this focus concerns the suitable units of measurement, and the fact that parts of the system will be of direct interest only to certain groups. This focus has led to useful methods being developed to explore certain areas, but they perhaps lack the flexibility to encompass areas where interface within the system exists.

The three sub-divisions of value indicated in Figure 2.1 have been incorporated into the methodology for this project due to their relevance and appropriateness to the subject matter. In addition, it is essential that workable models for appropriate groupings be drawn up. For example, by isolating "financial" variables, a model using currency as its basic unit is achievable. Great care was taken when applying these divisions within the overall value assessment, however, as a number of important links can be seen to extend across the boundaries shown.

The effects of stone cleaning on value have been investigated to only a minor extent in the past and methodologies for direct application within the current topic were therefore unavailable. However, much of the value system has similarities to key aspects of the value system associated with the natural environment. The importance of financial valuations to the built environment has been established over many years and an overall value assessment must recognise that mainly that aspect determines "value" for practitioners. Whilst the natural environment is difficult to link directly with economic markets (thus making the use of classical economic methodologies difficult), methods of environmental valuation have assisted by applying the theory to hypothetical markets, the desire being to produce a more accurate and reliable method of evaluation. The strengths and weaknesses of such methods will be investigated further in chapter four.

The sub-groupings shown in figure 2.1 share a number of similarities with the list of value types shown in Table 2.1 that Spellerberg (1992) suggested for consideration with regard to the sustainable development of natural resources.

Table 2.1 - Value types and subtypes associated with sustainable development of natural resources

Value Type		Subtype	Example
Use values	direct	consumptive	home consumed forest fruits
		productive	plant breeding
		non-consumptive	tourism
	indirect		ecological process
	option values		potential value of medicinal drugs
Non-use values			existence value of certain species

Although it is clear from the examples given by Spellerberg that all of the specific value types are not appropriate to the consideration of buildings, the types and sub-types certainly are appropriate, albeit with a unique set of practical examples. A set of values is presented in table 2.2, below.

Table 2.2 - Value types and subtypes associated with stone cleaning

Value Type		Subtype	Example
Use value	direct	consumptive productive non-consumptive	use of building (e.g. commercial) income from property tourism
	indirect		aesthetic value of built landscape
	option values		alternative use for vacant properties
Non-use values			preservation of important historical properties

Use values can be seen to derive, as their title might suggest, from the subject building by providing some sort of good for consumption by the building user (e.g. the owner, tenant, employee, visitor, etc.). Non-use values refer to circumstances in which the building can be felt to provide a certain degree of utility despite no actual use of the building taking place. The concept of non-use values stems from consideration of the natural environment with regard to, for example, endangered species or threatened habitat. It could be argued that the preservation of either would derive "value" without actually providing any fiscal gain. Examples of how this applies to the built environment are given in Table 2.2.

2.4 Overall value change

It is hypothesised that the overall value change resulting from stone cleaning can be represented using an aggregation of the discrete benefits and costs associated with each aspect of value. Where difficulties arise in the objective assessment of any one of those aspects, a subjective assessment should inform the overall model, as indicated in figure 2.3.

Figure 2.3 - Overall cost/ benefit value analysis framework for the consideration of stone cleaning

Benefit	Cost
Objective gains	Objective costs
Subjective gains	Subjective costs
Overall benefit	**Overall cost**

An overall value **increase** is present where overall benefit > overall cost.
An overall value **decrease** is present where overall benefit < overall cost.

Reference to figure 2.3 illustrates that the investigation to be followed through this thesis involves the assessment of objective and subjective value. Although conceptually clear, in practice the "aggregation" of value may require an approach other than simple arithmetical addition of objective and subjective results, due to different units of measurement.

2.5 Intrinsic value

Thus far, it has been recognised that value is largely ascribed to objects, rather than existing as a clear entity in itself. Therefore, as the knowledge, attitudes or experience of the individual change, so too might the magnitude of value associated with an object. The concept of intrinsic value deals with the possibility that some objects may be of value despite having no clear link with a production of tangible benefits.

Lockwood (1997) describes how intrinsic value refers to an object or good which may be regarded as valuable as an end in itself, as opposed to simply being of value as part of a value chain (e.g. as a step towards financial gain). Much research regarding value assessment has focused on a situation where a certain amount of substitution between goods is possible, and thus allows for a classic economic model to be built (i.e. where a loss in some good can be readily compensated by some gain in another). With regard to the value system to be examined here, such substitution may not be possible for all parts of the value system. For example, it is possible that a financial loss created by increased maintenance requirements could be balanced by some increase in short term marketing gain, but a loss of intrinsic values cannot be balanced in this way.

Classical economic supply and demand equations could be drawn to represent parts of the overall value system being investigated here, but should not be mistaken as representing the entire system. Lockwood suggests that within accepted methods of decision assisting, there is often little scope for making comparison between various value facets. Cost/benefit analysis tends to represent only those aspects which affect economic welfare (i.e. where trade-offs between cost and gain are possible), whereas multiple criteria analysis methods attempt to better organise or rank those aspects of value which are to be considered. A difficulty exists in that the, "*underlying value structures are simply not known*", leading to the almost inevitable re-introduction of subjective rankings into an artificial objective system.

Lockwood suggests a method by which the aggregation of economically led methods of assessment, and non-compensatory methods (i.e. where value aspects tending towards an intrinsic nature are given prevalence) need not be attempted. By initially identifying which basic model type the majority of a situation belongs to, prior to data gathering and analysis, a route to be taken by the decision making process can be identified also. If the situation were found to be based heavily within a "non-compensatory" value structure (that is, where intrinsic or fixed values prevailed), then models relying on economic gains and losses could be disregarded. If this were not the case, then models based on changes in economic welfare could be used.

What Lockwood presents is not a solution to the problem of different aspects of value being measured most effectively using different units, but rather a method by which one unit can be identified as representing the majority of a situation. This study is concerned with developing a holistic value assessment methodology, so such an approach is not entirely suitable. It does nevertheless present an interesting picture of value and the ways in which definitions for value facets can suggest different value measurement techniques. In turn, it is clear that the manner in which conclusions are drawn must be related to those definitions and reconsidered on each occasion the value sets are changed.

Lockwood defines intrinsic value as *end value*, where a good is valuable as an end *in itself.* Functional values are described as existing where a good is of functional use to another end.

The concept of intrinsic value may be manifested in heritage values, in the sense that heritage is derived not from market forces or practical requirements, but from the subject being *deemed* valuable in itself. Where the subjects are buildings of historical interest, the reasons for any heritage value being associated with them lie to a great extent with social definitions for a particular culture, but will be manifested in an intrinsic manner. This is hypothesised in Figure 2.4.

Figure 2.4 - The position of intrinsic value with regard to stone cleaning

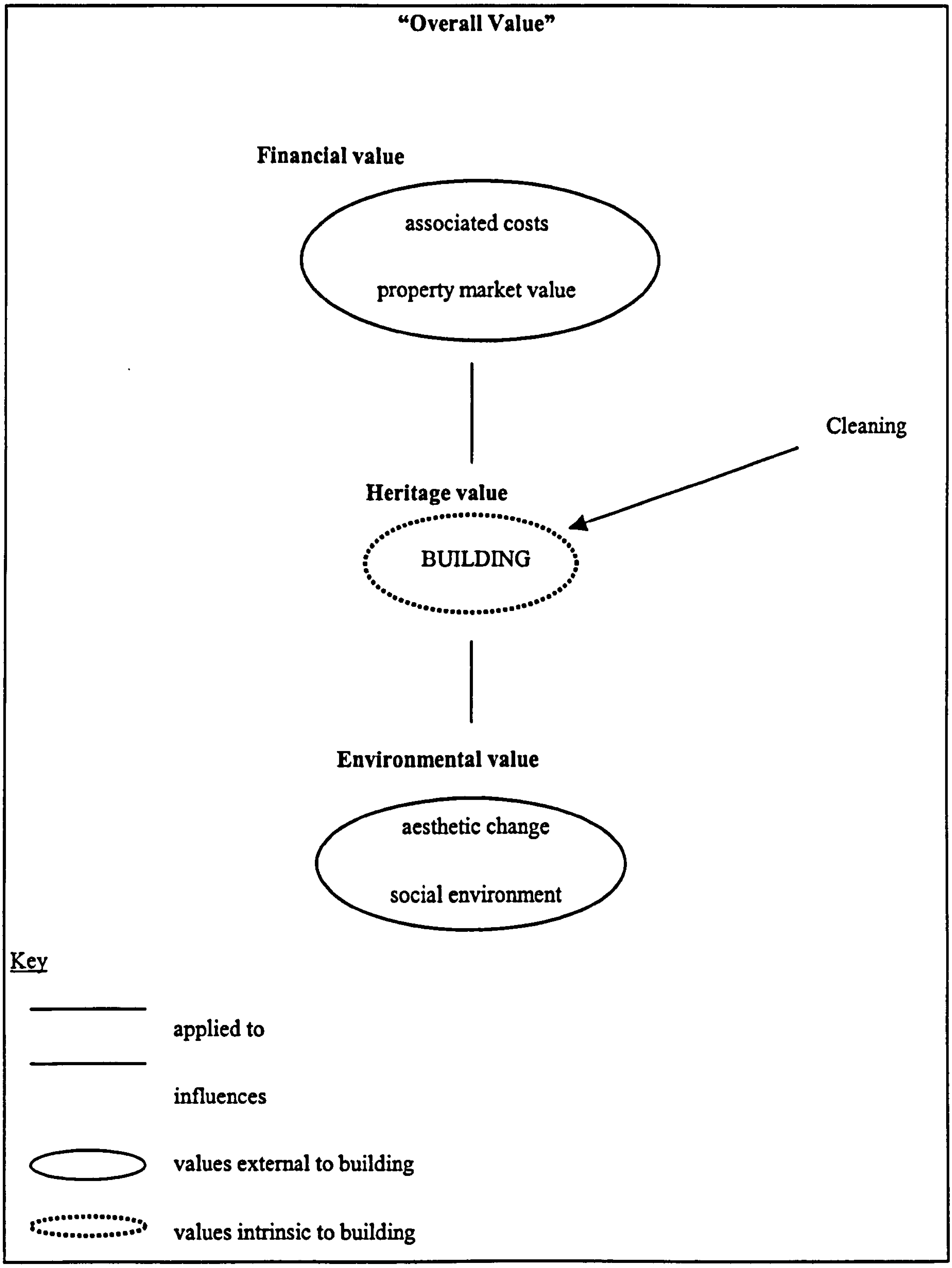


Figure 2.4 illustrates how assessments of financial (F) and environmental (E) value reflect areas of value extrinsic to the building actually cleaned. Whilst these are of great importance to a number of parties (e.g. owner, occupant, local residents), they could conceivably alter greatly and leave heritage value unchanged. Were the heritage value of a building to greatly reduce, however, this would certainly have implications for both financial concerns (Scanlon *et al.* 1994) and environmental values (i.e. prestige values, social impact).

A distinction should, however, be drawn between intrinsic value and heritage value. Whilst heritage value is manifested in an apparently intrinsic manner, society benefits from its existence at a deep and meaningful level. Heritage exists due to society's needs, and the continued existence and protection of heritage satisfies that need. In the absence of society, however (or even the absence of society ascribing heritage worth to an object in the first instance), the meaning and purpose of heritage value may be lost[4]. Likewise, where a building were damaged, it is possible that the rationale for apportioning heritage value would be weakened, lessening or removing heritage worth. Therefore, the built heritage is intrinsically valuable in certain contexts, but may cease to be valuable if that context is changed.

2.6 Financial value

Stone cleaning may influence the financial value of a property in both the short and long term, as in addition to the initial costs associated with cleaning itself, other aspects of the financial profile might be affected. The financial profile of a building should encompass not only the immediately obtainable selling price of the property, but also should also take account of any ongoing maintenance costs, and certain isolated items of repair, such as stone replacement or re-pointing costs. The importance of life cycle costing to the proper understanding of long term economic effect is especially important for this project, as longer term effects of cleaning will require intervention to be funded long after the initial cleaning itself is complete.

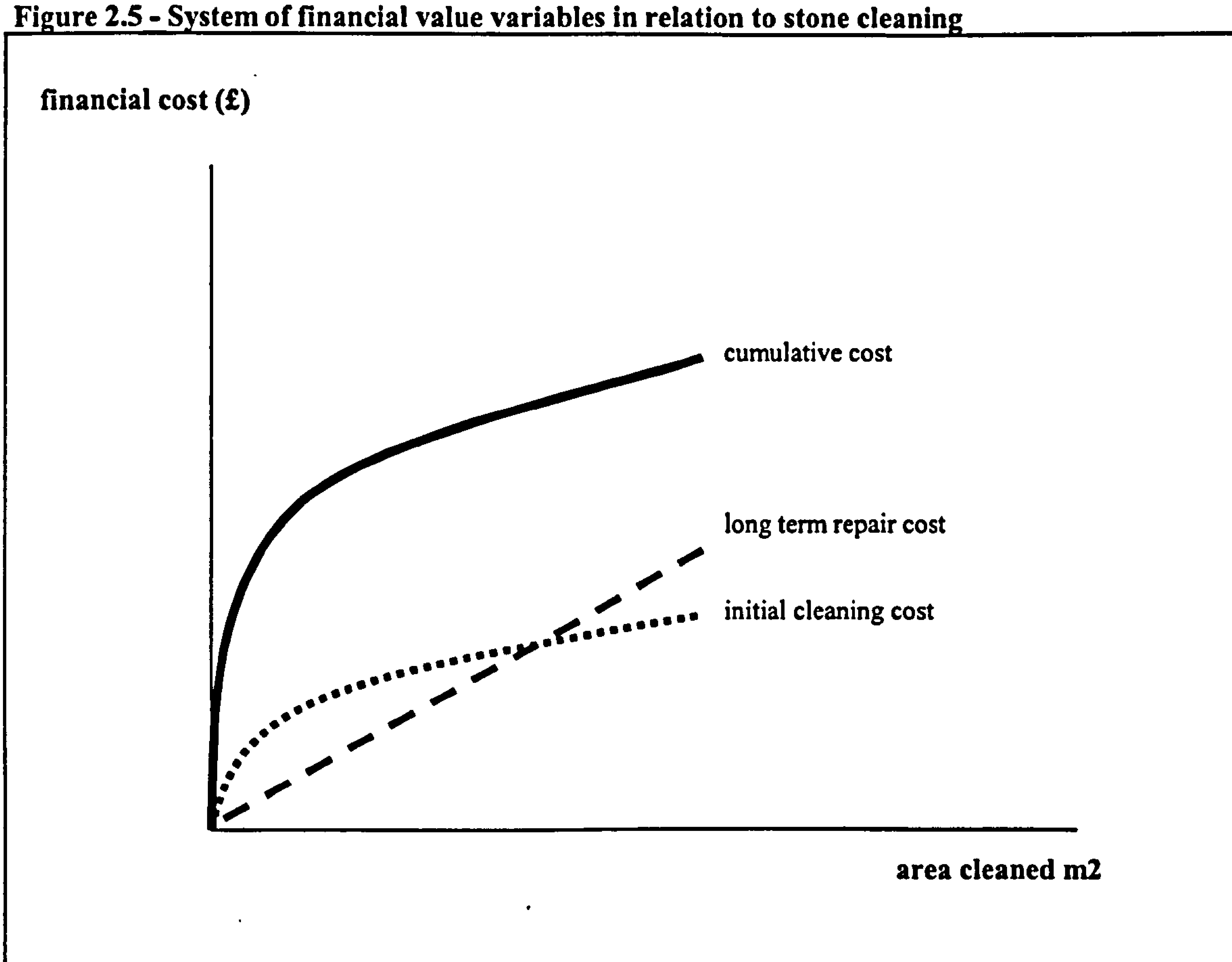
The property market selling price of a building may be altered as a result of cleaning, as may the marketing period required between initial advertising and selling/ letting. The availability of grant aid to assist in the funding of cleaning works in the first instance might

[4] The same could perhaps not be said of natural heritage, where for a range of environmental (ecological) reasons, intrinsic value is largely independent of society.

also have an important effect on the longer-term fiscal plan. The extent of grant assistance will vary also between properties, as the policies and regulations of the Local Authorities responsible will have an important effect on the amounts available.

Figure 2.5 shows how the overall set of financial values can be modelled in their own right. The figure represents a generic situation, in the sense that the cost of cleaning a building is related directly with the area of facade. If decay results from cleaning, then repair costs also dependant on overall area will emerge. The initial cost of cleaning is shown as a curve to reflect possible economies of scale. A need for repair would be expected in most cases to apply to only isolated parts of a facade, so no economy of scale is reflected in the figure. It should be stressed that the figure is non-specific to any one building and that each case requires individual modelling. The initial costs of cleaning, and any repair costs, relate only to the area in m2. It is accepted that the relative magnitude of these in financial terms would depend also on the nature of the stone base (e.g. level of detail, stone type), but suggested that the relationship shown in the figure is generic.

Figure 2.5 - System of financial value variables in relation to stone cleaning



By grouping together variables measurable using currency, an important part of the overall value system can be developed for a generic case and an appropriate practical methodology developed.

The financial implications of stone cleaning are potentially far reaching and long lasting. It is of great importance that these are understood fully by all parties involved, in order that anticipated financial gains are not lost due to foreseeable consequences being ignored.

2.7 Environmental Value

2.7.1 Introduction

The term "environmental" can refer to a wide subject area and this section explores definitions and limitations of those variables in greater depth. As concepts of environment vary or develop, approaches appropriate for assessment will also change. The potential importance of stone cleaning as an instrument of environmental change must be recognised.

2.7.2 Environmental user and option values

A major part of the environmental value sub-system should be taken to include the value placed on buildings by those using and occupying them, as well as any indirect value obtained by the wider population[5]. The level of soiling on a building has been shown to be a criterion by which respondents judge visual preference (Andrew 1992). Therefore, the analysis of stone cleaning as an environmental instrument is an essential step towards the fuller understanding of how changes in appearance can be related to the overall value assessment.

A subjective assessment of the effects of cleaning in the absence of a reliable procedure for decision making is not a suitable method by which conservation and environmental improvement schemes should be judged. The complexity of effect following cleaning demands that a wide range of factors are considered and related and this is facilitated through a rigorous value judgement.

[5] With prominent public buildings, it is likely that non- use value would account for a significantly larger proportion of overall value than where less prominent buildings are to be considered. For example, even where an individual does not plan to visit a building themselves, it is possible that in certain cases the value placed on that building by them might be considerable.

Preservation of the environment, in both the built and natural form, may be facilitated through the promotion of sustainable development. Pearce and Markandya (1989) define total economic value as being the total user benefit plus the total intrinsic benefits of an environmental good. However, the assessment of total economic value also tends to rely on the knowledge of the respondent group. How can we estimate the value of something we do not understand?. Care must be taken to understand how environmental values can be related with other areas of value, ensuring that no parts of the value system are overlooked due to simplification of the subject matter.

User benefits comprise both consumptive and non-consumptive aspects. In terms of the built environment, these would be in the form of financial return (consumptive) as well as, for example, the enjoyment gained from the visual appeal (non-consumptive) of the built landscape. Many of the benefits that may be derived from stone cleaning, in the short term at least, could be described and categorised as being user benefits.

2.7.3 Aesthetic value

For the purposes of this study, the term aesthetic should be read as being synonymous with the accepted dictionary definition of the word. Chambers 20th Century Dictionary (1983) offers the following definition:

> "**aesthetic** - originally relating to perception by the senses: generally relating to possessing, or pretending to, a sense of beauty; artistic or affecting to be artistic"
>
> "**beauty** - the quality that gives pleasure to the sight, or aesthetic pleasure generally"

The extent of the effect which stone cleaning has on the aesthetic (i.e. visual) value of a building facade is extremely difficult to measure objectively. Although it is possible to show that stone cleaning is one criterion by which aesthetic value may be judged, a methodology to place an exact figure on the extent to which such value may be altered remains elusive. The variations that exist between different buildings in terms of orientation, size, design, stone carving complexity, age, use, knowledge and derived opinions of the observer and perceived historical significance all contribute to the overall visual utility the building may deliver. At present, work completed on the aesthetic effects of stone cleaning has shown conclusively that cleaning alters the perceived visual value of a building. Indeed, although a tentative model was produced to show the relationship between aesthetic value, soiling level and visual complexity (Andrew 1992), the scales used for each axis vary depending on the building subject.

This research aimed towards a better understanding of the system of variables defining the relationship between stone cleaning and aesthetic value. Aesthetic value has an impact on overall environmental value, can influence financial value, and can lead to changes in heritage value. The circumstances in which stone cleaning can cause aesthetic change, and the extent and direction of that change, are therefore worthy of close consideration.

The objective measurement of environmental value and methods to allow such work to be undertaken have been developed over many years and have considered a wide range of situations (Kahnemann 1992, Pearce and Markandya 1989, Garrod and Willis 1990). An assessment of the benefits which society may derive from an environmental intervention can in theory be assessed using a number of different methods. This research will adapt established methodologies in the area of environmental evaluation, in order that a more exact and rigorous examination of the effect which stone cleaning has on environmental value may be completed.

2.8 Heritage Value

2.8.1 Heritage value and stone cleaning

Heritage value can depend upon a range of factors, reflecting social, architectural and historical significance. The extent to which a building can be said to reflect, be part of, or contribute to the heritage of an area or community must be influenced by a similar range, and the significance of each aspect will vary from case to case. The following should certainly be considered.

- colour of the facade;
- use of the building;
- setting of the building;
- the context in which the building lies today;
- age of the building (both perceived and actual);
- significance of the building in historical terms (for whatever reason);
- significance of the building in social terms;
- architectural form of the facade and stone carving work.

The perceived heritage value of a building may vary over time, as tastes are affected by fashion, and consensus of opinion might shift. Where an attempt is made to measure environmental value, a potential difficulty arises in that an attempt is being made to treat an essentially subjective area as being measurable and thus wholly objective.

The extent to which stone cleaning might influence or alter the heritage value of a building or area will depend on a number of factors including:

- the visual perception of the effects;
- the buildings surrounding environment;
- the extent to which changes in future maintenance patterns might affect such standing.

Before these points can be addressed, an understanding must be reached as to the meaning and definitions which might be attached to the concepts of, "heritage value" and "cultural heritage". To a great extent, these terms can be regarded as synonymous, with the former representing an attempt to evaluate the latter.

Feilden and Jokilehto (1993) offer "*the tendency today is to understand cultural heritage in its broadest sense as containing all the signs that document the activities and achievements of human beings over time*". For the purposes of this thesis, such a definition requires to be narrowed considerably, to define the extent to which it might be possible for such heritage to be affected by an alteration as specific as cleaning. Clearly, past research has shown that the structural soundness of a building would usually not be affected by cleaning, but that the outer layers of stone (containing perhaps intricate stone masonry working) can be lost where cleaning is improperly implemented. The reasons for a building being regarded as having cultural worth are vital when considering the effects of cleaning. Feilden states, "*the intrinsic values of a cultural resource refer to the material, workmanship, design and the setting of the historic monument or site...The aim of conservation is to safeguard the quality and values of the resource, protect its material substance and ensure its integrity for future generations*".

Feilden refers to Riegl's view on the historical time-line in relation to heritage in that,

> "an object created at a given time both reflects the artistic trends of its period and contributes to these trends. A heritage resource that is substantially reconstructed today would become a product of the present".

It is this essentially non-renewable nature of heritage that makes the minimisation of damage all the more important. Feilden offers an assessment of those aspects of value that should influence the choice of treatment.

Cultural values: identity value
relative artistic or technical value (based on research)
rarity value (based on statistics)

Contemporary socio-economic values: economic
functional
educational
social
political

It is recognised by Feilden that the suggested list is indicative only, and that a number of the values could be both positively and negatively influenced by whatever conservation methods were to be adopted. It is the view of this thesis that such lists are useful for the purpose of ensuring the evaluation process is holistic, but the constituents of any such list must be considered as being parts of a larger whole. Feilden footnotes the list with the statement that,

> "if the values for which the site has been nominated, particularly its '**outstanding universal value,**' are diminished or threatened, the site may be recommended for inscription to the List of World Heritage in Danger"
>
> [emphasis added by the author].

The respects in which such universal value might be affected by cleaning should be given paramount importance by any evaluation. Within Scotland, protection is afforded to those buildings with statutory Listing protection. The potential for the cleaning of any building to influence cultural values must be recognised, however, and explicitly included as part of a decision process.

2.8.2 Longer Term Maintenance - definition of terms

It is essential when contemplating heritage value that the long term implications of any action (or inaction) are considered fully, and that historic monuments[6] be "*maintained on a permanent basis*" (ICOMOS 1966). The manner in which historic monuments should be conserved is laid down in a number of conservation "charters"[7], each of which is implemented at national level within the context of "culture and tradition". ICOMOS (1988) state, "*the aim of conservation is to retain or recover the cultural significance of a place and must include provision for its security, its maintenance and its future*". Important aspects of this article reside in the definitions given to conservation, place and cultural significance.

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[6] "Monument" in this context refers to "not only the single architectural work but also the urban or rural setting in which is found the evidence of a particular civilisation, a significant development or a particular civilisation" (ICOMOS 1966). Clearly, buildings or groups of buildings could fall under this category, depending on history, use, design, and so on.

[7] See in particular ICOMOS 1966, ICOMOS Australia 1988, UNESCO 1972.

Further definitions are offered:

> "**Conservation** means all the processes of looking after a place so as to retain its cultural significance. It includes maintenance and may according to circumstances include preservation, restoration, reconstruction and adaption and will be commonly a combination of more than one of these.
>
> **Place** means site, area, building or other work, group of buildings or other works together with pertinent contents and surroundings.
>
> **Cultural significance** means aesthetic, historic, scientific or social value for past, present or future generations."

It is notable that the definition of cultural significance presented here is similar in scope and content to the breakdown of value presented in this chapter, and significant for its wide range. The charter, whilst allowing sufficient scope for interpretation at national level, clearly states the aims and meanings which should form a part of conservation practice, thus suggesting the manner in which heritage should be interpreted and cared for.

A clear link is made between conservation and cultural significance, to the extent that the retention and protection of cultural significance is given overriding importance. The charter is useful for the consideration of stone cleaning, as it gives clear guidance as to the consideration of life cycle requirements (i.e. maintenance and repair). Maintenance should be differentiated from repair of a place, being the, "*continuous protective care of the fabric*". Repair involves restoration, which is further defined as, " *returning the EXISTING fabric of a place to a known earlier state by removing accretions*". The importance of the known earlier state of a place is important, as the effects of cleaning, whilst clearly removing accretions in the form of soiling will result in a stone face which has not been exposed at any point in the past. The aesthetic as well as physical implications are clear and are critical to the consideration of stone cleaning as a conservation device.

2.9 Towards an overall assessment of value

The main aim of this study is to investigate the overall value system described, and by so doing present a method through which more robust and better-structured decisions can be made. Problems facing the decision-maker at present concern complexities of the value system, leading inadvertently toward approaches based on those aspects for which assessment methods are either well established or familiar to the assessor.

The consideration of value in relation to the built landscape demands that a wide view be taken, in that the effects of any change will influence financial, social and cultural aspects of that environment (BSI 1998, Ilozor *et al.* 1997). A value assessment concentrating on one particular area of value could be accused of considering the views of a minority, at the expense of society as a whole. Legislation and guidelines concerning protection of the built environment (BSI 1998, Historic Scotland 1993, ICOMOS 1966 and 1988), present approaches to the planned development of the built environment which will protect the longer term needs of society, and ensure a sustained protection of the environment in which the greater part of western society lives. Whatever methods are employed in the assessment of value, is must be ensured that a wide and inclusive approach is taken, both conceptually and practically.

2.10 References

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3. *Review of literature relevant to the research*

3.1 Introduction

When attempting to assess how the effects of stone cleaning are perceived, it is important that these effects are seen in context. Williams (1993) defines the performance of a building as,

> "the contribution made by a building or estate to the functional requirements of the occupiers and the associated physical behaviour of the fabric, services and finished over time."

This definition is interesting in that it clearly refers to a building as being an entity in itself, as opposed to being part of a larger built (and natural) landscape. Aesthetics and any "subjective" element to the definition suggests that "performance", as seen here, is related less to overall value assurance, and more towards the financial model only. The fact that concentrating on finances ignores obvious and strong links with other aspects of value (e.g. resource need, long term non-financial implications, visual impact) removes a great deal of validity which the definition might have otherwise possessed. Ilozor and King (1998) note that "aesthetics" have been repeatedly excluded from a consideration of building evaluation, despite a great deal of research and discourse in the area (for example, Nasar 1988, Nasar 1994, Oostendorp and Berlyne 1978). Indeed, where a "least cost" approach to project selection is taken, the value presented by more subjective criteria (including aesthetics) may be overlooked, in preference for a defined objective gain (e.g. financially). The effect which stone cleaning might have, given the approach to building evaluation taken by Williams will vary, and is inevitably limited by the narrowness of the definition itself. The initial results of stone cleaning work and the effect that such results have on the long-term condition of stone have implications in the context of performance evaluation. For example, where a building evaluation programme is used, the importance of an emphasis on life cycle considerations might well vary considerably, depending on the condition of the stone post-cleaning.

Douglas (1994) proposes an approach whereby the performance of a building can be assessed using a list of ten key criteria. These were developed from a similar list proposed by Holdsworth (1994), in addition to work reported by Becker (1993), Sneck (1988) and Stanilopolos (1994). Whether the criteria might relate to financial (F), environmental (E) or heritage (H) value is noted alongside each (added by the author).

- Investment returns - F;
- Energy efficiency - F, E;
- Space utility - F;
- Cost in use - F;
- Restoration costs - F;
- Code compliance - logistical/ legislative?;
- Building integrity - E;
- Internal environment - E;
- Quality - F, E;
- Durability - F, E.

It can be seen that a slight skewing towards financial appraisal is apparent, with environmental concerns featuring in half the categories. No explicit consideration of heritage is made in the list[1]. Although Douglas states that the list is not intended to be definitive or restrictive, it is also far from inclusive. This is illustrated by the lack of consideration given to aesthetic requirements, the quality of the living environment or the potential for a change of use or impact on a wider community than the users. As such, it is difficult to see how the "guidelines" could appeal to or be applied by designers, builders, planners or the public, without the accusation that a wide range of criteria and potential user needs have been ignored. Batstra (1993) notes that location, quality, flexibility and cost efficiency should be considered, but falls far short of even beginning to explain what is actually meant by any of these headings. "Quality" appears limited to an extremely shallow consideration of "looks/ style" whilst "cost efficiency", rather than being linked to a larger consideration of value management through the design process, appears to be limited to maximising floor space or installing "cost effective energy systems". These attempts at "evaluation" really fall far short of being a robust approach at both practical and philosophical levels.

[1] Perhaps compliance with Planning requirements is considered sufficient, although this should be stated if the case.

While there would seem to be a certain amount of scope for the introduction of wider environmental considerations, the highly subjective and emotive titles used reduce the probable reliability of the criteria. However, the strong emphasis on longer term considerations (costs in use, durability, quality and restoration costs), means that the stone cleaning process might well have an important effect on any assessment made. For example, where the stone cleaning process led to acceleration in the deterioration of the stone itself, costs in use would be affected. Conversely, where the cleaning process removed a potentially damaging biological growth from the face of the stone, costs in use might ultimately be reduced.

As noted by Mohsini (1989), "*the implied assumption that a building's performance is equal to the aggregated performance of its components is not valid. A completed building ... is much more than the sum of its parts*". Mohsini is concerned largely with the technical performance, however, and the processes which will lead to technical success or failure. This in itself would suggest that although a route through which technical process can be monitored and controlled that again the performance "evaluation" has failed to consider a large part of the overall value system. This is of importance with regard to stone cleaning (Andrew 1994) and the integration of a building within its surroundings, and the great importance of order and unity have been identified (Nasar 1988) as having an important influence on perceptions of the built environment. For example, Webster *et al.* (1992) identify the preservation of a tenement's aesthetic continuity as being a prime objective of any major stone cleaning project.

Rather than focus on the costs and benefits to users of the building itself, Lichfield (1964) recognised that from a town planning perspective "performance criteria" are far more wide ranging, including political, administrative and technical feasibility, and certainly not excluding economic and social costs and benefits. Rather than attempt to arrive at a single mechanism through which all can be assessed, though, Lichfield argues that there must be clarity as to what is being evaluated, and when. It can be argued that Lichfield, rather than being exclusive towards areas of the evaluation, is simply recognising that in practice a wide range of knowledge and skill is required to conduct a holistic assessment. An important additional point raised by Lichfield is that feasibility testing of projects must take place prior to the evaluation stage (e.g. political, economic, technical), and projects which are unlikely to proceed disregarded.

This section of the literature is interesting in that it considers a wide range of ostensibly subjective criteria, without illustrating how any of those criteria might fit into a wider assessment of value, performance or quality (or indeed how the approaches noted could have an influence on design, maintenance or occupation). The historical reasons for such a limited view of "value" in the construction industry and built environment come from a typically narrow understanding relating to projected investment income streams, and theories which "*assume general principles on the meaning of value arising from the application of indiscriminate and arbitrary personal impressions hidden behind a mask of pseudo-mathematics and claims of expert intuition*" (Eccles 1996). A danger also is that the criteria suggested seem arbitrary, and the extent to which they might be applicable across the built environment is suspect[2].

A lack of rigour or wide base for the understanding of value inevitably undermines the decision-makers' stability. This project took the approach that a non-holistic assessment leaves open the possibility that bias might be introduced simply through those parts of the assessment left to one side[3]. It was decided, therefore, that a closer analysis of discrete sections of the overall value system would provide a more fruitful methodological approach.

[2] Barsh (1993) found that supposed links between "human rights and other variables" were suspect, due to problems of reliability, validity and equivalence, with regard to both sides of the "equation". Complex situations and subjects require that complexity to be adequately recognised in an assessment.

[3] For example, a purely financial assessment resulting in a value gain does not in itself demand positive action. Were such a gain in itself to lead to cleaning be completed, the implication is that other parts of the value system have been deemed unimportant.

3.2 Financial value

3.2.1 Introduction

The effects of stone cleaning on financial value were hypothesised in chapter two, and this section deals with how the effects may be manifested, and how those costs (and benefits) might be modelled.

3.2.2 Property market valuation

A property's market price is arrived at, in the majority of cases, through comparison with similar properties, the similarities resting in a number of areas, for example:

- size;
- location ;
- use;
- architectural style;
- age;
- structural condition;
- aesthetic desirability;
- current market conditions (in relation to the particular building).

It can be seen that the variables present are wide ranging suggesting that the isolation of stone cleaning may be difficult.

Indeed, methods and procedures commonly used to arrive at market "prices" to buy and sell buildings and land in the marketplace are difficult to apply where we attempt to measure the value that may be obtainable from the application of stone cleaning. Where a building is "valued", the size, position, remoteness of services, intended use, and other such factors, are likely to be of *much greater* influence on the final value.

Stone cleaning, where poorly carried out, can have a detrimental effect on both the fabric condition and aesthetic appeal. In such cases, this would most likely be eventually reflected in the market price as a slump in value. However, where cleaning is relatively successful, without any apparent decay or damage immediately afterwards, impact on market price would most likely not be exhibited to such a noticeable extent, and not attributed to cleaning in any case.

Were cleaning not carried out at all, the effect on value would be determined by a number of possible scenarios. Should the stone suffer as a result of the soiling layer contributing to a physical deterioration, repair work would be required in order to prevent premature obsolescence occurring, and for reasons of safety. It is possible that a building could suffer aesthetically as a result of cleaning work not being carried out, although the magnitude of such an effect is difficult to gauge. Were the facade to undergo a dramatic improvement in aesthetic appeal as a result of stone cleaning, such an improvement must be regarded as temporary (in relative terms), due to the likelihood that re-soiling will occur, and the aesthetic benefits likely to disappear as a result.

Flanagan and Stevens (1990) discuss the concept of "risk analysis", in relation to the construction industry. By it's very nature, the construction industry is extremely uncertain (due to factors such as weather, finance and client experience). This means it is difficult to predict what is likely to be the outcome of a construction project with any real accuracy, for any great length of time in the future.

Similarly, building conservation related to stone cleaning and stone repair demands a number of answers as to the long-term effects of the process to be carried out. From the point of view of the client, faced with the prospect of spending a large amount of money to have cleaning work completed, an awareness of the degree of "risk" is inherent in the project is essential.

> "Risk can manifest itself in numerous ways, varying over time and across activities. Essentially it stems from uncertainty which, in turn, is caused by a lack of information. The environment within which the decision-making takes place can be divided into three parts:
>
> - certainty;
> - risk;
> - uncertainty."

As stone cleaning is an area in which a degree of field data is now available, it can be stated that the completion of cleaning carries a degree of risk, but that the results will be unique to a given situation.

Millington (1982) states that

> "another important feature of property is that, relatively speaking it is durable...Even when a property is so old that the deterioration is considerable, it is often found that the value of the land on which it stands has appreciated at a greater rate than the rate of depreciation in the value of the building...although the quality and physical condition of the building has deteriorated, the overall value of the land and the buildings has been maintained, and more often than not has increased."

The effect of stone cleaning on such "durability" is central to this thesis. Millington's use of the word "value" refers clearly to financial value, but would be unlikely to hold for environmental or heritage values. Indeed, where a building is Listed (reflecting a recognition of heritage worth), statutory protection of the property might lead to direct cost links between deterioration and the requirement for maintenance work. The cleaning of stone facades is carried out often on buildings (and monuments) which, due either to their being considered national treasures of historic importance (e.g. The Scott Monument in Edinburgh, the Victoria and Albert Museum in London), or position in the public sector, have no market "price". In the case of such buildings, a completely different set of criteria exists, by which decisions regarding the treatment of the stone must be made.

Britton *et al.* (1989), discuss what they term the "principles of value". They state that, in the majority of cases, the valuer's role is to estimate the market value of a property, market value being defined as:

> "the capital sum or the annual rental which at a particular time, on specified terms and subject to legislation, should be asked or paid for a particular investment in property."

The property market is one where a certain imperfection of competition exists, due to the uniqueness of each property (i.e. location, size and structure). The lack of detailed information regarding transactions within the market and how prices were arrived at contributes greatly to this imperfection (Britton *et al.* 1989). The property market may also be split into a number of other markets, existing on local, national and international basis. Therefore, the valuation of property requires a great deal of information regarding the proposed transaction before a market value may be arrived at.

The "market value" of a property is defined by Britton *et al.* (1989), as being:

> "...the amount of money which can be obtained for the interest at a particular time from persons able and willing to purchase it."

This definition of value, with a specific reference to property markets, is quite different to a general definition of value. Britton *et al.* (1989) state that "*concepts of social value, aesthetic value or other values are not appropriate to this work, but it should be remembered that value can be considered from these points of view*". Whilst it is recognised that Britton *et al.* do not regard "social" or "aesthetic" values as impinging directly upon the property market assessment of value, it surely cannot be argued that such factors play an important role in the definition and formulation of the realised price.

Britton *et al.* accept that property market values exist within a larger value system, but that established methods to deal with property market values have tended to focus on buying and selling prices alone. This is a primary concern regarding the analysis of traditional market values in relation to stone cleaning, as the wider effects of the cleaning process might not be reflected in the final market valuations, or will certainly not be explicit.

Nevertheless, methods used to arrive at nominal property market values for property may often give a useful guide to the importance or otherwise which the potential occupants and/or owners of such property place on certain property aspects. The financial implications of stone cleaning work, if reflected in the selling prices of treated properties, will be of great importance to any potential investor, and will therefore become an important aspect of the value system. A study to examine the effects of cleaning on such markets should therefore be seen as extremely important.

Although the effects of stone cleaning have not been studied previously, the effects of other environmental and conservation instruments have been investigated in some depth. Research has shown that the level of air pollutant present can negatively influence market values (Anderson and Crocker 1971, Atkinson *et al.* 1985, Freeman 1974, Ridker and Henning 1967, Wieand 1974). Work concentrating on the effect air pollutants might have on property markets has been criticised due to the difficulties of generating reliable data, and hence the difficulties which can arise in developing sound conclusions. Where the set of variables to test against the "market price" is flawed in any way, the conclusions emanating from such would must be questioned (Atkinson *et al.* 1985). Links between location within a city and pollution level cannot be ignored, either, as areas encompassing heavy industry would not have traditionally been areas of high market value[4].

On a related note, from studies concerning the public's perception of the dangers of radon (Lee 1992), a complex situation emerged where awareness of a problem did not necessarily lead to action being taken. Hollis (1992) reported that although "*many surveyors now include radon in their reports*", there was no evidence that this was deterring house builders or purchasers. An alternative example given is that "*where dry rot is identified, the cost of eliminating the dry rot is usually seen as a direct reduction in the price of the property...In dealing with radon, the difficulty is that it is unseen*". Although stone decay, at the point where stone repair is necessary, is certainly seen and should have an effect on market price, whether that repair is recognised as being due to cleaning is another matter. If not, benefits due to potential *increases* in market price may be artificially high due to ignorance on the part of the purchaser. In addition, decay may not always be recognised by Clients as requiring repair, thus further complicating the issue of cost planning.

As Britton *et al.* (1989) state,

> "although the aim of the valuer is to provide an estimate of market value, it should not be assumed that the valuer's estimate of value and the market price or market value will always be the same. Different valuers could well place different values on a particular interest at a particular time because they are making estimates and there is normally room, within certain limits, for differences of opinion."

Although this point is valid, where buildings are considered, the price determined by the valuer is often that accepted by the market. Valuations depend on a large number of criteria, and identifying the discrete contribution of stone cleaning within the price would be extremely difficult. Market forces, and the highly subjective manner in which properties might be selected are both factors which contribute to the final selling price.

[4] It is interesting to note that although a great deal of work was completed in the late 1960s and 1970s concerning links between air pollution and property prices, in a bid to "price" the "costs" of air pollution, that area of study has more recently changed direction and used alternative environmental valuation techniques to perhaps greater effect (e.g. Brajer *et al.* 1991).

Ridker and Henning (1967) examined the effect which measured levels of air pollutants have on property market values. The amount of "pollution" present in the air was measured using sulfation levels. This measure was regarded by those pollution experts consulted to be representative of air pollution levels generally. The characteristics of individual properties used in the study included number of rooms, a measure of "recently built" housing and the frequency of houses per mile. A number of variables were also used to represent the location and neighbourhood of the properties. The study concluded that it was possible to estimate the effect of air pollution levels on property values, where a certain amount of knowledge was available regarding the property and residents, and an accurate measure of air pollution was available.

Such work has tended to rely on the fact that air pollution levels may be measured easily (by measuring the levels of various gases present in the air). With stone cleaning, the process is not quite so simple. It is possible to measure colour changes resulting from cleaning accurately (Young 1993), and Andrew (1992) succeeded in showing that a link existed between the results of stone cleaning work and aesthetic preference, but concluded that a generalisation of such preference was difficult. In addition, the degree of soiling present on a building does not necessarily reveal the aesthetic value of the building (Webster *et al.* 1991). Therefore, although it may well be possible to measure the discoloration of stone as a result of soiling (perhaps via the use of colour meters), such a measurement would be unlikely to be of use to this study. Clearly, one side of the equation used by Ridker and Henning, namely the non-market price variable (i.e. the amount of soiling) at the present time remains unclear, making use of the approach unworkable.

Anderson and Crocker (1971) state, "*of all the approaches used to measure the benefits of air pollution control up to this time...quantitative studies of the relationship between air pollution dosages and real estate values appear to be the most promising*". The methodology analysing property market values is being used here to approximate a representative measurement of another variable (air pollution), and the extent to which it is valued. Garrod and Willis (1992) examined the effect which selected countryside characteristics were observed as having on house prices in a rural area of England. That study used the hedonic price method to develop a model of environmental quality against the consumers willingness to pay for it, through the medium of house purchases (this method is described in greater detail later). Although analysis of data on rural house prices did identify that the proximity of woodland and water seemed to have an effect on house price, Garrod suggests that other methods of valuation such as travel cost or contingent valuation may be more suitable for measuring recreational and existence values, respectively.

3.2.3 Financial models

The financial costs of cleaning must be properly considered over the life span of a building, and must be balanced against any benefits that might accrue. It is also essential that the manner in which the variables are modelled employs a reliable methodology. A number of the variables that should be incorporated can be represented using a range of possible values (e.g. the frequency of stone repair required). A number of techniques have been developed previously to model the costs of construction and building repair work, and these provide an obvious starting point.

The ability to forecast the long-term cost of stone cleaning will assist in the production of better value judgements. Where an unacceptable degree of approximation is unavoidable in a decision-making scenario, the results are likely to be less than acceptable. This study aimed to develop, through the application of established methods of cost forecasting, a framework which could be applied to future stone cleaning programmes, helping to ensure that a representative range of factors are taken into consideration prior to works being completed. This avoids the situation where only the initial capital required to complete the works is considered, leading to problems regarding the funding of proper maintenance and repair programmes at a later date. The main financial modelling methods available (and used commonly within the construction industry) can be categorised under four main headings (Ashworth 1986):

- i- empirical methods;
- ii- algorithmic methods (including regression analysis);
- iii- simulation;
- iv- heuristics.

Empirical methods

Empirical models are based upon the observation and analysis of gathered data. For the present study, where the aim was to consider the likely effects of cleaning in the future, it would have been necessary to gather a large quantity of data concerning the past impact of cleaning on buildings, and the impact this had had on repair and maintenance programmes. Research concerning the exact degree to which cleaning could be considered to increase (or decrease) maintenance requirements is at present insufficiently advanced to allow for an exact measurement tool to relate maintenance expenditure with the effect of cleaning[5].

Whilst certain effects of cleaning can be said to have clearly detrimental effects on the stone surface, and that it is likely these will lead to an increased need for repair, any model produced should reflect this across a likely range of effect. In addition, the nature of the stone cleaning industry has meant that a large amount of the work completed to date has been carried out by companies not necessarily undertaking cleaning as their main line of work. A great deal of cleaning has been completed with little or no records being taken at the time, with little or no information currently available regarding the date of cleaning or the exact method of cleaning used. Therefore, the use of wholly empirical modelling techniques may be difficult.

Algorithmic methods

The use of algorithmic techniques (such as regression analysis) demands a sufficiently large sample of data to allow an optimisation in the reliability of resulting equations. The implementation of an algorithmic analysis requires that a sufficient size and quality of data set is available, within which a discrete measured variable can be compared against various criteria. Studying the financial effects of stone cleaning, although a range of constituent variables can be identified, these operate in relation to the constraints of a particular building, rather than as a generic system.

What is required here, therefore, is a model generated from known facts and concepts, rather than being derived from the data set.

[5] Future work in this area is to be completed by the Masonry Conservation Research Group of the Robert Gordon University, Aberdeen, and Historic Scotland. The results of such work will form a useful addition to the cost modelling process, but until such work has been completed, the use of traditional empirical modelling techniques remains difficult.

Simulation models

Simulation models are used where the system of variables is complex, and are useful where a degree of uncertainty and risk is inherent in the model. A major problem that can be experienced when attempting to run a simulation is that the results will reflect only those variables that were included. Therefore, a concept of the immediacy of effect with regard to all of the variables considered becomes important. For example, the effect of cleaning on tourism levels might well be great, but is difficult to isolate from a number of other causes including travel links, accommodation availability, location, climate and so on. Therefore, although it is important that some consideration is made of the concepts, uncertainties remain.

The Monte Carlo technique is an established method of cost simulation, operating by completing a number of samples of supplied ranges of data, to simulate the uncertainty of real life situations. For example, the effects of cleaning on property market prices are potentially predictable over ranges, where the mean, standard deviation and distribution shape are known quantities. For other variables, such as the cost of cleaning, it is possible to estimate the initial costs of cleaning, testing and pointing to an acceptable level of accuracy using established methods of approximate estimating. As with most real life situations, the value system associated with the cleaning of stone buildings is complex, and many of the parameters cannot be represented using discrete measurement variables. That is to say that the effect on each variable can only be predicted for most situations within a range of possibilities. With regard to a variable such as stone repair, it is certainly possible to prepare a maintenance schedule to be adhered to, but this again will rely to a great extent on factors presently unknown. Therefore, the variable cannot be ignored by any consideration of financial value, but can only be effectively estimated within limits.

The Monte Carlo approach uses these ranges of estimate to produce an estimated total cost for a project. By completing a large number of such estimates, it is possible to gradually reduce the variance of results, and move towards the most likely outcome. Provided an acceptable estimate can be made for each variable, simulation models provide a mechanism by which experimentation can allowed for within a controlled framework.

The Monte Carlo method operates by allowing a statistical model to consist of variables that exist over a distribution. The first stage involves describing each variable in terms of the distribution shape, standard deviation, maximum and minimum possible values and mean.

Each variable should be described to as realistic a degree as possible, with the distribution shape used to reflect uncertainty. By incorporating uncertainty into the model in this way, the results obtained through the use of Monte Carlo are consequently more realistic and reliable. The method itself operates by generating random samples of each variable over a number of runs, building up a probabilistic estimate of the cumulative effect of the variables taken as a group (as they would be in reality).

The second major problem that has theoretically been associated with the method is the fact that it relies on random number generation for success. In theory, the production of random numbers is extremely difficult, with absolute mathematical proof of results difficult to achieve. For the purposes of this study, it can be concluded that the random number generation facilities available through the use of computer based Monte Carlo modelling would be sufficient to meet the project needs. Considerations of distribution shape are paramount to the success or failure of a Monte Carlo simulation, particularly where subjective or uncertain data is to be used (Chau 1995). The distribution shape must, as accurately as possible, match the real life distribution. Using a triangular or normal (i.e. mean +/- standard deviation) in inappropriate circumstances, will inevitably lead to less reliable results.

Heuristics

The fourth model type, heuristics, refers to models which rely on the prior knowledge and experience of the models user. Ashworth and Skitmore (1982) report that, "*proficiency in cost forecasting...was said to be a result of skill, experience, judgement. Knowledge, intuition, feel, academic background, personality, enthusiasm, hunch and a 'feeling in the back of the head*'". Cusack (1984) found that the results from heuristic models were comparable to those achieved through the use of apparently more rigorous mathematical models. It was desirable that the model produced in this thesis could be used readily by most individuals, regardless of their previous knowledge of stone cleaning. After all, a large amount of cleaning is completed on non-Listed properties where the building's owner would supply a large proportion of the funding. Whatever model is finally presented should be applicable even in situations where expert advice is not to hand.

Table 3.1 - Summary of modelling techniques

Technique	Description	Data requirement	Relevance to study/ problems
Empirical	An attempt to relate design variables and financial cost. Observed relationships used as predictors (e.g. wall/floor ratios).	Overall costs against physical factors (such as size of facade, amount of decay, size of building, building use).	May be difficult to find in reliable data sources; extent of long term effect not measurable at present; simplistic approach given complex nature of subject matter.
Algorithmic	"*Precisely defined procedures for performing calculations*" (Ashworth 1986). Accurately reflects the relationship between financial cost/ benefit with a series of indicator variables.	To develop an algorithm, a "measurement" is required against which a series of variables can be tested. Once significant relationships have been established, the "measurement" can be derived from the variables.	Of great relevance in relation to areas such as social perception of cleaning. Could potentially allow the identification of socio-economic indicators influencing perception of the built environment as a whole.
Simulation	Avoids the need for direct experimentation and can reflect uncertainty in real world situations. Experimentation can be completed without the need for direct use of resources.	A sound knowledge of the value system and likely ranges/ frequencies for the constituent variables.	Uncertainty due to stone type, cleaning method, location, quarry source, market conditions and scale makes the use of simulation techniques almost unavoidable.
Heuristics	Rules dictating the course of action to be taken, based on past experience.	Data on the current situation; knowledge of the effects of cleaning; knowledge of what constitutes a justification for proceeding.	Areas of the value system as identified clearly require an element of subjective judgement. That judgement will rely on a structured approach, within which informed decisions can be reached.

The intrinsically inexact data sets available to the estimator in most construction projects mean that a certain amount of risk and probability can be usefully employed to optimise the reliability of an estimate. With stone cleaning, the range of variables, which must be considered, and the manner in which these must be measured, means that a model should reflect this uncertainty. Therefore, it can be surmised that the Monte Carlo technique would be applicable for use within the financial model (developed in chapter four).

The development of suitable distribution curves for likely financial outcome relies to an extent upon expert judgement at this stage, due to an insufficiently high number of buildings existing in a post-cleaning state for upwards of two decades. In addition, as cleaning methods have been recently developed which seek to cause minimal damage to the stone itself whilst still achieved desired levels of soiling removal, the long term effects of cleaning cannot be proven categorically to exist in anything other than a possible range of results.

3.2.4 Life cycle costs

Life cycle costing has emerged from the practice of terotechnology to monitor, analyse and predict the cost of components or buildings over their (residual) lifespan. Components of elements are difficult to cost at the design stage and a need to record accurate data regarding the "*operation and maintenance...leading to...failures*" was identified (Barden 1978).

Unless extremely abrasive physical methods of cleaning were employed, which is unlikely in today's stone cleaning market, it is equally unlikely that decay or damage to the stone surface as a direct result of cleaning would become apparent until some time after cleaning has occurred. To this end, it is essential that this project consider methods through which financial costs incurred until some time into the residual lifespan following cleaning (and due to cleaning) can be considered (bearing in mind uncertainties over magnitude).

The consideration of longer-term costs should form a significant part of the design process of any construction work and cannot be ignored (Ince 1992). An immediate difficulty arises in that attention must be given to interest which may accrue over the time between construction and repair (or cleaning and repair in this case), for which a discount rate should be applied. This means that a figure which would cost a certain figure at the base date (time of cleaning) will have a lower figure included in the life cycle cost model due to discounting (at a % per annum).

As stated by Ince,

> "The rate used is critical e.g., the present value of an investment with a life of 32 years at 8% is similar to that of an investment with a life of 20 years when a 13% rate is used."

For this reason, a number of rates would usually be applied in any given situation, better reflecting uncertainties in the future. What this means also, of course, is that the decision-maker, rather than being presented with a clear financial outcome is presented with a range of what may or may not come to pass. This becomes problematic only where either the cost must be balanced against a clear benefit, or where not all of the outcomes suggest the same course of action. Variables required by the life cycle cost calculation are as follows:

- rate of interest;
- life of the building;
- life of components;
- estimate of initial cost;
- estimate of costs in use.

"Life of the building" can for the purposes of this study be considered to be synonymous with the "life of components", as both refer to the time between cleaning and repair need. Costs for cleaning and repair (per m^2) can be obtained, leaving only the discount rate and time until repair unknown. It must be clear that although the time variable here is uncertain, that will be the case in any life cycle costing study, with designers often working to a subjective anticipated life span.

Ashworth (1996ii) supplements the list by identifying that uncertainties can be problematic in relation to life expectancy, data availability, technological change, fashion changes, cost and "value" changes, policy and decision making changes and accuracy. Without the removal or reduction of problems in these areas, the widespread use of life cycle outputs generally will be compromised. With regard to fashion and legislation, over time the desire to clean will obviously be affected by each. For buildings already cleaned, the long term effects of cleaning may not yet be apparent, and are as such unaffected by changes in attitude occurring now. It is interesting, though, that a clear link is made between the financial (objective) and social/ environmental value areas (at least partially subjective). Ashworth's failure to recognise "value" as having other than financial implications is disappointing in that life cycle costing, by considering not just finances but also the circumstances with will influence such cost, suggests a much wider range of concern than simply finance. Some projects, it is agreed, might be compromised through changing fashions (e.g. obsolete materials or out of date appearance), but rather than regarding this as a weakness of the life cycle cost method, this surely signals the use of life cycle costing as an indicator from which projects prone to social/ political influence might be identified as unlikely to succeed in the long term.

This project is, in effect, not faced with a poorer supply of information than most other costing studies. Flanagan *et al.* (1987) argue that a decision based on initial costs alone (e.g. cost of cleaning and scaffold) is susceptible to far more risk than a decision based on initial cost (accurate) and anticipated later costs/ resources (less certain). However, a life cycle cost based on *any* estimate of cost is clearly not acceptable, and will be likely to mislead. Flanagan's argument is true to a point, but where the output of any life cycle calculation contains uncertain elements, these must be indicated. Ashworth (1996i) illustrates how the life expectancy of any component can be difficult to predict with accuracy, particularly where the calculation requires a discrete figure. Use of the Monte Carlo simulation technique is suggested, in that the method allows for such uncertainties (within limits) to be incorporated into the model itself.

A cycle of monitoring and feedback into the knowledge database concerning the effects of cleaning (or timescale and magnitude of any change) is necessary to ensure that a life cycle model set up in the present continues to develop and become refined as time passes (Ashworth 1996i). Elements uncertain today need not be so *ad infinitum.* Whatever approach is taken towards the calculation of the life cycle cost of stone cleaning, it is essential that the figures and indicators used are realistic, and if not available are so identified and analysed separately to the main calculation. Newton (1991) agrees that the usefulness of life cycle costing is unclear unless areas of uncertainty are explicitly identified.

3.3 Environmental value

3.3.1 Introduction

The practice of building and architectural evaluation (Ilozor *et al.* 1997) should include consideration of various subject areas, a number of which can be influenced by stone cleaning, for example:

- investment return;
- life cycle cost;
- aesthetic change;
- quality of detail.

The importance of aesthetic value in an overall building assessment depends on the use, occupancy and location, but should nonetheless always be considered[6]. Although each point can be assessed to a greater or lesser extent, no one aspect can be said to represent adequately the overall value change. Indeed, it is suggested by Ilozor *et al.* (1997) that a range of factors: economy, efficiency, durability and aesthetics (or, financial, environment and heritage) be considered equally, and that an over-emphasis on any one part would jeopardise the consideration of others.

Within the field of environmental valuation, a number of methods have developed which may be used to assess the value of environmental interventions where no associated financial market exists[7]. Stone cleaning is an area where a limited amount of data may be collected from existing markets (e.g. property market selling prices, the market for stone cleaning itself), but where a great deal of the necessary subject matter to be considered is not explicitly represented in the marketplace (i.e. aesthetic, social, intrinsic and heritage value).

[6] Ilozor *et al.* (1997) note that evaluation approaches proposed by the likes of Malyan (1992) and Williams (1993) focus on the "least cost" approach to building or project evaluation, where non-financial or non-objective approaches to assessment can be overlooked.
[7] Where a good is normally bought or sold in actual financial markets, a value of sorts can be drawn from the prices realised (for example, the operation of property markets). However, where markets are overly sensitive to outside influence, or where no such markets exist, obtaining a realistic value measurement from the observation of realised prices is not possible.

3.3.2 Socio-economic value

An environmental impact assessment should consider the "environment" from the widest perspective. Glasson and Heaney (1993) found that the majority of environmental impact statements completed in the UK between 1988 and 1991 had not *"addressed any social or economic impacts"*. Clearly, any environmental alteration has the potential to affect a wide range within the value system, and the links between environment, social impact and financial pressures are apparent. With regard to this project, it was essential that such problems of "subject exclusivity" were avoided.

Nijkamp (1987) suggested a method by which the socio-economic value of urban monuments may be better assessed. He states that,

> "Monuments represent part of the historical and cultural heritage of a country or city and do not offer a direct productive contribution to the economy. Clearly tourist revenues may sometimes reflect part of the interest of society in monument conservation and/or restoration, but in many cases this is a biased and incomplete measure, so that monument policy can hardly be based on tourist values".

Although Nijkamp refers to monuments as opposed to buildings, a number of similarities should be noted. The business ongoing within a building may contribute to the economy directly, but the extent to which the building itself, and the appearance of that building, contributes to the turnover is difficult to measure.

Nijkamp continues,

> "...we take for granted that the socio-economic value of a cultural good is a multidimensional indicator which cannot be reduced to one common denominator".

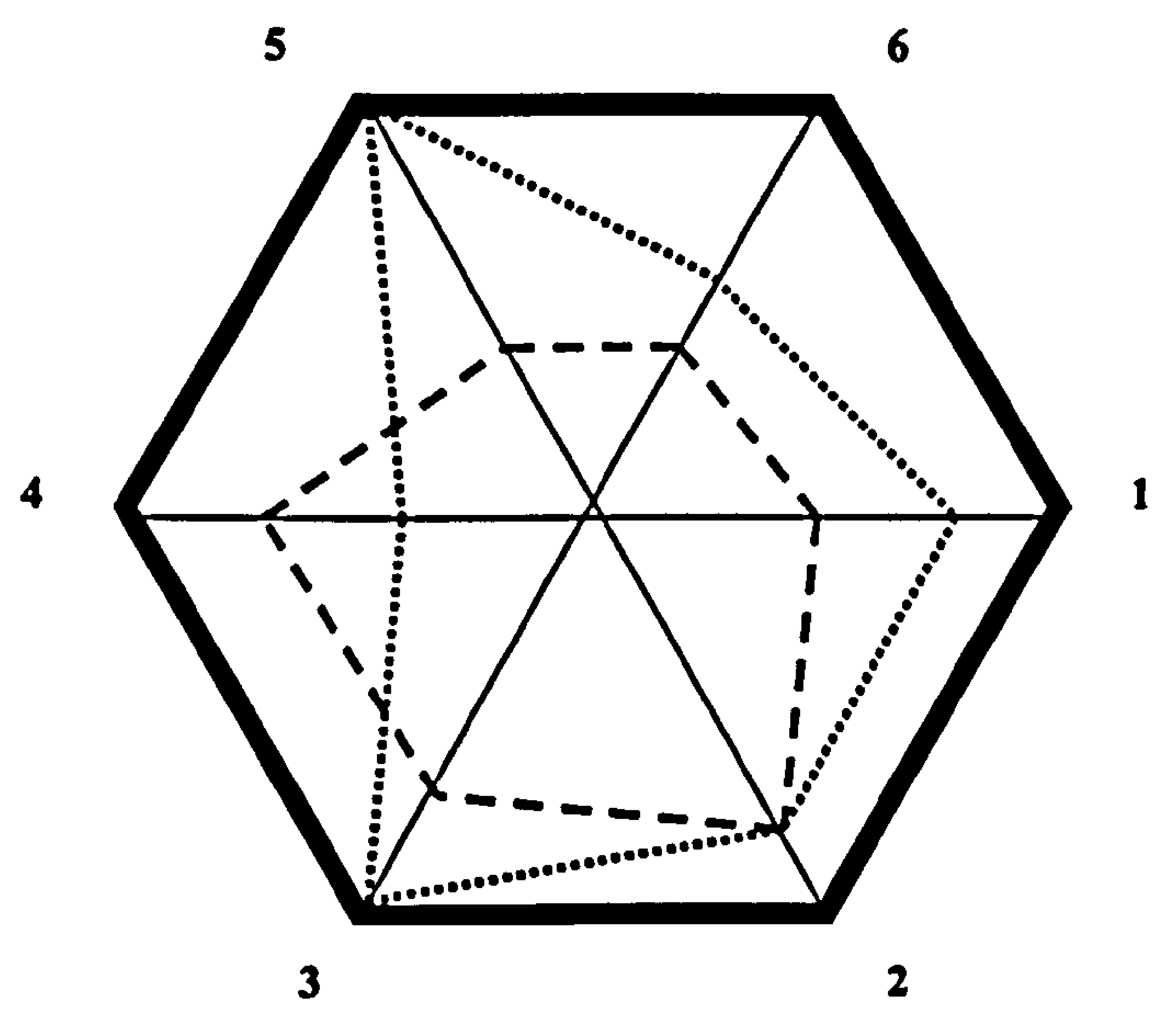
While it is true that the complexity of many situations presents great difficulty in terms of accurate and objective assessment, this does not in itself excuse the researcher from addressing the problem. Rather than relying on the judgement of the Planner to relate the various attributes to one another, a method that more closely related subject areas that are ostensibly incompatible (in terms of their appropriate units of measurement) would be extremely useful.

Nijkamp continues,

> "it is useless to look exclusively at the cost side of monument policy. Monuments have a social benefit, whose (economic, social and cultural) value is related to the history of society, as it is perceived by the present generation (including all direct and indirect users) in view of the future".

Relating this view to stone cleaning, it can be surmised that the large financial input over a number of decades must be balanced against a resultant benefit, or set of benefits. Nijkamp suggests a means by which assessments of the criteria being considered can be represented graphically (see figure 3.1), thus allowing a prioritisation of monuments to take place, in order that the limited funds available for the general maintenance be directed more effectively.

Figure 3.1 - Graphical assessment of socio-economic value



Key

Assessment for building "A" ....

Assessment for building "B" – – – – -

Criteria are numbered 1 to 6, one per axis.

Nijkamp suggests that each axis of the hexagon is allocated a "criteria", and each building or monument then "scored" on the diagram. This approach is interesting in that the scores can be compared both graphically and mathematically. A ranking of buildings is achieved quickly and concisely.

A problem arises in that a number of the criteria suggested by Nijkamp, such as, "uniqueness", and, "artistic value", are essentially subjective qualities[8]. By placing a subjective assessment of these on the same diagram as objective measures for variables such as age and economic revenue creates a false impression that the methodology provides a far more reliable method of environmental assessment than is in fact the case. Indeed, the point at which "age", for example, would become of great importance is debatable. In addition, were a number of buildings compared using this approach, and no one building clearly stood out, a weighting of criteria would be required on the part of the decision maker (Buckley 1988). Although Nijkamp's method recognises that a number of ostensibly subjective quantities must be considered in an environmental value assessment, it should be clear that the solution does not lie in the use of artificially objective measurements. Nijkamp suggests that rather than attempt to measure each attribute using a continuous scale, it may be easier to use a limited point ordinal scale. This method may allow for a faster completion but the placement of each attribute measurement on the scale will in a large number of cases be non-definitive. That is, where the assessment of a subjective variable tends to be inaccurate on a continuous scale, regarding a non-continuous scale as more reliable is flawed also.

[8] Nijkamp suggests categorical methods of assessment which rely on the judgement and knowledge of the model's user. Through the adoption of large scale mapping of a number of buildings, a consideration of such factors as "uniqueness" might well be possible.

By attempting to measure each aspect or criteria as discrete entities, and then amalgamating these measurements, there is a danger that a deeper understanding of that value facet will be lost. That is, the age of a building will in many cases have an influence on condition, and the "artistic value" could well be influenced by the circumstances surrounding it's creation, hence uniqueness. Although considering the variables discreetly does not in itself preclude an appreciation of the inter-dependency, care must be taken to ensure that overall, rather than fragmented, conclusions are drawn. The question of how to ascertain weightings between criteria is not addressed, and possibly relies unduly on opinion (as opposed to fact) to be truly reliable.

The method of assessment represented in diagram 6.1, whilst providing a useful and interesting starting point, produces as many problems of sensitivity and subjectivity as it attempts to solve. Although it is recognised that the method could be employed usefully to structure the comparison of a number of buildings, as suggested by Nijkamp himself (and similar in many ways to the "Planning Balance Sheet", among others Lichfield 1968), the approach is of less use where the two alternatives are the relatively simple "preserve the status quo and do not clean", or "clean and consider the complex system of *potential* effects".

With further development, for example in relation to the definition of criteria, experimentation in the spacing of axis, the approach could become useful in a wider range of contexts. At present, however, it's simplicity is a significant weakness rather than a strength, leading the project towards the consideration of a number of environmental valuation techniques.

3.3.3 Environmental valuation

Stone cleaning has an immediate and obvious effect on the built environment, and can be regarded as an instrument of environmental change. It was essential that the assessment method adopted for this project addressed complexity within the situation, whilst also providing an understandable outcome. Ilozor and King (1998) suggest a range of methods through which non-financial aspects of design in the built environment can be "objectified". Approaches range from the subjective to the quasi-objective (see "contingent valuation", below), and suggest that financial design processes can be made to consider non-financial aspects by presenting all aspects on the same financial scale. It has been argued that natural environments are of value for their aesthetic value alone (Thompson 1995), and the same argument could be applied to the built. The environmental change caused by stone cleaning (including aesthetic change), is a vital part of an overall assessment.

Questions as to whether "objectification" really solves the assessment problem must be raised, in that environmental valuations will in many cases produce a "measurement" of sorts, but more often than not enlightenment will be provided by the reasons underlying such values. Difficulties relating to respondent abilities to actually "rate" personal values have been noted in the past, and methods to assess environmental value must attempt to overcome the difficulty of measuring highly subjective subject areas which the public are rarely called upon to quantify. Mohr and Schmidt (1997) stress that economic valuations consider a far more diverse subject area than "*money and profit*", and the inherent diversity of the cultural heritage must be reflected in the methodology.

Each environmental valuation method carries a number of advantages and disadvantages and can be divided into two sets, namely indirect and direct (Braden and Kolstad 1991, Hanley *et al.* 1997, Pearce and Markandya 1989, Smith 1993). Each available method has been developed and has in time become associated with a range of case study types. As the environmental value associated specifically with stone cleaning has not been addressed in the past, the range of methods was examined with a view to assessing their potential for use in this study. In the following sections, a number of indirect and direct methods of valuation are described, and the appropriateness within this project discussed. As one of the aims of this project was to evaluate the environmental value implications of stone cleaning, the method chosen would form the basis for a major part of the data collection and analysis.

3.3.3.1 Indirect valuation procedures

Introduction

Indirect valuation procedures attempt to ascertain the value associated with an economic good by analysing the response of a buying public to a particular level of effect. Indirect methods are useful where large parts of a population are not consciously aware of an environmental effect, and would therefore perhaps return an unrealistic response if asked to place a value on such an effect (Kahneman and Knetsch 1992, Pearce and Markandya 1989). Pearce and Markandya state "*in general, dose-response approaches are always applicable to environmental problems. That is, if there is some damage and it is linked to a cause, the relationship between that cause and effect is dose-response linkage. This does not mean that* *it can be estimated with any precision: it simply states that a physical relationship exists*". The effects of cleaning would be the "dose", although the "response" variable is less easy to define or even identify.

Indirect methods of valuation have been used effectively in the past to examine the effect of air pollutants on the physical well being of a respondent group, or the effects on property market values (Anderson and Crocker 1971, Ridker and Henning 1967). This was made possible by the fact that established methods of ranking pollutant levels are available to the research team, and that established links exist between air pollution levels, and medical health. Stone cleaning has had a major impact on the appearance of many of Scotland's towns (Webster *et al.* 1991), and this might well lead to an improved feeling of well being in targeted areas. Although difficulties exist in terms of measurement, there are definite indications that stone cleaning might be reasonably viewed as being an instrument of significant environmental change[9].

Stone cleaning can indeed cause damage to a stone surface, and this might in turn have some effect on related property markets. However, a number of possible negative effects of cleaning, including spalling or accelerated weathering, could also be the result of a number of other factors, such as air pollution or basic flaws in the original building design (e.g. poor quality stone, improper design of rainwater runoff zones). In turn, due to the large number of factors other than the condition of essentially non-structural stone facing work which will effect the property markets, it might not be possible to detect and isolate the effect of cleaning within such an equation. Pearce and Markandya.(1989) state, with regard to the use of indirect valuation procedures to concentrate on materials corrosion that,

> "the fundamental problem of benefit estimation in this context is not the determination of the economic parameters, although the procedures for estimating them are not straightforward if a very detailed assessment is required. The difficulty lies in the physical data, notably in estimating the quantity of material that is at risk."

That point is vital in the development of a methodology for this project, as the validity of any conclusions reached would be flawed were the data obtained found to poorly represent the good being valued.

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[9] That is, a significant effect on the perception of aesthetics has been proven to exist (Webster *et al.* 1991), and the preceding chapter modelled how effects might be manifested financially. From this should follow the realisation that stone cleaning must lead to a change in the "holistic setting for society", discussed previously.

Hedonic Pricing Technique

The hedonic pricing technique for valuing (non-market) environmental change operates through the comparison of indicators of that change, with changes in the performance of an actual, surrogate, market. The method involves two distinct stages, namely the construction of an index estimating implicit prices for a good, and the use of that index to estimate the demand for a particular attribute.

Although suffering no flaws of logic, and a statistically significant positive relationship between market (often property) price and environmental amenity was found in many cases (Brown and Pollakowski 1977, Dewees 1976), the method has generated disappointing results when applied in practice (Harris 1981). Harris (1981) voices concern that although such relationships have been identified, a deeper analysis of supply responses from markets, or the dynamics which might operate within markets have been linked with the hedonic results. As a direct consequence of this, the applicability of the method would seem to be compromised. Of what interest is the total "value" in the absence of an accurate and reliable explanation of what factors underpin its magnitude?.

Changes to a stone surface might be manifested in a number of ways, and the 'results of cleaning can be measured and categorised using a number of differing criteria. For example, for the purposes of an hedonic pricing experiment, the magnitude of effect might be categorised using the change in surface colour of the stone. This approach has the benefit that established experimental techniques can be used to measure the colour change, and statistical analysis completed to establish the extent to which such a change is significant (Young 1997ii). The major weakness of such an approach for the purposes of this project is that colour change is not clearly either good or bad. Likewise, changes in the perception of a buildings appearance are equally difficult to "measure".

The selection of a suitable market from which monetary values can be extracted to represent the effects of cleaning presents another problem. The property markets, offering a large amount of data regarding selling prices of properties in any given area might lead to difficulties were they chosen due to the fact that a very large number of criteria might lead to the selection of a property's final selling price. Whilst the effects of cleaning on the property markets could be ascertained through the variable's extraction from the overall valuation process, due to the influence on other key variables including building size, location, intended use, owner and physical condition, the use of hedonic pricing is difficult. The effects of other more prominent variables might statistically mask subtle changes in market price.

The extent to which the market itself (i.e. potential owners and lessees of property) is aware of the effects of stone cleaning is also of great importance. If it were the case that important facts relating to the effects of cleaning were known only by an insignificant proportion of individuals, any apparent links between that markets realised prices and the value of cleaning would be unreliable. For example, were only visual changes considered by a respondent, with no regard to maintenance implications, the estimated "market value" would be misleading.

The hedonic price method,

> "works poorly if the [environmental change] is one whose effects are unclear to the individual affected and which cannot be easily measured or quantified".
>
> Pearce and Markandya (1989)

Garrod and Willis (1991 and 1992) examined the effect of "selected countryside characteristics" on house prices in rural areas. They identify that the method is problematic in that the variables selected to represent and overall good (e.g. colour change due to stone cleaning) and the market observed (e.g. property markets) might in fact measure only that variable, rather than the entire good (i.e. the overall environmental impact). Although the number of variables used for an hedonic pricing study is not critical (Follain *et al.* 1979), and studies have shown the method to produce values similar to those produced by professional house valuers (Dodgson and Topham 1990, Willis and Nicholson 1991), the specification of the variables actually used can be critical (Ozanne and Malpezzi 1985).

Garrod and Willis (1991 and 1992) identified 1km^2 areas within which eight variable areas were noted and recorded. Unfortunately, the rationale behind the variables selected appears rather arbitrary, with "natural" variables such as cover by forestry given equal weighting with "distance from nearby towns". In addition, many variables are either sufficiently subjective (e.g. "potential view) as to make measurement difficult, or no explanation offered as to why they are included at all (e.g. "height above sea level"). Indeed, the variable "distance from nearest urban centre" could arguably lead to both increases and decreases in house price, depending on the personal value system of the buyer.

As Garrod and Willis (1992) recognise, preferences can change over time (citing Kennedy 1979), making the choice of representative "positive" and "negative" variables difficult in the long term. Results obtained indicated that "discrete" variables such as "is there a woodland view?" tended to reflect a more significant relationship with prices than "continuous" variables, such as "what % of the land is wooded?". The results are surely compromised by uncertainties behind the measurement of "discrete" variables", as previous work (Tan 1997) has indicated clearly that visual preference is complex, and cannot be measured using dichotomous choice questions.

Graves *et al.* (1988) suggest that whatever variables are selected, these should be categorised using focus variables (of particular policy interest), free variables (known to affect property prices) and doubtful variables (which may or may not affect prices). It must be recognised that market prices analysed through the hedonic price model reflect market demand, which will not necessarily reflect option or existence values. For example, an area of natural landscape may not hold high a market value, and could even negatively influence market prices nearby, but may be of significant environmental value. Similarly, a building in a state of disrepair may still hold significant environmental value, despite the need for repair works reducing market price. In this respect, the hedonic price model is limited, and would require other approaches to supplement its findings in relation to existence or non-use (option) values.

With regard to stone cleaning, it could be argued that both of these criteria apply. Whilst the visual change in à building might be detected by the respondent, the longer-term physical effects might not be. Therefore, whilst application of the hedonic pricing method with regard to stone cleaning seems acceptable. Although cause and effect have been identified by past research, a methodology through which the data gathered could be linked with reliable indicator variables is unclear, and would require a large amount of work without a guaranteed (or even likely) positive outcome.

Travel cost approach

The travel cost approach estimates the environmental value of an area through the analysis of the time and money expended by visiting respondent groups. The method has been used in the past to estimate the value of natural landscapes, and the recreational benefits which might be derived from those landscapes (Bockstael and McConnell 1981, Chevas *et al.* 1989). In such cases, the entire landscape could be said to be "the good", in that the entire area is being visited. In this project, reasons underlying and explaining travel to an area of the built environment are more complex. Nevertheless, the travel cost approach could well be useful to the current subject, as it is based around data obtainable for most towns and cities.

A range of data must be collected in order for the method to produce meaningful results (Brown and Mendelsohn 1984, Pearce and Markandya 1989):

- travel costs and travel times;
- household characteristics;
- recreational facilities.

A general problem relating to the method is that the data set gathered would relate only to those respondents who did visit a site, and will not contain information on those who did not. Where a site is large, travel time once on the site itself should also be considered (Wilman 1980), and this would apply to many towns and cities (where the effects of cleaning may extend over a large area). This was a significant weakness in relation to this project, as stone cleaning tends to be completed within the city and town centre areas of Scotland, making the cost of travel to many sites either small enough to be negligible, or zero. Where there was a cost incurred, that cost could be attributed to many factors other than the results of cleaning. In such cases, the validity of a data set gathered would be questionable.

Pearce and Markandya (1989) suggest that, *"travel cost methods are a useful tool for valuing recreational benefits in situations where sites are visited by a broad range of users specifically for recreational purposes and where adequate data on the characteristics of the site and the user are available"*. Case studies where an isolated property were cleaned might provide a suitable situation, but the method would require that:

- cleaning was the sole change;
- adequate and comparable data was available for both before and after;
- there were no other reasons for travel to the site other than the building itself.

Generalising one study for all buildings would have weak reliability. Many case studies would, in fact, be required before a useful model for wider application could be developed, making the potential for use in this project unworkable[10]. In addition, the accuracy in terms of amounts estimated has in the past tended to overestimate benefits or underestimate decreases (Brown and Mendelsohn 1984). Issues of accuracy, reliability, as well as time and

[10] Refer to "recommendations for future work", for further comments on this point.

resource limitations of this project made rejection of the travel cost approach inevitable, over and above any methodological considerations.

A number of methods have been used to categorise the effects of cleaning, such as surface roughness testing, colour meter readings, and core sampling to detect changes in the chemical make up of a stone surface. Although each of these methods have been tested and applied in the past, none could claim to represent all the numerous and widespread effects of cleaning which are known to exist. This fact alone means that the use of indirect valuation techniques generally to assess the value of stone cleaning might be unreliable, as the scale to represent effect would inevitably be exclusive to some extent.

The potential for use of indirect techniques in the built environment should not however be ruled out. If a link between an existing market and a reliable indicator for the effects of cleaning could be established, the results would provide both an interesting predictive device and a useful assessment tool[11]. Recent work (Fix and Loomis 1998) reported that the results of a travel cost study and a direct (contingent) valuation study concurred on the willingness to pay (although that study was quite specific in terms of the goods being valued). Previous work (Carson *et al.* 1996) is in agreement with this finding, suggesting that a matching of method to situation, rather than selection of a "generally best" approach, is required.

The compilation of a reliable value indicator is an essential step towards a better understanding of the effects of cleaning, but the extent of previous work concerning value in relation to cleaning has been insufficient to allow the use of an indirect method in this project. It is necessary that other methods be considered.

[11] See "further recommendations"

3.3.3.2 Direct environmental valuation

Introduction

Direct valuation techniques can operate through the use of actual markets, from which the effect of an environmental change can be inferred, or through the simulation of markets for the purposes of experimentation.

> "The surrogate market approach looks for a market in which goods...are bought and sold, and observes that environmental benefits or costs are frequently attributes of those goods ... The experimental approach simulates a market by placing respondents in a position in which they can express their hypothetical valuations of real improvements in specific environments."
>
> (Pearce and Markandya 1989)

The former describes the travel cost approach, the latter the contingent valuation method. The travel cost method is centred around the analysis of established demand and supply relationships in (real) markets, where the relationship being analysed properly represents the environmental change being investigated. With the latter, hypothetical markets are established within which estimates of value change can be made.

Stone cleaning exists within a marketplace where the choice of whether or not cleaning will be implemented is very much at the discretion of the building owner, or investor, coupled with current planning regulations. The wider community response to the results of cleaning is, however, of great importance. Cleaning is an instrument of environmental change where the extent of that change is difficult to measure using a single scale. In such a case, it is usual that the researcher can estimate the environmental value change using direct valuation techniques.

Direct valuation techniques are so named as they ascertain value as an actual estimated figure, as opposed to analysing two distinct sets or variables in an attempt to find some relationship (as is the case with indirect methods). This section includes a discussion of the most commonly used direct valuation technique, the contingent valuation method. The technique attempts to overcome the problems of indirect methods by focusing on the good itself. Whilst this can be criticised for presenting an unrealistic situation, it nevertheless allows a statistical analysis of an environmental effect to be completed, where otherwise only subjective discussion would be possible.

Contingent Valuation Method

Environmental intervention will often require a significant financial input over a period, meaning that as well as the initial cost of implementation, associated maintenance and other costs should be expected over the life span. Therefore, the perceived benefits which might accrue from such finances will in themselves inform the decision making process. The reasons for stone cleaning being completed can be recorded using a number of methods, such as interviews with members of the affected group, or the elicitation of expert opinion. The extent to which the various parties regard the environmental intervention as good or bad is however often unclear and methods which attempt to determine "unbiased, efficient and consistent estimates of the value of environmental goods" (Garrod and Willis 1990) are of great use.

In a contingent valuation study, respondents are typically provided with information about a hypothetical programme, and asked to provide information as to the economic sacrifice they would be prepared to make to ensure the programme went ahead - the "willingness to pay" (Arrow *et al.* 1993). A contingent valuation survey should consist of three elements:

- a description of the environmental change;
- a description of the method of payment;
- a description of the contingent market.

(Hoevenagel 1992)

The method provides a highly flexible framework through which most environmental goods may be evaluated. In addition, the contingent valuation method, by avoiding reference to actual markets (where in most cases only those actually using a good will pay for it), the opportunity exists for existence values to be identified. That is, were a respondent to value the continued existence of an object, environment or building (despite having no reason to believe they might actually use that object), the contingent valuation method can record that response (Garrod and Willis 1990, Grosclaude and Soguel 1994, Stevens *et al.* 1991), and identifying attitudes which might influence the valuation level (Lynne and Rola 1992).

Two concepts of economic value may be assessed through contingent valuation, namely willingness to pay for a benefit (WTP) and willingness to accept compensation for a loss (WTA), both of these based on values held by individuals (Morey *et al.* 1997). The total value of stone cleaning to society is the sum of WTP over the population. Clearly, the population selected to represent "society" for any part of the built landscape is vital.

The results of a contingent valuation are useful when related to the socio-economic background of the respondent group and it is possible to derive conclusions relating to respondent knowledge and motivation within a case study. In addition, it is hypothesised that a representation of society's values derived in this way, compared with a prediction of financial cost and benefit, presents an aggregate that objectively presents an indicator for overall value.

The contingent valuation method requires respondents to estimate their own WTP for an environmental change. Where both a market reflecting the effects of that intervention and a method of "measuring" that intervention exist, the hedonic pricing technique might be more appropriate. Where either one or both of these is absent[12], the contingent valuation method would tend to be used. As an alternative to the surrogate market used in hedonic pricing, a hypothetical market is established for experimentation purposes, and WTP figures registered against that market. In addition to the final WTP or WTA bids, additional information relating to socio-economic indicators for each respondent should also be collected, allowing a regression analysis identifying which influences, if any, are significant.

Concerns as to the reliability of the WTP bids received has been tested in the past, with the major concerns resting on the fact that as no market actually exists, the respondent group will be often unable to estimate such bids accurately or realistically. A number of studies have been reported (Bohm 1972, Dickie *et al.* 1987, Johannesson *et al.* 1987, Willis and Powe 1998) where WTP levels have been tested against actual markets, the results showing contingent valuations to have produced reasonably accurate results. However, other studies (Bishop *et al.* 1983, Neill *et al.* 1994) returned results suggesting a significant difference between WTP bids and actual amounts paid. Neverthless, it should be recognised that the identification of significant criteria on which bids seem to have been based represents a more useful indicator as to the success or otherwise of the method[13].

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[12] For example, "measuring" stone cleaning is difficult due to the variety of ways in which its effects can be recognised. Although it is possible to measure changes in stone colour and texture, no one measurement could be said to represent overall effect. Therefore, unlike with air pollution where agreed levels of certain gases can be said to adequately represent levels of overall pollutant, finding a scale against which an actual market can be gauged is not possible.

[13] By this, the author means that with many projects, where the resources are made available to proceed with a contingent valuation study at all, the chances are against the results being used to veto work progressing. Rather, important criteria to which either positive or negative results are significantly linked would be used to further develop the project itself. In the case of stone cleaning, however, data regarding respondent knowledge of

Of great relevance to this project, a previous contingent valuation study (Willis and Garrod 1991) reported that where the method was related to to changing natural landscapes that bids indicated a favouring of the *status quo*. What Willis and Garrod *actually* found, however, was that intervention to preserve what was regarded as the natural environment was favoured over allowing landscapes to develop naturally. A major criticism regarding this study must be directed toward the information presented to respondents, advising them of possible future landscape appearances. Coloured drawings were presented, and rather than altering variables in the scene in a logical pattern (possibly allowing an iterative analysis), each drawing presented a new scene with wildlife, water, tress and buildings, with alterations occurring in a rather haphazard manner. The stated aim of the images used was to present a range of interventions, and potential economic/ industrial futures for a landscape. Research (Kaplan *et al.* 1972, Tan 1997) clearly illustrates that the visual stimuli provided to allow the assessment of a scene can be altered considerably by the addition or removal of items from that scene, and the results of Willis and Garrod are difficult to gauge for that reason.

Kaplan *et al.* (1972) also found that slides of "nature" were preferred over "urban" slides, and that the difference was not due to complexity in the scene, indicating that the Willis and Garrod approach is flawed. Within this project, cleaning could potentially result in a variety of colour and surface changes (due to stone type, location, shading and cleaning method), so great care must be taken to ensure that any information provided to the respondent does not complicate subsequent analysis of the results.

The gathering of information to supplement the basic WTP bid is essential to the success, or otherwise, of a contingent valuation (McLeod *et al.* 1994). Where either a positive or negative bid is received, that bid can be validated against other co-variables, indicating important value relationships held by the respondent group, and possibly indicating why results are at a certain level.

The contingent valuation method pre-supposes that individuals believe the net utility from a course of action determined whether that action is right or wrong. A public "*operating on the basis of rights or principles*" (Spash 1997) would have cause to argue that a willingness to pay (or otherwise) cannot be aggregated to produce overall value simply because

methods, concerns over funding and longer term effects might be used to determine which buildings should be cleaned (or otherwise) or whether the rationale for contemplating work (possibly aesthetic or social) is justified.

individuals "*holding a rights-based belief system would be forced to adopt a utilitarian mind-set as they answer a contingent valuation method questionnaire*". A failure to respond might be interpreted as a protest bid or as the respondent placing no value on a proposal, or be removed as an "outlier".

Goodman *et al.* (1998) report that some respondents may experience difficulties in assessing environmental values where the "goods" are multidimensional (the example given being the conservation of natural resources). Where an alteration is made to any building, particularly externally, significant changes in the social environment for both residents of and visitors to an area might result, thus producing complex environmental and financial changes. The importance of questions supplementary to the main "bid" is stressed, as attitudes toward funding, prior knowledge and the subject matter itself will influence the bid.

Although the contingent valuation method presents logistical problems regarding control of the hypothetical scenario and the manner is which data is treated[14], where other methods of environmental valuation are not appropriate contingent valuation presents a mechanism whereby otherwise intangible subjects can be assessed with a degree of objectivity.

3.3.3.3 Summary of environmental valuation techniques

The contingent valuation technique appears to present a path through which an assessment of environmental value could be completed for this project. Although a number of potential problems exist, of the alternative methods, a recurring difficulty is how to "measure" soiling against a clearly objective co-variable such as realised market selling price. The contingent valuation method theoretically allows a change in environmental value to be measured through the use of hypothetical markets. The impact of stone cleaning on the appearance and image of the built environment is obvious, although whether this is felt to be of great significance by the general public is still unclear.

The methods summarised above share a common problem in this respect. Where an environmental change both has a significant effect of the recognised environment of the respondent group, and where the link between cause and effect is recognised, an environmental valuation will have greater chance of success. However, the direct valuation approaches in particular may suffer where respondents are either unaware of a change, or

[14] The contingent valuation method, although in theory a clear and direct method of valuation, deals with complex real life situations. Adequate care must be taken in the methodology development and analysis of results to ensure sufficient information is gathered to allow an understanding of that complexity.

are simply ambivalent (Ready *et al.* 1995). Through use of the contingent valuation method, the lack of a discrete "market" can be overcome and the effects of stone cleaning drawn out (as opposed to being embedded in complex cause and effect scenarios). Great care is required, however, to ensure that the survey format does not lead respondents toward an unrealistic valuation.

3.4 Heritage value

3.4.1 Introduction

The concept of heritage, an inheritance from past generations, to be cared by current generations for the future, is of great importance to society. The built heritage comprises of buildings constructed over a long time period, and which have come to symbolise and define a setting for society. Heritage value, rather than existing on an ordinal scale, must be examined through the consideration of public benefit, understanding, respect and integrity (Feilden and Jokilehto 1993, ICOMOS 1966, Parks Canada 1998), with every case by necessity considered separately. The manner in which a building might contribute heritage worth will vary (for example, age, architecture, design, materials, history, and so on), but every building potentially offers such value.

3.4.2 What is cultural heritage?

A number of definitions have been produced in the past to help define heritage, at both a national and international level. UNESCO Article 1 (1972) defines monuments, groups of buildings or sites as follows:

- **monuments**: architectural works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of outstanding value from the point of view of history, art or science;
- **groups of buildings**: groups of separate or connected buildings which, because of their architecture, their homogeneity or their place in the landscape, are of outstanding universal value from the point of view of history, art or science; or
- **sites**: works of man or the combined works of nature and of man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological points of view.

At a national level, work to buildings deemed to be of historic importance is controlled through the Town and Country Planning (Scotland) Act 1972. Buildings considered to be of importance are "Listed" under three categories[15]:

Category A: buildings of national or international importance, either architectural or historic, or fine little-altered examples of some particular period, style or building type;

Category B: buildings of regional or more than local importance, or major examples of some period, style or building type which may have been somewhat altered;

Category C(S): buildings of local importance; lesser examples of any period, style or building type, whether as originally constructed or as the result of subsequent alteration; simple, well-proportioned traditional buildings, often forming part of a planned group, e.g. an estate or an industrial complex, or grouping well in association with buildings in a higher category.

The principles to be followed in selection of buildings relate to the age, designer, the social and economic history, technology, regional variation, association with persons or events or "group value" embodied in the building. The process of Listing a building requires that these criteria be considered, and that a building be Listed at an appropriate category. The generally wide and rather imprecise category heading definitions can be criticised on the basis that where a strong, transparent and robust rationale for Listing is not in place, the impact of alterations to the value which required Listing in the first instance will not be clear. The counter argument to this is that the legislation is designed to be applicable over a large geographical area (i.e. the whole of Scotland, in both urban and rural contexts), and that more prescriptive guidelines would be inappropriate to the diverse range of buildings to be considered. Current (established) approaches to Listing must be considered as part of this study, and appropriate criteria reflected in any assessment procedure developed.

Following these definitions (and in some cases a period of evaluation and designation), the definitions can be used as directions towards a conservation rationale. A heritage resource, be it a building or site, can be of value through the whole, the quality of materials,

[15] Scanlon *et al.* (1994) investigated the effect which the Listing of a building had on it's market value. It was found that whilst costs in relation to the listing (i.e. maintenance and repair) were borne by the owner, society as

workmanship, deisng, setting or relationship to the setting. Where buildings were to become damaged or altered over time, it is quite possible that what remained could become part of a new whole, of different yet equal value to that of the original. Feilden and Jokilehto (1993) state further that the aim of conservation should be "*to safeguard the quality and values of the* [heritage] *resource, protect its material substance and ensure its integrity for future generations*". The manner in which a heritage resource is protected or managed must relate to cultural (identity, artistic, technical, rarity) and socio-economic (economic, function, education, social, political) values[16], all of which it could be argued take account of history, whilst also being concerned with the present and the future.

Within Scotland, Listed Building Consent is required (Town and Country Planning (Scotland) Act 1972) for Listed buildings prior to demolition or "*it's alteration or extension in any manner which would affect its character as a building of special architectural or historic interest*". Where a building is not Listed, but is within a Conservation Area, consent would be required prior to demolition. Planning Authorities must decide what works "*would affect the building's character*", and reference should be made to the original rationale for Listing, if possible (Historic Scotland 1993). Within the legislation, stone cleaning is identified as an alteration and which must be so considered by Planning Authorities. Therefore, prior to any Listed building in Scotland being cleaned,

- an application must be made for planning permission;
- that application will be advertised;
- the local Planning Authority must consider the case (possibly including an environmental assessment;
- the application will be processed, taking no longer than two months.

After two months, the application would either be approved, rejected, or referred to the Secretary of State. Clearly, this process must be borne in mind in any case where a building is Listed, as the time and resource implications of preparing an application (before submission) alone are significant[17]. It is important for this project that the implications for non-Listed buildings are considered, as cleaning will influence not just the appearance of the

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a whole tended to benefit. In areas where many buildings were listed or protected (e.g. Conservation Areas), properties tended to hold their value due to the condition of an "area".

[16] Larkham and Jones (1993) concur with this approach, in that designated conservation areas in the UK are sufficiently diverse as to preclude the use of prescribed technical guidance. A clear approach to good practice is essential, however.

building treated, but the environment of those surrounding buildings also. The proper consideration of how a building contributes to the surrounding built environment (making reference perhaps to the criteria used for Listing, particularly those relating to the importance of grouping), will aid in the consideration of any design process. Legislative controls over cleaning will have an immediate and enforceable effect in many cases, but should be considered prior to all cleaning projects.

The creation of heritage is of importance to this project, and to the understanding of what constitutes heritage generally. All objects (be they artefacts, buildings or even areas) embody material memory, either for individuals or for society at large. Objects with obvious commodity value have been identified as carrying long term worth, but usually only after a personal attachment has been formed with the owner or user (Pearce 1998). Indeed, it is not the natural qualities of an object which lead to value, but the "*relative social attribution of qualities to things*" (Zancheti and Jokilehto 1997). A relationship between gender and heritage preference has also been shown, in that men tend to relate to the instrumental capacity of objects, whilst women favour memorial or affective objects (Csikszentmihalyi and Rochberg-Holton 1981, Pearce 1998).

The emergence of heritage at a personal level is linked closely with the family experience, and at a wider community level, heritage objects, buildings or areas will often be similarly linked to the experience of a community (with a shared collective memory of events and history). Built heritage is created, then, through an active societal process, and a valuation as such will depend upon the values held by people in a society[18] (Snickars 1997). Fladmark (1994) defines heritage as being "*anything from the past that may be inherited, or handed down by tradition, in the sense of an inheritance being passed from one generation to another*". Whilst this definition is "*conveniently broad*", the link between heritage, culture and civilisation is stated, making clear that a social, historical and essentially subject-oriented approach to heritage assessment is inescapable and entirely appropriate.

The dangers of regarding the "built heritage" solely from an architectural or historical perspective at the expense of cultural identity have been highlighted in the past (Hubbard

[17] This factor in itself must be considered prior to the completion of any further "value assessment". If a building is thought unlikely to be granted planning consent for alteration works, an early "decision" to not clean may be logical.

[18] Worcester (1996) found that 74% of over 2000 UK respondents interviewed expressed the feeling that "heritage" was something they loved about Britain. In addition, those who agreed strongly with this notion were identified as social rather than individual in outlook, suggesting that not only does heritage arise from society (as opposed to individuals), but may in time be most strongly accepted by society.

1993). Whilst the value of having an awareness of history and past events in not in doubt, a strong rationale for what should be conserved and for whom is required, unless conservation might run the risk of being branded elitist. To counter that suggestion, Nasar's (1984) contention that familiarity and stability form important elements in the perception of buildings suggests that conservation of the wider built environment may have positive social implications. Although many buildings would have been preserved in the past due to their social or historical importance, there may come a time where such importance is known only to historians, and the tangible social impact has gone. Over a long time period, buildings become part of the urban landscape, and the locus of heritage value may shift (Zancheti and Jokilehto 1997).

The assessment of historical architecture, rather than referring to a personal relationship with a building as suggested by the work of Pearce (1998), or meanings attached to aspects of a design through experiences, is more often afforded a formalised assessment approach (Hubbard 1993). Heritage value can be ascribed or attached to any building, quite independently of the formal design process, as individuals and society will ascribe meaning and value through the course of the building's (and their own) lifetimes. Such socially driven aspects of heritage worth are of paramount importance.

Ashworth (1998) argues that the terms "preservation" and "heritage" must not be regarded as synonyms, as the former describes an ongoing process of protection, whilst the latter has been generated through events in the past leading to individual and collective memories, historical references and the survival of relics (or sites).

Young (1997) notes that the traditional Australian model regards "heritage" as referring to sites, whilst "artefacts" are objects (in the care of museums). It is argued that heritage should really be taken to be the totality (the holistic consideration) of sites and artefacts. After all, the built environment in particular is surely more than just a "sum of its parts". An additional difficulty lies in those items of cultural worth which fall somewhere between the two.

It becomes clear that the personal (clearly non-academic) contributions towards a "meaning" of heritage are of at least equal importance to the definition of formal, universal criteria. Indeed, although it may be possible to derive approaches through which heritage can be "assessed", those approaches may need re-definition depending upon the application, or even time of application (Graham 1994, Hubbard 1993, Kearns 1982, Snickars 1997).

Regardless of a building's architectural merit, all buildings symbolises to some extent a transient period in time, and contribute to an "*ultimate sense of place and reflect community*" (Smith 1974). In terms of scope, depth and definition, Davidson and McConville's (1991) definition of heritage as "*what we value in the past*" appears desperately limited.

Conservation of the built environment must be regarded as "*an important means by which groups can maintain their socio-cultural identity, as familiar objects indicating shared cultural values are more important than unfamiliar or foreign objects in creating*" a sense of place (Hubbard 1993). In addition, since every heritage resource can been created from unique circumstances, all cultural resources (be they buildings, sites or objects) are essentially non-renewable[19] (Feilden and Jokilehto 1993). The townscape is important with regard to its stabilising power at a personal and group level, and that stability should extend between generations.

Stone cleaning offers benefits in terms of the appearance and colour of stone, but also has the potential to inflict considerable damage on built facades. Damage to stone can be repaired, and the financial costs of such work can be budgeted for. It might also be the case that where the colour of a building is lightened by cleaning, and the perceived visual value increased, that damage in the longer term would become disassociated with the cleaning operation and thus "missed" by an environmental assessment. Neither of these scenarios considers the effect on heritage.

Alterations to a building (such as re-dressing to make good damage from cleaning, or the cleaning itself) it could be argued reduce the integrity of a building, and thus its heritage worth. Likewise, where short-term visual gains give way to long term physical costs, the heritage value (intrinsically long term) is reduced irretrievably. A similar difficulty is faced through the management of many heritage sites, where dangers may result in the site no longer being available to the public - to those whose heritage is embodied within (Carter and Grimwade 1996). A balance must always be struck between protection and ensuring the heritage is apparent to the society it seeks to serve. Nevertheless, the desire to communicate the worth of a site, building or object of heritage value should not override the basic need to manage the continued preservation for future generations.

[19] For example, where a building has been destroyed or damaged, rebuilding or repair work may help recover the structure, but cannot recover the original heritage.

Three main reasons for conservation have been identified (Snickars 1997):

- historical;
- aesthetic;
- social.

Historical motives suggest that the built environment should be preserved simply to record what that environment was like in the past. Historically, buildings were preserved for mainly utilitarian reasons, but as the designed life of new buildings has decreased, and user needs and technology developed, that rationale has lost some credence. This approach does, however, facilitate the incorporation of the values and approaches of society to be preserved and applied anew in future designs.

An aesthetic approach suggests conservation on the grounds of visual perception - of "beauty". Unfortunately, this approach is largely subjective, and it may prove difficult to produce reliable indicators applicable over many building types, or even materials.

A social approach to conservation links with the findings of Nasar (1984) and Pearce (1998) in that the built environment has the capability of helping ensure stability, whilst embodying social experiences, memories and values. Consideration of "heritage" from an architectural and non-social standpoint would fail to understand the importance of society and individuals to the creation of cultural resources (Feilden and Jokilehto 1993, UNESCO 1976).

For conservation to be truly effective, these motives must be considered in parallel.

3.4.3 Assessment of heritage value

Financial, and to a certain extent environmental, value can be measured using a definite scale, where magnitudes of effect can be charted accurately (or as accurately as the available information allows). This in turn permits the assessment of value in relation to certain aspects of the overall value system to be assessed for individual cases.

Heritage value by its very nature is less easy to quantify, due to its being an essentially non-market good[20]. Although the subject of heritage can be approached from the perspective of use, option and existence values (Darvill 1994), as with other areas within the value system the relative difficulties concerned with measuring the vital aspect of existence value precludes the use of wholly objective assessment mechanisms. In addition, the merits of a system where heritage value is quantified in some way must be brought into question by the importance of social pressure and current opinion. Even where it is possible, through the observation of trends over time, to establish definite criteria for important heritage buildings or monuments, actually assessing the extent to which value exists is difficult. Therefore, attempts to measure "changes" in heritage value begin from a point where such value is regarded as intrinsic.

Value of the built heritage must be capable of being asserted, so as to ensure that important parts of that heritage are not needlessly lost or damaged[21]. Social, economic, political and scientific aspects must be balanced (Snickars 1997), before the conservation process can be regarded as successful. Heritage values, how they are formed, and how they can defined, are central to the planning process, and should as such be incorporated into the decision making process (Zancheti and Jokilehto 1997).

Historically, conservation has often been argued as being preservation by the many for the few, or regarded simply in terms of the cost to society. As Lichfield argues (1998), though, striking that balance may not require an onerous burden on the financial part of the value system. Preserving the cultural built heritage at a wide level can contribute to the "creation

[20] See, also, discussions by Lichfield (1998) and Hewison (1987), wherein the potential economic benefits associated with "heritage" are discussed.
[21] Indeed, as Kozlowski and Vass-Bowen (1997) state, rather than being concerned as to what *is* cultural value, a mechanism through which such value can be assessed in required as part of the planning process. Otherwise, there is a clear danger that parts of the cultural heritage will be lost. After all, buildings that might contribute to a socially centred heritage will not necessarily be protected formally through Listing.

of wealth in its broadest meaning, and as a socio-economic contribution to the welfare of the community" (see also, Ashworth and Tunbridge 1990).

The application of a scaled measurement of heritage value is prone to the problem that even small changes in the surrounding environment, or the building itself, can lead to great differences in the outcome. Thus, the assessment of such changes relying on a clear understanding of the cause and effect of heritage. Of importance, also, are the views and motivations of the population, whose support for continued conservation and preservation of areas of the built environment may suggest a way forward.

A clear understanding of both the methods of preservation available to conservators of the built environment, and the rationale through which "heritage" is assessed and defined should be developed, and understood to be useful (Ashworth 1998). Whilst methods and approaches exist which can preserve the built environment, the justification for doing so is vital. Whilst some cases might suggest an intrinsic worth as being sufficient to justify continued protection, the value of preservation must be dependant upon the worth of that building to future generations. The treatment of "heritage" as a commodity can perhaps be justified where a communication of information takes place. Where the building embodies little information from the past, the location of heritage value is uncertain.

It is argued that:

- Those buildings from the past which exist now, exist only due to a number of intervention decisions made through a variety of planning and maintenance procedures, by a number of both private and public sector parties.
- Conflict between involved parties regarding the suitable treatment of "heritage" is often predictable.
- A co-ordination of effort is therefore required to ensure that the complex system of motivations, varying between bodies, does not interfere with the well being of the "heritage".

This project understands that the user of a heritage assessment model may have unpredictable or even conflicting motivations. What is essential is that space is allowed in the model for those motivations to be expressed as a part of the assessment.

3.4.3 Methods of assessment

3.4.3.1 Introduction

The consideration of how cleaning can affect heritage is central to the consideration of any cleaning work proposed, and not just where the building(s) affected are regarded as being of great cultural significance in themselves. Cultural value is an area of this project, and any other considering an holistic approach to value, where difficulties are experienced trying to objectify the benefits. As discussed elsewhere in this chapter, methodologies available to measure environmental value must be matched closely to the subject matter to ensure meaningful results.

Cultural activity or artefacts rarely contribute directly towards an economy, instead usually representing part of a larger good to be exploited through retail or tourism gains. Difficulties presented to the decision-maker relate to both whether existing data can be used to measure aspects of "culture", and whether the assessment requires a value to be placed on one property, or rank a number of properties. Economic valuation of the built heritage, as discussed, tends to find itself based in the present, rather than being able to ensure adequate consideration of the past, or indeed a suitably far sighted regard for the future. Whilst economic valuation is a suitable approach to determine the immediately perceived social/ environmental value effects of a changing landscape, the rich influences contributing toward the creation of heritage cannot be reflected through such approaches[22].

Nijkamp (1995) offers the following possible approaches to the assessment of the cultural built heritage:

- monetary analysis;
- adjusted monetary analysis;
- point system;
- adjusted point system;
- compound score method;
- decision support method;
- generalised regime method.

[22] Stabler (1998) argues that economic valuation would be a suitable method for assessment of the social and economic value of conservation. Whilst it is agreed the results would undoubtedly be interesting, other than allowing a justification (or otherwise) of conservation budgets, the benefits towards an understanding of why, or what, conservation should be continued would be limited.

Each of the methods has been developed to allow the assessment of value in a variety of circumstances, and for a number of reasons. As with the methodologies available for the assessment of environmental value, not all of the approaches are suitable for use in relation to stone cleaning, and the potentially applicable methods may provide little beyond a basic framework. Stone cleaning has a range of both positive and negative effects, which may affect heritage value. Most of that effect will be limited to the facade on which work is completed, so where the heritage value of a building lies in its interior, or some element other than the stone treated, the overall effects of cleaning appear to be proportionally reduced. Therefore, the root of a building's heritage worth must form the root of the assessment.

Each approach is discussed in turn, and the advantages and disadvantages of each to this project highlighted. These methods are of great importance in that they signpost a direction towards a deeper understanding of the challenges facing conservation planning strategies (Nijkamp 1995). Any similarities existing between the methods described and the approaches to environmental economic assessment are noted.

3.4.3.2 Monetary analysis

Monetary analysis involves what is essentially a cost-benefit analysis. As discussed earlier, direct monetary analysis in relation to stone cleaning is difficult due to the non- market basis of many of the outcomes. Mansfield (1988) and Newby *et al.* (1991) explored the economic implications of stone cleaning, basing their study on the market reaction to environmental standards. A prediction was made that a growth in the stone cleaning market would make apparent the benefits of reduced air pollution, thus leading to greater public support of pollution controls, and to a greater longevity in the aesthetic results of cleaning.

Whilst it is recognised that both studies concentrate on the potential financial effects of soiling, rather than the removal of that soiling, the studies failed to take any notice of the potentially negative effects of cleaning. For example, the "economic" benefits arising from an increased incidence of stone cleaning might well be balanced by corresponding (or greater) increases in biological growth or rates of stone decay. Current attitudes toward repeat cleaning (i.e. that repeat cleaning indicates a poorly implemented cleaning strategy in the first instance) are therefore contradicted. The overall value assessment methodology envisaged by this project inevitably required a fresh approach the subject, taking adequate account of both the longer term effects of cleaning, possible damage in the short term, or any wider implications which these effects might have.

The monetary analysis approach to heritage assessment cannot, however, be ruled out due to the failure of that previous study to produce an adequate overall assessment. That study was completed at a time when some important publications in the field of cleaning were either just becoming available or had not yet been published (Webster *et al.* 1991, Andrew *et al.* 1991, Young 1997). Had they been available, those publications would have indicated a wholly positive assessment of cleaning to be flawed. It is recognised, however, that the link made between environmental concern, airborne pollution and stone cleaning is clear, but that the apparent solutions offered by the latter must be balanced against possible damage to the built structure. Reductions in airborne pollution, rather than dealing with the consequences of increasing levels, would surely be the more logical approach.

Nijkamp recognises that a monetary analysis of heritage value may be flawed in any case, though, as a large part of the heritage system is un-priced in market terms, thus making the importance of "dummy" prices unacceptably high.

3.4.3.3 Adjusted monetary analysis

Lichfield (1987) recognised the failings of a straight monetary analysis, and suggested an approach through which some barriers could be overcome. Commercial values relate mainly to "real estate transactions", which will be dealt with in chapter five, and the costs of stone cleaning extend beyond initial costs toward long term maintenance considerations. Changes in maintenance requirement as a result of cleaning are reflected in the commercial values attributed to the buildings affected. Linked closely with those commercial values, though, are cultural considerations, which may not be adequately reflected in market prices or transactions, but which in many cases will be of equal or greater importance. Short-term financial costs may seem insignificant if they lead to the protection of heritage for future generations. Likewise, saving financial costs in the short term may lead to greater social costs in the future if heritage artefacts are lost as a result.

The method of assessment suggested by Lichfield suggests the appraisal of a number of cultural artefacts, each of which are scored in terms of minimum intervention, rehabilitation or restoration. Scarce financial resources can then be directed toward the projects that are deemed most in need of assistance. In a similar vein to the approach suggested by Nijkamp

(1987) described in section 3.3.2, Lichfield's approach is highly dependent upon expert opinion being correct. It produces not a "measurement" of effect, but instead a ranking of buildings or monuments.

For this project, such methods are of interest in so far as the elicitation of expert opinion is concerned, but of little use where the cleaning of single properties is to be considered. A method is required through which the heritage effects of cleaning individual buildings can be defined, where the question as to whether cleaning will present an acceptable level of risk can be better addressed.

3.4.3.4 Point system

The point system approach to building appraisal was first suggested by Crompton and Lichfield (1962) and operates through a "scoring" based on pre-determined criteria. The definition of those criteria, and what might constitute a high or low score of each, is open to considerable debate. At this stage in the thesis we must consider the place of stone cleaning within the overall heritage system. Where entire buildings are assessed to determine their heritage importance, many parts of the building unaffected by cleaning will be considered. There is a danger, therefore, that if the point system criteria chosen for this project reflects the entire building, rather than those aspects which could conceivably change due to cleaning[23] that the assessment will produce a measurement which suggests a lesser potential change than is the case. Weightings between criteria might also have a great influence on the outcome.

The great advantage of the point system is that it produces a "measurement" for any given situation, but the disadvantages and difficulties cannot be overlooked.

3.4.3.5 Adjusted point system

The adjusted point system is in reality a development of the point system, originally devised by Melhorn and Kellor (1973) to allow an assessment of natural landscapes. By presenting a list of criteria sub-divided into three sub-groupings (physical, biologic and human use), an "assessment" can be completed. Although Nijkamp (1995) states that the method can "*easily be used for cityscape evaluation*", the converse seems undeniable, in that complexity of

[23] Clearly, if cleaning led to a great increase in overall financial value, that could in time be reflected in the internal as well as the external quality. Likewise, were the environmental value to increase significantly as a result of cleaning, areas not specifically "cleaned" might benefit. Thus, the use of a point system concerning the whole building could over time assist in the production of an informative database of heritage value.

human use of cityscapes are greater than with natural landscapes. In addition, the method of evaluating each criterion in the study presented by Melhorn and Kellor presents no weighting between criterion (so, for example, water colour, erosion and land use are equally important to the overall assessment). Difficulties arise whenever weightings are introduced as it is difficult to ensure that weightings are reliable.

Nijkamp (1995) expresses concern also as to the transformation of ordinal scores into cardinal indices, where the following extract illustrates his point:

Table 3.2 - Adjusted point system scoring examples

Category	Evaluation 1	2	3	4	5
Erosion of banks	Stable	-	Slumping	-	Eroding
Land use	Agriculture	Recreation	Urbanisation	Recreation and urban	Agriculture and urban

The first category clearly requires the assessor to place the evaluation on a scale where 1 would represent stability, with 2,3,4 and 5 moving towards increasing instability. With the second category, the evaluation numbers do not represent developments as the numbers increase, making the usefulness of an aggregation uncertain[24]. Where the weighting of criteria could be based on an established body of knowledge, and the approach to evaluation numbering standardised between criteria, it may be possible to overcome this problem. As with a point system, this method offers the possibility of a discrete measurement for any given case, and cannot be disregarded.

3.4.3.6 Compound score method

Kalman (1980), focusing on the cultural built heritage in Canada, presented a development of the Point system. The advantage of this method over the others discussed so far, for this project at least, is that it was specifically designed to deal with the built heritage. In addition, it does not attempt to assess such a wide range of subject matter so as to marginalise the importance of any. The method operates through the division of heritage value into five sections, namely architecture, history, environment, usability and integrity. Each of the basic criteria is then allocated weighting, with the total of these weightings

[24] Where a large number of buildings were to be surveyed using this method, it might be possible to complete a regression analysis between the ordinal variables and criteria where the assessor much choose an option, but where isolated buildings are to be assessed using the method, regression is not possible.

equalling 100. An assessment of sorts can then be completed, with each criterion sub-divided further (e.g. "history" could be sub-divided into "person", "event" and "context").

As with the adjusted point method, this approach has the advantage that a "measure" of heritage value is provided to the assessor, although the same problems of objectivity are present. For example, the basic areas of criteria are weighted, as is proper considering that they would be unlikely to carry equal weight to the decision-maker. However, no assurance other than "expert opinion" can be given that the criteria are appropriate, or the weightings accurate. For this project, it was recognised that the physical and visual effects of cleaning might influence only certain areas of a building, but that clear physical effects are known. The generation of weightings and the criteria themselves could thus be based in those physical effects. If deemed necessary, an assessment of the heritage effects of cleaning could take the form of a two-stage process, considering a building as a whole, and also just those aspects that might be physically influenced by cleaning.

For example, where the majority of a building's heritage value lies in the interior design, stone cleaning of the external facade may well damage the stonework, whilst leaving much of the heritage value intact. In such a case, the decision of whether to continue with cleaning would lie with the financial and environmental value assessments. Conversely, if the stonework of the external facade represented the bulk of heritage value, any damage to that facade (even if justified through financial gains offsetting potential maintenance increases) would represent an unjustifiable loss in heritage.

This method suggests an approach to heritage assessment that allows buildings to be considered in isolation, and provides a discrete "measure" of the heritage change that might be caused by cleaning. The major difference between the model's previous uses and the current project was that the where the model is being used to assess the current heritage worth of a building, the assurance exists that known information is being used to generate the assessment. With stone cleaning, whilst a "current" (or "before cleaning") assessment is based on observed circumstance, the "future" (or "after cleaning") assessment must be based at present on a projected likely cleaning outcome[25]. Providing care is taken to ensure that the criteria chosen are based in known facts regarding the effects of cleaning, and that the measurement scales are representative of the potential for damage, the compound score method was identified as having the potential for use in this project.

[25] As mentioned previously, work currently ongoing at The Robert Gordon University, Masonry Conservation Research Group, will clarify this situation.

3.4.3.7 Decision support method

Nijkamp (1995) reports the work of Anselin and Talin (1984), structuring the decision-making process in relation to the built heritage. The approach is innovative in that community preference is included as part of the assessment itself, rather than the assessment being based exclusively on data collected, expert opinion and previous findings. The chain of data collection, decision and placement of the case study within the context of an urban district, with the associated concerns of resident opinion (delineation). While providing the decision maker with a structure within which to make an assessment, no assistance is offered regarding the assessment itself. In addition, the importance of buildings that form part of the "built heritage" may not necessarily be identified as such through consultation only.

3.4.3.8 Generalised regime method

Nijkamp (1995) reflects that there is a need for an integrated cultural and functional economic urban development strategy, recognising that heritage can produce benefits to balance costs (e.g. financial costs incurred through continued maintenance).

The generalised regime method is mechanism through which a number of urban districts, buildings or group of buildings can be critically compared and ranked. The method differs from the adjusted point system in that rather than dividing the criteria into physical and human use, the areas considered fall under that headings of socio-economic profile (w1), geographical-environmental profile (w2) and cultural-architectural profile (w3). In the example presented by Nijkamp, 11 urban districts are compared, and for each of 12 criteria ranked from 1 to 11. Following the completion of all 12 "assessments", the ordinal ranking of the districts in terms of w1, w2 and w3 can be determined. Depending on which area of assessment is deemed to be the most important, a "definitive" ranking of districts can be drawn up.

Obvious problems with this method involve:

- the definition of criteria;
- the reliability of rankings used;
- the usefulness of the rankings produced.

The correct definition of criteria is essential, in that criteria which either poorly reflect the complexity of a case study, or which give undue importance to parts of the value system, will produce unreliable results.

Related to this problem is the reliability of the rankings produced. Where subjective decisions are required to be made in a repetitive manner (in this case 11 districts x 12 criteria = 132 instances), can it be guaranteed that a different assessor would not produce entirely different results? Certainly in relation to stone cleaning, where the predicable effects of cleaning exist not as discrete figures but as possible ranges (of both timing and extent), the danger of errors entering the frame is high. The possible use of risk modelling techniques (such as the Monte Carlo technique) to reflect this in the rankings could be considered, but the following point makes this seem rather fruitless for the current project.

The usefulness of ranking a number of outcomes, or the effects of cleaning on a number of buildings might be of use in other circumstances, but for this study the requirement is that an assessment for individual properties is produced. For example, a ranking could be produced for ten buildings, where the "best" represented no heritage value loss resulting from cleaning with the ranking showing a progressively poorer result. The lack of any indication of the point at which "loss" becomes unacceptable, or any indication to tell the decision-maker the extent of effect, reduces the usefulness of ranking considerably.

For this project, a method of assessment was required which both produced results from one sample building only, and recognised the importance of financial and environmental assessments completed elsewhere.

3.4.3.9 Discussion

As illustrated in the foregoing, much of the literature concerning the evaluation of the built heritage is concerned with obtaining a ranking of buildings or sites, to enable a prioritisation of funds to be both equitable and philosophically robust. With regard to stone cleaning, other than in the situation where a number of buildings may be cleaned, and where the funding and control bodies for the group of buildings is constant, it is likely that a decision as to clean or not will concern a sole property. Therefore, knowing the position of a building within a ranking of, for example, buildings in the same street or area does not in itself aid the decision process. The possibility that all buildings considered in the ranking should be cleaned (or otherwise) could not be ruled out. Therefore, a method is required through which individual buildings can be assessed without a need to assess other buildings also.

Assessment of a building's heritage worth includes by necessity a degree of uncertainty. Protection of buildings which have been Listed, due to established historical importance, is enforced by statute (Historic Scotland 1993), with stone cleaning recognised in Scotland as an alteration requiring planning consent.

This thesis gives consideration to the physical and aesthetic effects of stone cleaning. When considering the heritage value implications then it is necessary that the assessment process is rooted in the implications of those proven effects of cleaning. Philosophical concerns may still be addressed, but should be rooted firmly in a strong decision making structure. Likewise, the framework may be modified as necessary to allow the inclusion of expert opinion or developing research. Every building presents a unique case, but this does not preclude the use of a consistent approach to value assessment.

The compound score method suggests an approach whereby the heritage value of a single building can be considered in isolation. For the purposes of this project, the basis for that approach was ideal as constraints on project time did not allow for ranking large numbers of buildings, and the associated analysis of the rankings produced. In addition, cleaning is more often than not completed where individual buildings are being cleaned, rather than entire streets or areas. The aim of the heritage assessment is to develop a method through which the known physical effects of cleaning can be related to heritage considerations. That assessment forms a vital part of an overall value assessment, as the heritage implications of cleaning must not be allowed to become overridden by temporal financial or environmental gains.

3.5 Systems thinking

3.5.1 Introduction

The preceding sections illustrate how a range of methods are available to assist with the assessment of various aspects of value, but show also how the factors affecting each are often common, or difficult to define[26]. Checkland (1985) describes how a "*rational intervention in human affairs*" faces difficulties due to a changing environment, and a grounding not in theory, but in a continual developmental cycle between theory and practice (Jackson 1993). The initial grounding of an intervention is difficult to define, as it may lie in methodology and/or theory. Previous work dealing with the assessment of quasi- discrete areas of value has been identified, although a framework through which an overall assessment could be completed is lacking. Ilozor *et al.* (1997) suggest that a "least-cost" assessment and "*aesthetic value estimation*" are completed, and the results considered together. Whilst this seems, acceptable, no mechanism is suggested in their work through which such a dual consideration could be completed.

Systems thinking provides a framework within which complex or diverse real life situations can be modelled. Simply breaking down a complex situation into a number of parts will often fail to preserve the "*essence of the system and expose the mutual interaction of its parts*" (O'Regan and Moles 1997). Systems thinking attempts to solve complex problems whilst avoiding an unrealistic simplification of the complexity itself. The development of systems thinking falls broadly into two categories, "hard" and "soft" systems.

3.5.2 "Hard" systems thinking

Hard systems thinking is concerning with the reduction of any activity to a goal-seeking scenario. Ackoff defines the approach thus:

> "All problems ultimately reduce to the evaluation of the efficiency of alternative means for a designated set of objectives."
>
> (Ackoff 1957, ref. In Checkland 1985)

The measurement of **efficiency** against **objectives** drives work within hard systems thinking, within which a clear definition for both is required. An obvious problem with this approach,

[26] For example, the *location* of a building might influence financial, environmental and heritage value.

if applied to an holistic value system, is that the definition stage (of problems and solutions) may prove difficult to generalise, and that the relationship between areas (Checkland 1985) of value may in fact be more important than the "measurement" of value[27].

Goal programming is useful in that where both the problem and ideal solution are clear and unchanging, the method provides a quality assured framework geared towards the attainment of certain end points. Unfortunately, the goal programming approach, whilst founded in a pseudo mathematical base, can be approached from a number of perspectives (depending on calculation, variables used, data available and assessor). Whilst a measured outcome will result, different methods may produce different results of rankings (Hartog *et al.* 1989), leaving the decision maker with no clear solution. Although it is possible for the decision maker to incorporate preferences or aspirations into a model before running (Martel and Aouni 1990), there is a clear danger of results becoming skewed from the outset rather than allowing for the formulation of a value judgement.

Where an "ideal" end point is unclear or subjective, a value judgement cannot realistically be aided by the method. In addition, where aspects of the value system were to act beyond the logic confines of the value system, hard system models will inevitably result in a lack of analytical depth.

3.5.3 "Soft" systems thinking

Soft systems methodologies provide a mechanism through which a decision making process can be structured and managed. Checkland (1981, 1990) describes the approach as being "*based on systems thinking, which enables it to be highly defined and described, but...flexible in use and broad in scope*". Soft systems thinking can be seen as

> "an orchestration of the operation of an appreciative system in a human situation perceived as problematical."
>
> (Checkland 1985)

In other words, the soft systems approach assumes that the situation to be modelled is problematic, but that relationships or processes within that situation can be modelled. Soft

[27] Checkland (1985) offers chess as an example, where the clear aim is to win the game, within a set of rules. There is no ambiguity as to either the method or ideal end point, so the game is ideal for goal programming.

systems methodology is defined by a number of important characteristics, which should feature regardless of the application:

- investigation of a "problem" situation moves toward taking action in that situation;
- the system being modelled is clearly defined, along with the perspective to be taken by the user;
- conceptual models of the system are drawn and developed, and precede activity;
- once applied, comparison of the model with reality to allow revision/ re-definition/ refinement.

The final stage is clearly the beginning of a cycle, in that the system should evolve continually to reflect results and experience. This can be seen as both a strength and weakness, in that the continual critical process of system revision should result in the model improving over time, but that the model is unable to produce final and definitive results. Although the latter would be viewed as a clear deficiency in hard systems thinking, it could equally be argued that real-life situations offer definitive answers rarely, and that reflecting this in the output simply takes a realistic approach. Rather than concentrating on the objective features of the real world, the soft systems approach relates rather to the mental construct of the user. Rather than being a problem which in itself would be likely to lead to inaccuracy, provided this approach is grounded in a reliable procedural framework then complex (and often non-objective) scenarios are easier to consider.

The complex nature of the value system to be considered in this project dictates that whilst areas could be objectified and measured with apparent accuracy, the reality is that the demands and views of society are in constant flux. The value system associated with the built environment, therefore, is varying also, and requires continual monitoring and adaptation. A method is required to manage this change, and soft systems methodology provides a possible solution.

Smyth and Checkland (1976) suggest that the acronym "CATWOE" can be used to formulate definitions of process. CATWOE is broken down as follows (with definitions relevant to the current project provided by the author):

- **C** "customers" - parties involved with, or affected by, the transformation
- **A** "actors" - stone cleaners, specifier of method
- **T** "transformation process" - removal of soiling from facade
- **W** "Weltanschauung" - "world view" - removal of soiling can lead to aesthetic benefits (possibly more far reaching benefits also).
- **O** "owner(s)" - building owner, occupant, perhaps wider population
- **E** "environmental constraints" - planning controls over completion of stone cleaning. Completion of test panels where building Listed, to protect against possibility of damage.

This approach to definitions is used to ensure that the relevant factors and parties are included in a "root definition" of the system or problem. A root definition developed using the CATWOE breakdown, in relation to stone cleaning and value change, would read:

> "A value protection mechanism, where soiling may be removed from the stone facade of an owner-occupied building, in order to realise aesthetic and other benefits, whilst avoiding the potential for loss of value."

It is also important that we understand the meaning of "transformation". This can be illustrated as:

Figure 3.2 - Soft systems transformation process

Input	$\longrightarrow$	**Transformation process**	$\longrightarrow$	**Output**
(some entity)				(that entity in a transformed state)

(Checkland 1990)

The assessment of overall value tends to be overlooked due to areas of specialisation tending to focus on certain areas only. It was felt to useful that a CATWOE analysis be undertaken for the overall value assessment, complete with a root definition and monitoring and control system. In addition to providing a theoretical framework for the assessment mechanism, monitoring and control features are automatically suggested.

C- customers:	owner/occupier/public
A- actors:	stone cleaners/ specifiers
T- transformation:	soiled building $\longrightarrow$ non-soiled building
W- worldview:	optimisation of value from stone cleaning
O- owners:	decision-makers
E- environmental constraints:	a positive amalgamation of financial and environmental value, vetoed possibly by an unacceptable risk to heritage

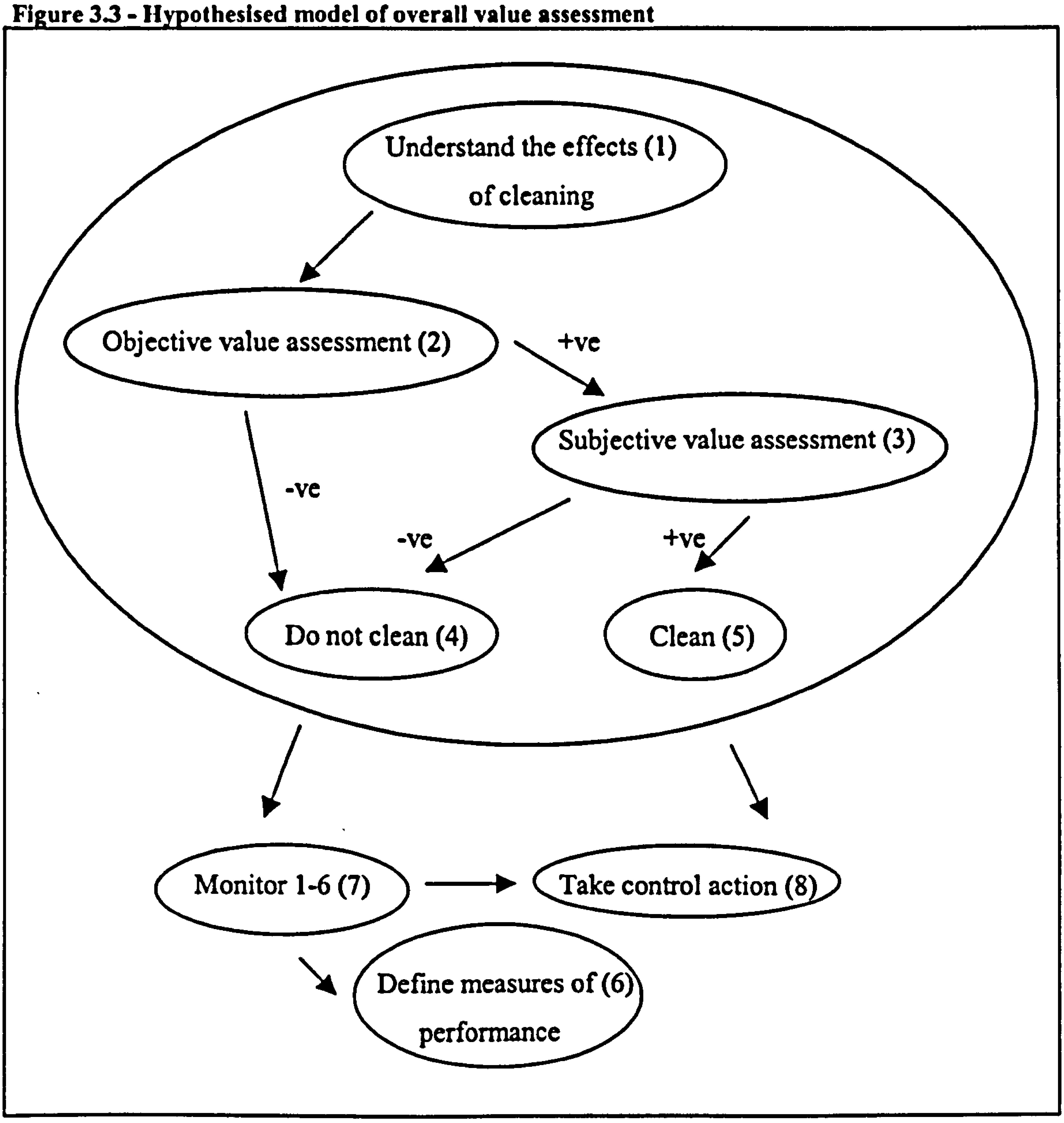
A root definition of the overall value assessment reads as follows:

> "An overall value assessment mechanism, where soiling may be removed from the stone facade of a building, in order to realise a number of associated benefits, providing that those benefits are not unacceptably compromised by value loss."

The model for this root definition is shown in figure 3.3.

This approach reflects the root definition and allows for the application of methodologies or modelling approaches developed in or from the literature. That the model could be applicable at a practical level was recognised as being important, thus facilitating "robust decisions" as aimed for in the hypothesis.

Figure 3.3 - Hypothesised model of overall value assessment



3.5.4 Discussion

The relationship between "hard" and "soft" systems, although not always clear, lies in their joint application. Checkland (1985) argues that soft systems reflect the general, widely applicable, situation, whilst hard systems may occasionally be used to satisfy part of a soft approach. The preceding discussion of how soft systems might be applied in the context of this project serves to illustrate this point, in that the central "activity" stages begin with a financial modelling exercise, and move towards progressively "softer", more subjective areas of value. The "goal" in a financial model (to produce a financial benefit, of a certain magnitude in some cases) is no clearer than with heritage assessment, but is certainly easier to "measure".

The modelling of complex real life situations has developed from hard to soft approaches, although in reality one (hard systems) has become (or can be regarded as) a sub-system of the other.

3.6 Summary

This chapter has provided a number of reference points for methodology developed in chapter four. Previous work has not considered stone cleaning from a value perspective, but rather suggests a number of starting points (often the physical effects). It has been shown that previous attempts at "building evaluation" must be regarded with suspicion, as the complex issues involved have tended to suffer from over-simplification. The literature review focused instead on approaches toward the assessment of areas of value, before returning to consider a method through which an overall assessment might be structured,

Previous work concentrating on the assessment of financial values within the built environment is well development with regard to structure and method. As with any objective method of assessment, however, the quality of data for use in a model is essential in the reliability of the output. Particularly where long term financial costs or benefits are to be considered, the extent and timescale involved are of great importance. A number of financial model types were identified, and their appropriateness, or otherwise, noted. It was noted in particular that where uncertainty in a data set is identified, that the uncertainty can be effectively included as part of the financial assessment itself.

A number of possible approaches toward the assessment of environmental value were identified. These methods could consider both the values of a building's "user", and those of an individual not using but still valuing the existence of a building. In this way, the values of society as a whole may be identified. The methodologies available fell under two main categories, namely "direct" and "indirect". Whilst the direct approaches operate through asking people directly for the value of non-market goods, indirect methods compare an "indicator" of the subject under consideration with an actual market. It was noted that direct methods have in a limited number of cases been used previously to value buildings, and that direct methods would seem to be applicable within the context of an urban environment.

The determination of what constitutes "heritage" was discussed from the literature, and a number of clear indicators emerged as to previous practice and guidelines. The social importance of heritage value, and the importance of social systems to the continued value of heritage, was identified as a vital concept. Previously reported attempts at assessing heritage value were identified, and noted to have suffered in many cases from an over-eagerness to objectify the subject matter. The indiscriminate use of arbitrary measurements was identified as problematic, although the links between certain methods and legislation in the area was noted.

Finally, the forging of links between objective and subjective areas of value was discussed, with particular reference to hard and soft systems methodologies. The recognition that prescriptive "hard" approaches to decision making can be readily incorporated as part of an overall "soft" approach is important, and will be returned to later.

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4. *Research methodology*

4.1 Introduction

This chapter identifies and develops methodologies to be used in the assessment of financial, environmental and heritage value. Methods based in previous work from the literature are so identified, and developed as appropriate to the current project.

4.2 Financial value

The various effects attributable to stone cleaning exist as a system, within which a number of more manageable groupings can be considered. This section investigates the effects which stone cleaning can be said to have on financial value (that is, variables which can be and are the subject of transactions in actual markets). Although these variables cannot be said to represent the overall changes resulting from cleaning, the financial requirements and implications of cleaning will often form a decisive element of the decision process. This section explores the issues that are important within financially motivated discussions, and identifies how a predictive cost model that can be used as part of future decision making processes can be developed.

Buildings exist within an environment that is partially financially motivated, therefore changes in the appearance of part of the built environment might well be reflected in its financial value. The stone cleaning process has a number of financial costs directly attributable to it, namely the initial cost of cleaning works and any associated maintenance work that may be completed in the longer term[1]. Cleaning can lead to major changes in the perceived aesthetic value of a property (Andrew 1992), and this change might well have some impact in the property markets. It can be recognised therefore that the financial effects of stone cleaning exist as a system, where both benefits and costs may result. As illustrated in Chapter 2, the form of that system is such that although it is possible to measure parts of the system by grouping contributory variables together (for example, variables usually measured in currency), thus presenting representative "measures" for parts of the overall network. Section 5.2 hypothesises the financial value system to be considered in this

[1] Urquhart *et al.* (1996) recommended that a properly planned maintenance programme should be prepared for properties which have been cleaned. In the immediate future, the implementation of such care and maintenance will have certain financial costs, but these might well be offset by the consequent avoidance of major repair works.

chapter. The constituent variables of that system are investigated in section 5.3, and a model established in section 5.4.

4.2.1 Financial value system

4.2.1.1 Objectives

A clearer understanding of the financial value system associated with stone cleaning is required and a number of objectives must be satisfied to enable the development of a model.

a) A conceptual model is required, based on established cost modelling practice. This model should identify the major variables to be considered, and the system through which they are likely to interact. The outcome from this model should be in currency (£), possibly enabling a later connection with the environmental valuation model.
b) The range of variables in the model should be identified, with each variable considered to identify the data required for its incorporation. Any costs or benefits, including immediate; one-off; regular; irregular; or delayed one-off payments should be identified at this stage.
c) Methodologies for data collection and analysis should be identified, with any practical implications recognised.
d) Data readily available for incorporation in the model should be identified.
e) Data gathering required as part of this study should be identified. It may be necessary during the course of study to recognise limitations on resource and time. Where such limitations precluded certain paths of research, these must be indicated and possibly considered in further studies.
f) The model drawn up for objective "a" should be progressed to incorporate the data collected. Shortcomings of the model presented should be identified, and it's sensitivity to errors evaluated.

4.2.1.2 Financial value methodology

The approach taken within the financial value research was structured so as to allow a gathering of data unavailable through the literature review, ensuring that the data and conceptual model were linked appropriately.

It was felt that the initial costs of cleaning could be gathered through approximate estimating each time the model was implemented[2]. Where data for inclusion in the financial model could only be estimated for any given case within limits, this was to be addressed using a risk simulation model.

The work, and this chapter, was structured following the objectives set out, i.e.

- conceptual financial model drawn up;
- data gathering undertaken;
- model developed.

The drawing up of a tentative conceptual model early in the work aimed towards ensuring that the data collection could feed into that model, and so recognise the resource implications. Since elements of the data set unavailable through the literature may have placed a great burden on the time allowed by the study, prioritisation towards aspects of the project which were more likely to be attainable was necessary.

The development of the conceptual model is described in section 4.2.1.3, followed by a discussion of the variables involved. Data gathering concentrated mainly on the property market study, although full consideration is given to all variables. The model is then further developed, placing it within the framework established and developed from the literature.

[2] The structure of how to use data gathered through an approximate estimate, and what data would be required, was to be included as part of the model form.

4.2.1.3 Conceptual cost model

The development of a financial cost model is rooted in the regarding of stone cleaning as a long-term alteration rather than a "one off" activity. In addition to the initial costs incurred at the point of cleaning, questions as to what effects might be realised over the life span must be realised (including the likely frequency and magnitude of any further intervention required).

Figure 4.1 - framework for financial cost model (costs only)

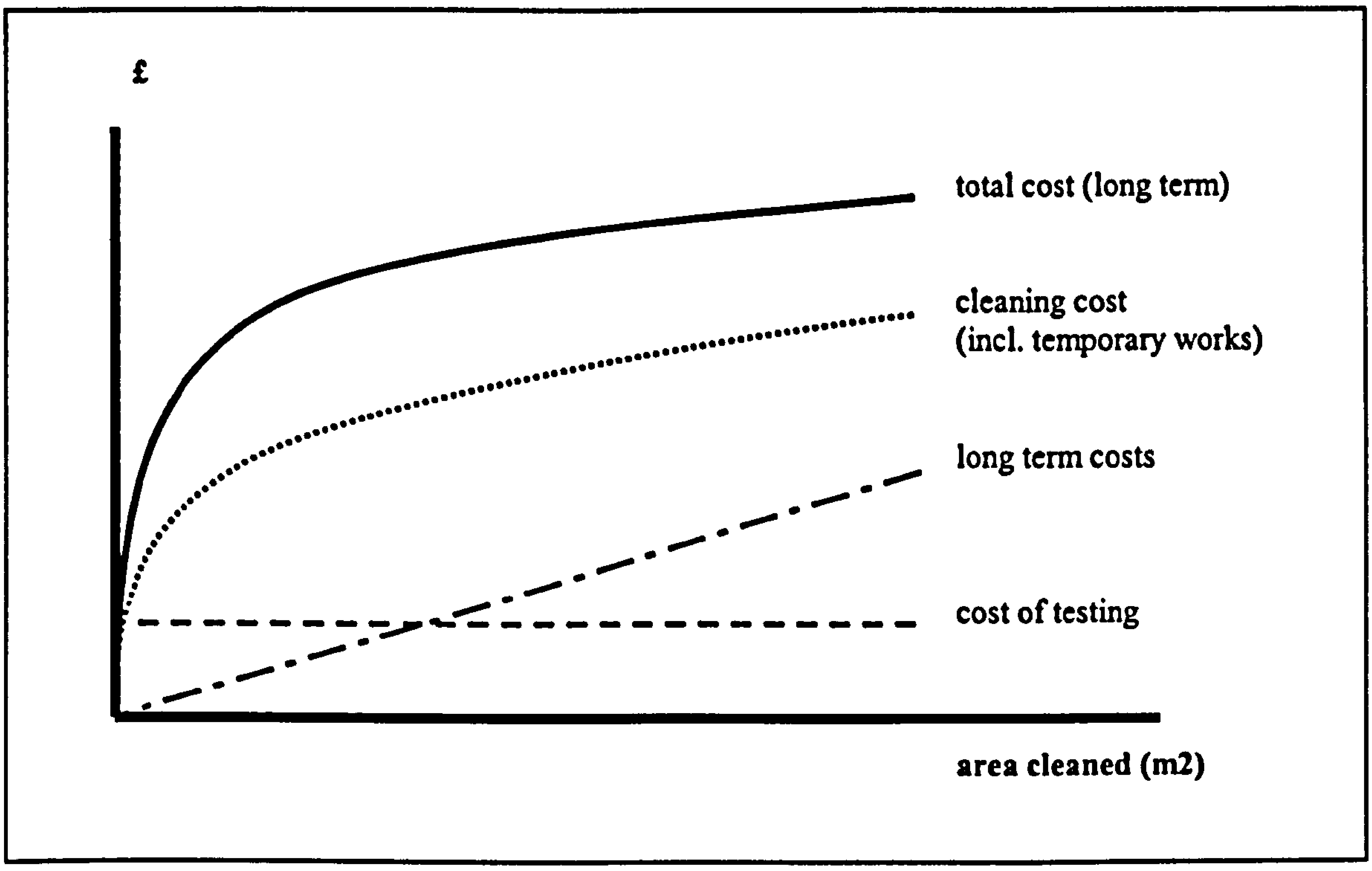


Figure 4.1 shows an amalgam of all the contributing variables and produces a cumulative total cost, varying over time. That variation is caused by the requirement for work as a result of cleaning, but not until some time after the original cleaning took place. The magnitude and frequency must be incorporated into the model, possibly considering range and distribution shape where appropriate. Where benefits resulting from cleaning emerge at a lower level than the heavy total cost, and overall financial loss will result.

The area to be cleaned (in m^2) is a vital measure of total financial cost. It is recognised that facades with isolated areas of carved detail, for example, may incur an increased cost per m^2 or variables rates but this should be addressed in the specific, rather than the generic, case. With regard to comparisons between the model to be developed here, and life cycle cost models prepared in relation to many other subjects, an immediately obvious difficulty is that of data availability and quality. This section (4.2) is concerned largely with the identification of such data, and where any shortfalls might lie.

4.2.1.4 Range of financial variables

The major financial variables which must be considered for inclusion in the model are as listed. These variables, and the manner in which they interact, will form the basis for the cost model produced, but must first be considered independently of each other, to explore the possibility of presenting changes in their measured magnitude due to stone cleaning.

Initial cost of the cleaning works

The initial cost of completing stone cleaning must be understood fully prior to any cleaning taking place. In addition to the cost of the cleaning itself, associated and potentially major costs may be incurred due to the requirement for scaffolding, the protection of the buildings' non-masonry components, protection of operatives employed by the cleaning firm, and protection for the general public. A great deal of cleaning work is completed as part of larger refurbishment works, allowing the division of temporary works cost between work sections. Nevertheless, an estimate for the total initial cost of cleaning must include for associated works, with perhaps a range of possible outcomes identified.

Long term costs

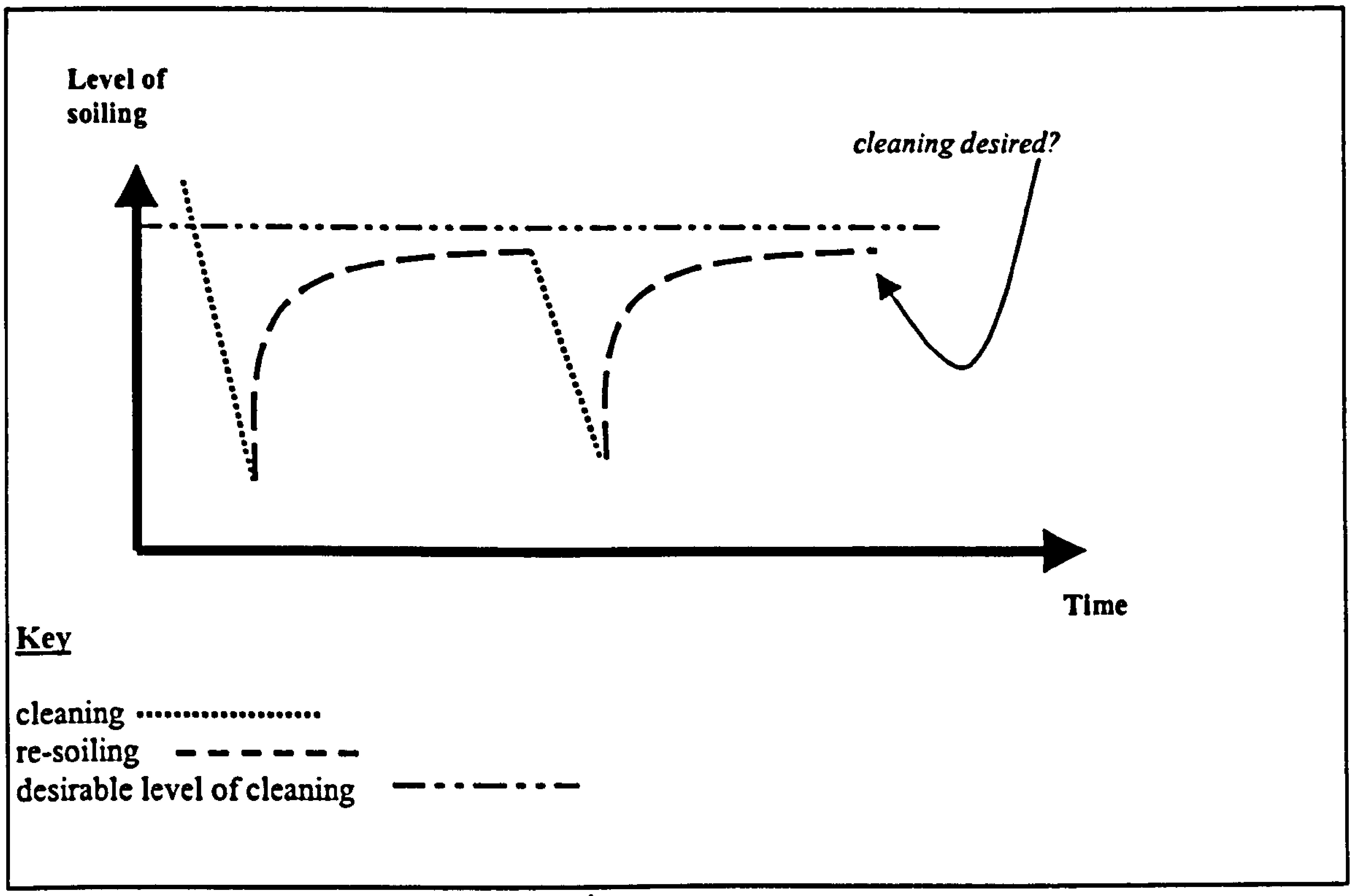
The cleaning of a stone surface should not be regarded as a single stage operation, but as one initial step in a longer term programme of work. The completion of regular maintenance work following cleaning ensures that the stone is kept at its optimum condition, without requiring reactive, unplanned and expensive work stages.

Andrew *et al.* (1994) suggest that the cleaning of a building should be followed in every case by the setting up of a structured maintenance programme. When consideration is made of the financial implications of cleaning, such maintenance must be considered also. The repair of stonework, or the application of biocide treatments, will carry with it an associated financial cost, related to the size of facade, and the extent of work required. Where such work is extensive the financial cost will be large, and an estimate of this should be incorporated in a financial model. It should be recognised also that the maintenance that would ideally be completed might well differ from that actually implemented. The reasons for this disparity might include the costs involved; the motivations of the owner or those responsible for the maintenance; or the fact that the need for intervention might be identified at an unnecessarily late date. The model presented in this chapter will reflect the cost of recommended practice, with a full breakdown of cost elements shown. Where recommended practice for the care of a building is not followed, costs in the longer term may be increased[3].

Cost of re-cleaning

Following stone cleaning, a building will normally be exposed to soiling and weathering mechanisms, though the nature of the air pollutants may have changed. Although controls on air pollution have been tightened during the current century, the facade of any building will inevitably re- soil (at a rate particular to any given situation). Therefore, a stone surface after cleaning is likely to maintain a constant surface and colour for a relatively short period of time (in relation to the predicted life span of many stone buildings), leading to a possible desire for re-cleaning. This situation is hypothesised in figure 4.2.

Figure 4.2 - The possible link between re-soiling and time



[3] The principles of established facilities management practice show that a proactive as opposed to reactive approach to care and maintenance will often decrease longer term costs. Work currently ongoing with the Masonry Conservation Research Group, RGU, aims to model the decay mechanisms following cleaning. This project assumes that work is completed as required, as opposed to when finances allow. In practice, the repair of listed buildings can be enforced, although non-Listed buildings might be repaired when finances allow.

It should be recognised that the nature of any soiling layer built up over perhaps a number of centuries will be different in composition to a soiling layer developed in the recent past, due to changes in the type of particulate matter in the air, and the potential for increased rates of biological soiling following cleaning. Where much of the industry responsible for a great deal of the historic particulate soiling has now reduced in terms of scale and emissions, the air in today's cities is polluted by greatly increased levels of road traffic (especially particulate elemental carbon, PEC).

Andrew (1992) suggests that in certain cases there might well be a period during which a level of soiling could be said to be aesthetically desirable. The complexity of the stone substrate, and the extent to which soiling might highlight such complexity in a positive manner, is extremely important. It is quite clear that the individual situation must be considered on its own merits, and it is difficult to generalise in this matter.

The likely financial cost of any re-cleaning must be discounted to the present day for inclusion in a financial model.

Effect on property market selling prices

The property markets are affected by many factors, and selling price can only be predicted effectively by associating a large number of variables. Again, the system within which these variables exist is complex, with certain factors having a greater influence than others. Any given building can be categorised using a set of variables (including size, location, structural condition, appearance and decorative condition), and it is these variables which will allow ultimately for an estimate of financial selling price to be determined. A proper analysis of the extent to which stone cleaning might affect property market selling prices is an essential step towards the better understanding of the larger financial value model.

Additional variables

The following variables might also be affected by cleaning, but only where cleaning exists as part of a large system of other factors, and where the individual magnitude of the effect of cleaning might be minimised as a result (additional factors which might contribute to each cost variable are shown in brackets).

Tourism Revenue	(advertising, travel provision, accommodation, leisure facilities, reason for visiting, location, climate)
Retail Turnover	(location, other businesses, local and national economy, business type)

With retail premises, the likely return on investment following cleaning will be a major factor for consideration where work is privately funded. With regard to stone cleaning, a recouping of the costs incurred through such cleaning might be realised by some perceived gain in the turnover of the firm, or by some improvement in the company image. Other variables which are important aspects of the overall financial value include tourism levels, the performance of businesses located in areas which have been cleaned and the changes which might take place regarding all of the variables listed where a large scale cleaning programme has been implemented.

With regard to changes in revenue accrued through increased tourism levels, this is a variable where difficulty is experienced in attempting to isolate individual causes. For example stone cleaning must here be seen to be but one variable, and perhaps a variable of lesser importance that others such as accommodation, transport provision and public facilities. As the relationship between each variable, and the effect which cleaning might have on it becomes more distant difficulties regarding the meaningful analysis of results become problematic. The hypothesised situation is illustrated in figures 4.3 and 4.4.

Figure 4.3 - Financial value changes caused by cleaning, and the complexity of this effect (commercial and retail properties)

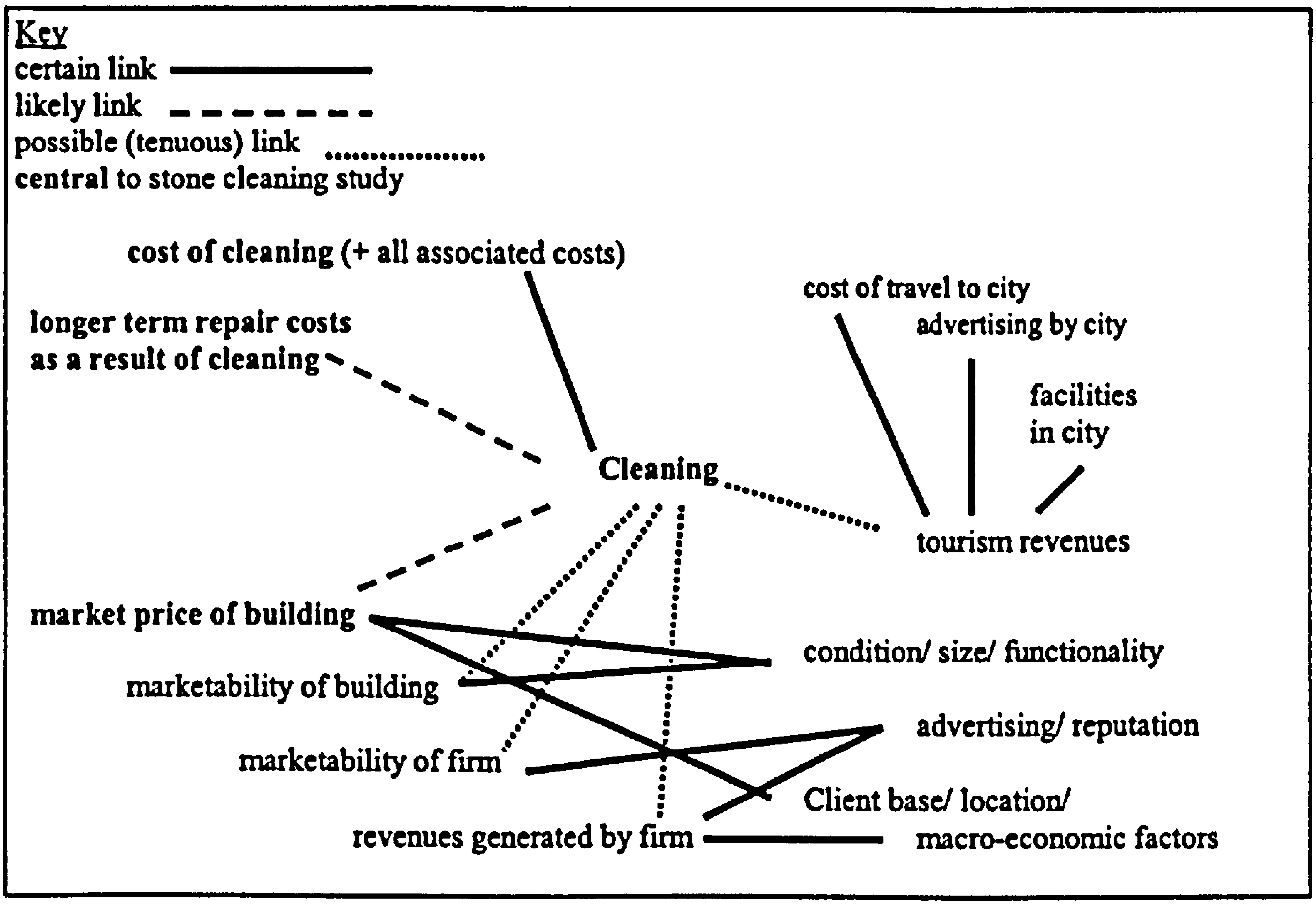
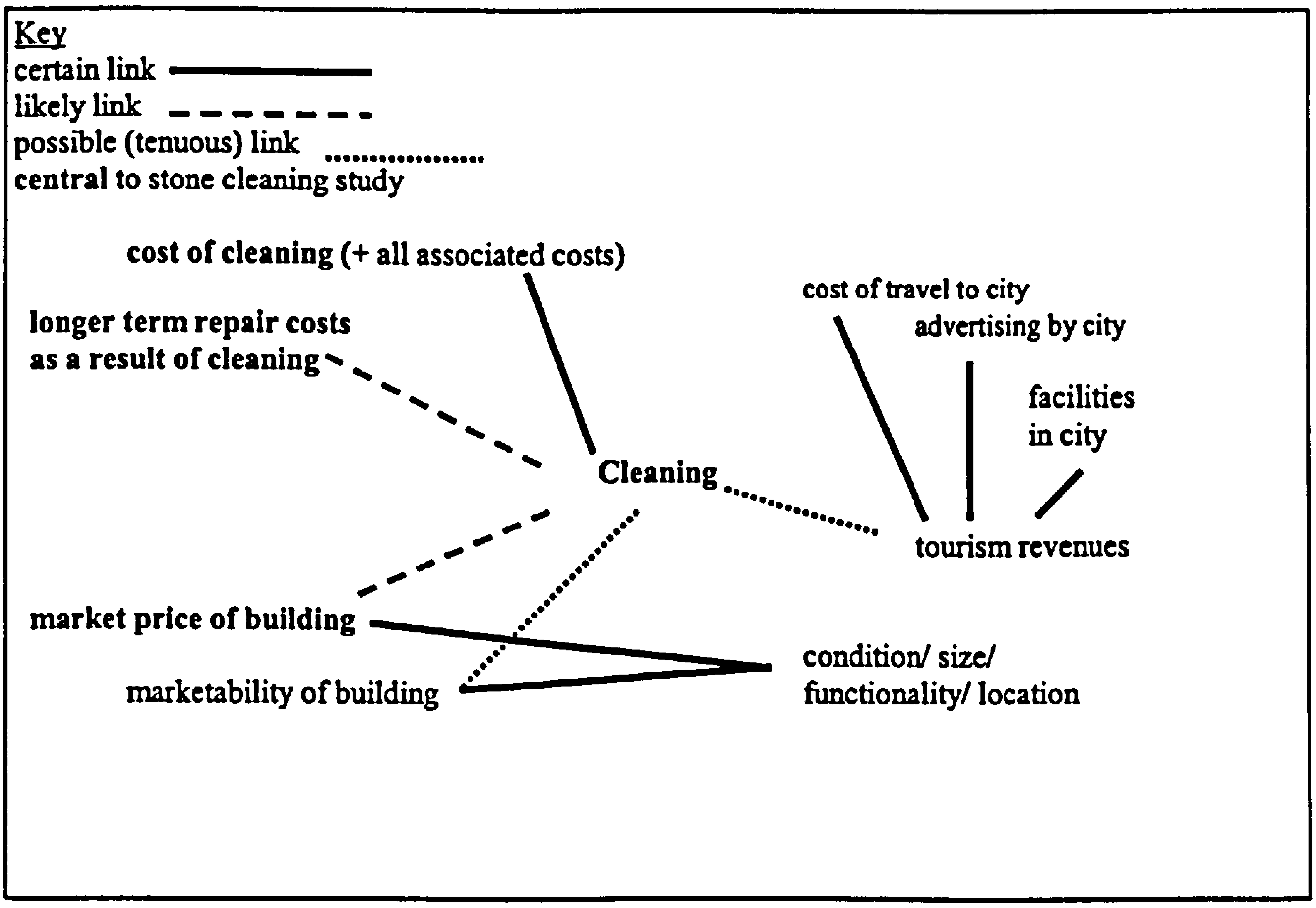


Figure 4.4 - Financial value changes caused by cleaning, and the complexity of this effect (domestic residential properties)



The extent to which the situations shown in figures 4.3 and 4.4 will be realised depends very much upon the scale of the cleaning works (e.g. number of buildings affected, success of the cleaning process, state of repair regarding the stone facing, public prominence of the buildings effected), and would be only part of a much larger value system including the likes of public assistance for businesses, marketing strategies adopted, existing public perception of an area, and so on. Indeed, a number of publicly funded and controlled initiatives (e.g. Aberdeen City Centre Project, Glasgow Development Agency "*Stoneclean*" programme) addressed specifically the subject of stone cleaning, and in certain cases set in place mechanisms by which future cleaning would be encouraged.

Although this section is concerned primarily with only financial value, in practice it would not be possible to isolate parts of the value system in this way. Aspects included within the financial model derived will be influenced by factors also associated with environmental or heritage value. For example, likely approaches to be taken toward maintenance strategy will most certainly be affected by the perceived and legislated heritage value of a building. Likewise, the level of grant funding available to aid the maintenance and repair of a building will depend to some extent at least on the buildings location and perceived social worth (possibly as a Listed building). Therefore, any attempt to derive a useful cost model of the effects of stone cleaning should take sufficient account of the placing of the building within socially structured scales of importance, as well as the structural and physical conditions which might in themselves not always be sufficient to ensure that appropriate maintenance is carried out.

4.2.2 Financial model

4.2.2.1 Introduction

Within the overall financial value system, a number of constituent variables have been identified and discussed. It is clear that many of the variables must be estimated over a distribution, and a number of these will change depending upon the situation.

In order to accomplish a long term value assessment, the variables described must be considered together, which requires the comparison of different types of data. For example, the initial cost of cleaning work, although complex to some extent, will occur only once. On the other hand, the cost of maintenance work (e.g. biocide application, stone repair) might be required on a number of occasions. Therefore, any model produced must regard the whole life cost of cleaning if it is to be of any real use.

Bennett (1987) states that a reluctance to use life cycle cost models may result from a feeling that a lack of available data, the uncertainties of predicting the future and problems where models fail to incorporate scope for managerial discretion, present little benefit. The decision making process can only be improved by this study if its findings are recognised and used. Although it is apparent that trends and likely outcomes can be predicted, each building should be considered as an individual case.

4.2.2.2 Structure of model development

When considering most projects in the building industry, it is accepted that consideration should be given to costs which are likely to accrue during the life span of the building. The physical properties of the external stone facade will change as a result of cleaning indicating that life cycle implications will be important. Stone cleaning constitutes a process which should not be looked at as an event taking place at a single point in time, but instead as an event which will lead to the external fabric of the building functioning in a modified manner over it's residual life span.

Life cycle costing can be regarded as an aid to decision-making (Flanagan *et al.* 1989). The processes that have been developed are thus extremely relevant to the current project. Ferry and Flanagan (1991), offer the following definition.

> "...life cycle costing involves putting the estimated capital, maintenance, operating and replacement costs into a comparable form and bringing them togteher into a single figure which allows for the fact that these items of expenditure will take place at different stages within the time- scale."

In many cases where life cycle costing has been used to aid decision-making, it has been used to compare a number of systems incorporated later as part of a larger project. Where consideration is being given to the cleaning of a building's exterior, the subject must be approached from a slightly different direction. Stone cleaning, rather than being an "addition" to a building, instead alters what exists. Rather than consider the running costs of an addition, therefore, the costs to be considered are related to the longer term implications of the initial cleaning operation.

Obtaining detailed information regarding the life cycle cost effects of stone cleaning in isolation may be difficult. Nevertheless, it should still be possible to incorporate a representation of the long term implications of cleaning into a value simulation. The use of non-economic methods and variables to temper results is debatable with regard to the methodologies available. Whilst it is accepted, and included as part of the methodology for this project, that non- financial variables and concepts are vital, the placing of measures and values on such concepts is difficult.

Dell'Isola and Kirk (1981) present a technique whereby a number of criteria are compared against each other (e.g. initial cost, efficiency, reliability), and then related to the anticipated performance of a number of possible choices (the "weighted evaluation" technique). Each comparison between criteria is marked on a scale of 1 to 4 in preference or one criteria (where a score of 1 equals no preference, and a score of 4 equals a major preference towards one of the criteria). Each option is given a score of between 1 and 5 in terms of how it performs against each criterion. For example, were option 1 to perform very well against **initial cost**, it would be given a score of 5. Were it to score very badly, it would receive a score of 1. Each option scores are then multiplied by the weighting attached to it, to arrive at a final score. The option with the highest score is deemed to be the most acceptable. Figure 4.5 illustrates how the method could be applied with a hypothetical evaluation of various stone cleaning methods.

Figure 4.5 - Weighted evaluation technique

Criteria scoring matrix

Criteria	B	C	D	E	F
A. initial cost	B4	C2	D3	E3	F4
B. Temporary works		C2	D2	E4	F4
C. Soiling removed			C2	E2	F3
D. Minimal grain loss				D/E	F4
E. Minimal staining					F4
F. Minimal roughening					

Analysis matrix		F	E	D	C	B	A	TOTAL	RANK
	Raw score	19	10	6	6	4	0		
Alternatives	Weights	10	5	3	3	2	1		
1. Cleaning method "A"		4 / 40	3 / 15	2 / 6	2 / 6	3 / 6	2 / 2	73	3
2. Cleaning method "B"		5 / 50	2 / 10	1 / 3	1 / 3	4 / 8	3 / 3	77	2
3. Cleaning method "C"		3 / 30	1 / 5	1 / 3	3 / 9	1 / 2	2 / 2	51	4
4. Cleaning method "D"		4 / 40	4 / 20	3 / 9	2 / 6	3 / 6	2 / 2	83	1

Criteria importance

4 - major preference
3 - medium preference
2 - minor preference
1 - (letter/letter) - no preference - each scores 1 point

Although it offers some outlet for the assessment of various elements, a number of problems relate to this method of evaluation. Firstly, because the model makes no use of monetary units, the results cannot be applied directly within a life cycle costing calculation. Secondly, the evaluation of criteria against one another is highly subjective. The extent to which "initial cost" might be more or less important than "maintenance requirement" is extremely difficult to determine. Thirdly, whether all variables can be compared along the same (1 to 4) scale, or each option marked against a scale of (1-5) raises the question of weightings at a more fundamental level. That is, how does a score of 3 or 4 against "initial cost" compare with a score of 3 or 4 against "maintenance requirement".

A wariness of the ostensible benefits of cleaning has been brought about by an awareness of the potential negative long-term effects. Forecasting what might happen in a number of years can be difficult even where data is available from previous projects and rigorously developed testing methods can be applied. Forecasting the effects of cleaning over a building's residual life span, therefore, carries with it a great deal of risk and uncertainty. Flanagan *et al.* (1987) recognise that this is a situation which exists with all life cycle cost studies, and presents techniques which illustrate clearly that life cycle costing is not "*merely based on guess work*", but can supply the decision maker with "*comprehensible information on which to base his judgements*". A danger in this investigation was that these uncertainties become buried in the methodology, masking weaknesses and thus resulting in misleading conclusions. By linking life cycle costing with risk management techniques, the reliability of any conclusions reached can be tested and incorporated into the process.

The two methods that dominate risk management are sensitivity analysis and probability analysis (Flanagan *et al.* 1987). Sensitivity analysis is used to "*identify the impact, on life cycle cost, of a change in a single risky or uncertain parameter*". For this study, variables including the discount rate used to calculate present values, the cost of future repair works and the incidence of such repair all involve a degree of uncertainty in their forecasting.

Sensitivity analysis allows for an assessment of the extent to which inaccuracies in estimations will affect the overall calculation. Where a number of uncertain variables are involved, the complexity of a sensitivity analysis is increased. By calculating the change in overall life cycle cost which would be experienced by incremental percentage changes (positive and negative) in a number of parameters in the overall equation, some understanding of the uncertainty intrinsic to the overall calculation is reached. For this study, a number of variables must be considered in parallel, and it is likely that the limits of probability within which each of these variables might exist will vary. Sensitivity analysis presents a useful method for comparing variables in isolation (i.e. the effect of changes in one or perhaps two parameters), but fails to analyse adequately the effects of a range of parameters might vary simultaneously (and not necessarily in similar directions, or to similar magnitudes).

Probability analysis, of which the *Monte Carlo* simulation technique is perhaps the most commonly and readily used methodology, and allows for areas of uncertainty (i.e. variables which cannot be represented using a single discrete figure) to be represented using probability distributions. For this project, it was possible to estimate the likely cost of these variables using established approximate costing techniques and making reference to the available cost data. However, these costs are inevitably subject to uncertainty when attempting to develop a generic model for use by the practitioner. In addition, all but those costs which will be incurred as part of an initial cost rely to some extent on the estimation of frequency of expense. That frequency though is uncertain, however strongly based it might be in fact.

Therefore, any estimation of cost should be regarded as little more than a mean figure in terms of probability, with that distribution possessing likely maximum and minimum figures, and distribution shape. Each variable will be unique in these respects. The magnitude of cost will vary over time (due to inflation, market pressures and the development of new technologies), but the probability distribution should remain constant.

Life cycle models within the built environment have been developed mainly for the study of entire buildings, or groups of buildings. Without considering the life cycle of the whole structure and fittings, the benefits of implementing such models would be reduced. For the current study, however, it was essential that a focus be made on the effects of cleaning, and the ways in which cleaning results might influence costs. Although only the exterior stone is treated directly, the subsequent change in appearance might well influence the maintenance approach towards other elements. For example, elements such as the external doors and windows might have a similar impact on aesthetic value and be reflected in replacement or maintenance costs.

The source of funding is also important to a study of the life cycle impact of stone cleaning, and specifically the extent to which future planning is likely to be considered by the party paying for the cleaning. This study considers the overall effect on financial value, and thus incorporates variables representing market values and possible future cleaning cost. With regard to market values, any changes will not necessarily be felt by the party supplying funding, and so would be irrelevant to their own particular financial programme[4].

With regard to the methodology to be adopted, Bromilaw and Pawsey (1987) suggest the following items for consideration (for buildings).

- the most appropriate timing for maintenance operations;
- the amounts which should be spent maintaining at a certain standard;
- the strategies which should be followed with regard to rehabilitation;
- the conditions under which (buildings) should be pulled down and replaced.

Point one is dependant with regard to stone cleaning on a number of possible outcomes post-cleaning. The requirement for a regular application of biological retardant to the stone surface will depend largely on the design of any stone carving work and the orientation of the building. The cleaning method used and the original condition of the stone prior to cleaning will partly determine any need for stone repair.

The realistic approach towards point two relates to the protection extended towards a building by Statute, and the motivations of those parties responsible for its upkeep. Whilst it is possible to produce a maintenance programme for any building, the application of such a programme might vary, certainly in the private sector. For this study, it was determined that a optimum standard should be described for each element of the life cycle analysis, and that these standards be incorporated into any models produced.

Points three and four can be seen to relate to conservation guidelines, including those charters discussed in this chapter. Where the end outcome from cleaning was that large-scale stone replacement was required, the conclusion would have to be that the process had failed. Cleaning is completed in order that certain gains can be realised. If these gains are outweighed over time by subsequent losses, then the rationale supporting initial work is flawed.

[4] The most obvious example here is that of grant aiding. Although the point made is true in a direct sense, it might be conceivable that public funds spent on cleaning might be recouped were the market values of property over an area to increase markedly, through property taxation. The amount of taxes obtainable through a property will be dependant on many factors other than the state of the stonework, with this being but one factor among many. Therefore, the effects of cleaning on market values will be included in the current study as part of a life cycle modelling exercise, but the model user should be aware that the model exists as part of a larger micro and macro economic system.

Life cycle costing techniques are based on the premise that total value is equal to the present value of future cash flows[5] (Johnson et al. 1987). This is represented by Bromilaw *et al.* (1987) through the following expression:

$$S_T = C_0 + C_{It} + C_{Jt} - d$$

where,

S_T is the present discounted life cycle cost measured over a period T
C_0 is the total cost of procurement at time zero
C_{It} is the annual cost, which may be regarded as continuous
C_{Jt} is the cost of non - continuous work, which will not happen on an annual basis
d is the value of an asset on disposal (taking account of the costs of that disposal)

This equation relates closely with the discussion so far, in that it allows for each of the constituent variables in the financial value system to be included. The inclusion of variable d allows for any possible gains, as opposed to only costs, to be included in the models. Table 4.1 indicates the variables which were considered, as well as the variable heading under which each is categorised.

Table 4.1 - variables for life cycle cost model

Variable	Cost elements relating to this project
C_0	• initial cost of cleaning • re pointing required at cleaning stage • testing at pre cleaning stage • biocide treatment at cleaning stage
C_{It}	• regular re pointing • biocide re application
C_{Jt}	• stone repair • re cleaning (including testing)
d	• changes in market value of building • reduction in stone repair incidence

The final variable, "reduction in stone repair incidence", has been cited to reflect arguments for the continued cleaning of stone buildings. The belief is that cleaning can uncover certain defects in the stone previously "hidden" by a soiling layer, prompting repair work at an earlier stage than would otherwise be the caşe. Where this were true, it is possible that a reduction in overall stone repair cost would be realised. This argument is flawed, however, in that soiling of a stone surface rarely if at all masks defects in the stone where the observer is experienced and trained with regard to building surveys. It is possible, however, that

[5] Past costs are not considered. The model assumes that only costs and benefits realised from cleaning onwards will be of interest. Variable C_0 refers to costs and benefits at the time of cleaning.

where an experienced observer is not present that cleaning might well result in financial and time gains being realised. Therefore the variable has been included in the model outline, but in reality would be likely to have little impact.

Any case studies presented later omit this variable, to reflect best practice. The data requirements of this investigation is shown in table 4.2.

Table 4.2 - data required for incorporation in the life cycle cost model

Variable	
Initial cost of cleaning	• cost of cleaning/m^2 for a representative sample of cleaning methods[6] • cost of temporary works (both apportioned with other works, and solely with cleaning) • cost of testing • specialist surveys and reports
Re pointing (initial)	• cost of re pointing
Biocide treatment (initial)[7]	• cost of treatment • extent proposed for model • biocide used (manufacturer) for model purposes
Re pointing (regular)	• extent (m2) for modelling purposes • projected cost • anticipated rate of incidence
Biocide re application	• extent (m2) for modelling purposes • projected cost • anticipated rate of incidence
Stone repair	• condition of stone pre (initial) cleaning • size of facade • stone carving present • stone type (e.g. sandstone or granite) • linked to method of cleaning • cost of repair work • will be modelled over a distribution • consultancy costs
Re cleaning	• anticipated rate of incidence • costs involved • influence of listed building regulations
Alteration in market value	• building use • location
Reduction in repair incidence	• Please refer to note at foot of table.

[6] Although generic costs have been used here, measured in m^2, costs would in reality be influenced by an on- site assessment by the works estimator. Therefore, additional work required around mouldings would be either incorporated into an overall rate/m^2, or charged separately.

[7] The application of biocide to stonework, as discussed earlier, is not an essential step in the cleaning process. However, the presence of biological growths on the stone surface would certainly alter the aesthetic achieved immediately post cleaning. Therefore, the model will take account of biocide requirement as an essential step towards the preservation of the aesthetic value of the building. By preserving the aesthetic in this way, a financial cost is experienced.

Discount rate

For all but the initial costs indicated, it is necessary to discount the costs calculated to values at the base year. The outcome of any life cycle cost model is highly sensitive to the discount rate selected. The discount rate is used to simulate the influence of interest rates and inflation over time, making the reliability of the model's outcome highly dependant on the chosen discount rate being accurate. Over time, however, it is obvious that interest rates will vary, meaning that a discount rate must properly reflect these long term changes, and represent a realistic mean. To help ensure that the model reflects the range of possible outcomes, a range of discount rates will be applied. Although the model's outcome will then exist over a range of possibilities, at least that range will more accurately reflect the likely outcome than one single figure.

Application of model

The modelling of life cycle costs in relation to cleaning is an important step towards the formulation of more reliable decision methodologies. The most appropriate method for calculating the likely cost of cleaning mirrors that for general construction work in that a number of aspects of value should be considered, and that these will be incurred not just in the initial stages (of construction or cleaning). However, despite research illustrating that costs incurred over the life of a building can rapidly overshadow initial costs of construction[8], a suitably in depth and rigorous use of life cycle costing in relation to cleaning has not taken place. With cleaning, where, "running costs", such as those concerned with heating and service provision, are not part of the associated life cycle, the visualisation of whole life cost in the mind of the client may seem intangible, leading to a reluctance to apply the results of a cost in use study.

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[8] Bird (1987) reports work by White (1986) that in a case study of an office block, "*running costs will exceed capital costs after less than 9 years of occupation*". Bird states that such a relationship is not uncommon.

A number of reasons exist to explain the low application of life cycle costing in practice (Bird 1987):

- a lack of appropriate and accessible cost and performance data in sufficient quantity;
- a mechanism for providing the necessary data at present does not exist;
- the legal framework is not conducive to manufacturers grading the performance of their products.

All of these points hold true with regard to cleaning, although the apportioning of blame in the final point is inappropriate. The effects of cleaning, either positive or negative, in the longer term might not be apparent for a number of years. Indeed, cleaning took place with little control for a number of years prior to its being listed as a building alteration requiring Scottish Listed Building Consent[9]. The reasons for this lie mainly in the fact that the benefits in terms of immediate colour change (carrying with it a gain in aesthetic value in many cases), might be seen to represent a complete gain in overall value prior to the surfacing of any physical problems. Nevertheless, a lack of concern over the longer term effects has led also to a corresponding lack of reliable historical data being available. After all, where the benefits of a course of action seem to be overriding, the impetus to record fault might well appear fruitless. Bird rightly continues to highlight the unavoidable link between the concepts of performance and value. Exactly what is being paid for, and what can be expected in return, are at the heart of this chapter. Likewise, these concepts underpin the rationale for using life cycle modelling, in that only when the whole life costs are known can these costs be weighed against benefits both realised and expected.

[9] Indeed, BS 5390 (1976) stated that, "*periodic cleaning of stone buildings is a desirable part of maintenance since dirt can conceal, and in some cases encourage, decay*". A significant change in such attitudes has come about in the light of much subsequent research.

4.2.3 Property market prices

4.2.3.1 Introduction

The effect which stone cleaning might have on the market value of that property can be considered within the framework of valuation techniques currently used in the UK[10]. At present, the majority of valuations are completed using what can be broadly termed the comparative method of valuation. This means that a building to be sold on the property markets would be assessed for its value by comparing it with similar properties. Where the stonework on the face of a property is cleaned, this will lead to a change in the appearance, and perhaps a corresponding change in the value. However, it should be appreciated that the value will also depend to a great extent on a number of other, perhaps more commonly considered, factors such as the structural state of the property, the size and location, the facilities present and the general state of repair. In addition, consideration should be given to the possible cost of any repair work required due to the stone cleaning method used, and if this might be reflected within property markets (Hollis 1989). Although cleaning has the potential to provide visual benefits, were a clear link to become apparent between cleaning and later repair need, the effect on property market prices would (or at least, should) be inevitable.

Previous work (Andrew 1992, Nasar 1994) has also indicated that the aesthetic preferences which might be expressed towards a building are again influenced by a complex system of variables, and the physical state of the stone work should be considered along with the colour and light reflectivity of the stone in order to arrive at a visual evaluation. Hollis (1989) states, with regard to buildings where defects have been discovered, that the "*assessment of the value of a building in poor order cannot be achieved by the comparative method because it relies on the comparable properties being in a comparable condition*". Hollis continues to state that the valuer must consider,

- the price paid for the building;
- the market value of a comparable property in the neighbourhood;
- details of the defects undiscovered during the original survey;

[10] This path is followed by the research to help ensure that terms used would be understood by all parties contacted. From the early stages of methodology development, it was expected that professionals from the property markets would be contacted during data gathering. It was by no means certain that a familiarity with the subject of stone cleaning would exist, so it was felt to be essential that a reduction of the opportunity for misunderstanding in other areas took place.

- the cost of remedying the defects.

This information could be then used to determine the value of any loss incurred by dividing the cost of any remedial works required by the number of years over which such work could be deferred, and finding the difference between this figure and the original price paid for the property. With regard to stone cleaning, such a method might only be required where the cleaning method damaged the stonework to the extent that subsequent remedial works were required. Although it is the case that the large amount of stone cleaning work completed over the past few decades has carried with it the implication that financial and social benefits might accrue, it is a distinct possibility that where ill considered works were completed that the adverse implications could be severe.

The effect which stone cleaning might have within the property markets forms an important part of the financial value to be considered here. An investor in the stone cleaning process, or a building owner contemplating stone cleaning, should be aware of the likely financial repercussions of such work.

It was necessary that the effect which cleaning has within the property markets of Scotland be analysed, to provide a method by which that part of the value equation could be made predictable (even if within a range of possible values). If the cleaning of buildings is held to be of significant importance by the general public, then this might well be reflected within the property markets. The extent to which such an importance or otherwise can be analysed through direct observation of property markets is, however, difficult to determine. Harris (1978)[11] suggests that attempts to determine the effect of other environmental changes such as clean air requires in practice a "*degree of abstraction*", making such attempts impossible.

The main intention of the property prices study is to produce indicators for incorporation in a predictive model. The influence of such a mechanism on the potential investor in the cleaning process might be great, and allow for a fuller assessment to be made of the effects of cleaning, over the residual life span of a building. Such a study had not been completed prior to this project, and represents an area in which decision makers have in the past had to rely on conjecture and supposition[12]. The market value (or rent obtainable) associated with a property will be of great importance to the owners, as the implementation cost of stone

[11] Although this reference can be regarded as dated, the methodological problems mentioned still hold true.
[12] If, indeed, the variable were considered at all. If an effect is being felt in market prices, but not expressly stated, implications for the methodology here are great. Asking surveyors to quantify a variable not usually considered objectively might in itself skew results.

cleaning work might be only partially covered by grant assistance (if at all). When deciding upon the logistics of carrying out any work, or entering into any contract, which is likely to be a major draw on company finances, the question of whether or not the initial cost would be likely to be recouped must be addressed. Where stone cleaning work is being considered the effect on market valuation is an obvious and important starting point.

The property market is influenced by a large number of factors including general market trends, fashion, desirability of certain areas and the state of the economy, all of which are difficult to relate to each other in a manner which is not subjective, to some degree or another. The effect of stone cleaning, therefore, is extremely difficult to isolate through simple observation of actual property values. General Practice Surveyors serve their clients by reflecting the property markets in their valuations, and advising as to the likely buying and selling prices which will result if a property is made available in the marketplace. By focusing on their opinions and experience, therefore, it should be possible to determine the effect that stone cleaning may be reasonably expected to have in the property marketplace. From this, a guide by which predictions can be made regarding likely future changes in market selling prices as a result of cleaning can be derived.

4.2.3.2 Methodology for study of property market prices

The main intention of the study concentrating on property market selling prices was to determine the extent of the effect that stone cleaning can be said to have on such prices. Through the completion of this study, it was anticipated that the data gathered might be utilised in future decision making. Therefore, the development of a methodology to investigate the topic had to accomplish two objectives:

- indicate the extent of the change in selling price which might reasonably be attributed to cleaning;
- allow for any differences attributable to geographical area and use of a building to be identified.

It is likely that a decision-maker contemplating cleaning will be considering the cleaning of one particular building, or group of buildings. He or she will, therefore, require that sufficient data is available to enable a prediction as to the financial effects of cleaning be made in relation to the case in hand. By satisfying the objectives stated, the decision maker will be provided with information previously unavailable.

Contact was made with three general practice surveyors in Aberdeen and Elgin to determine the extent to which stone cleaning is usually considered as part of valuations. The outcome from these meetings was to confirm that the topic tends to be considered only towards the end of a valuation calculation, with consideration of condition, size, location and use more important. All three surveyors suggested that a straightforward analysis of actual market prices would be unlikely to yield meaningful results, due to the embedding of effect. It was also suggested that the effect on sandstone properties might be greater than for granite, due to a feeling that the visual change with sandstone is much greater. All three surveyors did confirm that the results of cleaning might well influence market values, and that a study would be worthwhile.

It was determined that the study of market values would be structured in three stages:

- **Stage 1:** Questionnaire survey of selected general practice surveyors in Scotland, to determine the % effect of cleaning on market prices. Additional information relating to the results of cleaning and the previous experience of the respondents would also be collected.
- **Stage 2:** Interviews with selected respondents, to discuss initial conclusions reached after the analysis of responses to (i).
- **Stage 3:** The study was repeated using a smaller respondent group in London, to highlight any differences between Scotland and London, and provide a validation of the method.

As mentioned, the subject of cleaning is rich in terms of both quantitative and qualitative argument. This approach will allow market prices to be included as part of the financial cost model, and allow a deeper consideration of how a respondent's knowledge of or opinions on the subject of cleaning might affect a valuation. Stage 2 also allows the project to confirm that the questionnaire format had been understood by the respondent, and generated meaningful data.

4.2.3.3 Respondent group

The choice of respondent group was essential to the success of the market values study, and required that the group targeted were both familiar with the operation of property markets in Scotland, and that a certain amount of knowledge was held regarding the perception of stone cleaning among prospective property investors and owner occupiers. Recent legislation controlling the availability of stone cleaning as an environmental instrument for Listed properties has perhaps meant that it has gained a greater prominence in the minds of property professionals than was the case historically. Regarding knowledge of the property markets, Ggeneral Practice surveyors are responsible for the conduct of surveys for the valuation of properties prior to purchase, and should be able to offer reliable advice on the subject. The respondent group was, therefore, entirely familiar with mechanisms operating within the property markets, and knowledgeable regarding the extent of cleaning within the geographical areas they carry out their business (data regarding respondent experience of stone cleaning was to be gathered).

It could be argued that the respondent group chosen simply records and responds to the actions of others within the property markets, rather than their own motivations. Therefore, effects of cleaning might be felt by purchasers and lessees, and only perhaps reflected in valuations. This argument can be countered at a theoretical level through the fact that surveyors and valuers have contact with the widest range of property types, or any possible respondent group, and are therefore best placed to offer advice on the range of buildings considered for this study. The practical realities of this study also required that the information be gathered in an efficient manner, likely to produce meaningful results. The logistics of contacting property purchasers and lessees in sufficient numbers as to be statistically meaningful precluded that course of action. It is argued regardless or such practical limitations, however, that the respondent group chosen was appropriate to the study, and offered the greatest chance of success,

A possible further criticism might be that the replies elicited from the respondent group will simply be hypothetical estimates, and that the only reliable measure of effect can come from an analysis of actual realised selling prices. As becomes clear from the literature, the major variables used to compile valuations will have a much greater effect on selling price than any change attributable to cleaning. In addition, unlike surveys completed analysing the effect of a variety of air pollutants on property selling prices (Ridker 1969), no reliable measure is available for the effects of stone cleaning which could be correlated against actual selling prices[13]. The use of an expert respondent group seemed, on balance, to hold the greatest chance of producing useful indicators for use in the cost model.

Reference was made to the Royal Institution of Chartered Surveyors (R.I.C.S.) geographical directory of member firms in Scotland, through which it was possible to locate the addresses of all general practice firms registered with the R.I.C.S.. The study was confined to Scotland in order that the influence of varying stone types, traditionally employed construction methods, and geographical effects on property markets could be minimised. Surveyors in eight cities were targeted by an initial questionnaire survey. The cities were chosen in part due to their geographical locations, allowing for large parts of the populated areas of Scotland to be covered. It was also desired that the stone types used in the past to construct much of the building stock in these cities be varied over the sample (e.g. granite predominant in Aberdeen, with various sandstone from a variety of quarries the common material in the other cities). The survey aimed to elicit, from the knowledge of the professionals working in the property valuation field, the effect which they perceived stone cleaning had on market value.

It is here noted that the sample size was limited for both methodological and practical reasons. Previous research in masonry conservation within Scotland has focused on both sandstone and granite buildings. The sample was selected, therefore, to include cities where each stone type is represented adequately. The questionnaire would require that respondents place an estimate on the effect of cleaning on market prices. It was anticipated that a 1% increment of property prices in Aberdeen would carry different implications to a similar shift in an Edinburgh or Dundee building. Were this shown to be the case by the gathered data, implications for the cost model would be clear. Within the cities selected, all firms identified as offering general practice services were contacted[14].

The questionnaire was piloted using Surveyors in the Greater London as the respondent group. The validation exercise was completed in order to establish that the questionnaire could be interpreted properly by the respondent group so that the results obtained by the main survey could be depended upon. Greater London was chosen because of the large

[13] For example, were a pair of buildings identified where the sole difference were that one had been cleaned, can the difference in market price due to cleaning be compared directly with another, similar, pair? Would it not be the case that factors including colour change, stone type, cleaning method employed and location (i.e. air pollutants) will create a complex system? For this reason, the decision to pursue indicators through the elicitation of expert opinion would be more fruitful.

amount of stone cleaning work which has been completed in that area, and the fact that the geographical spread of the respondent group could be better controlled. Results and an analysis from the validation exercise are given in Appendix 5.

[14] For the study of surveyors in London, every third general practice firm as listed in the RICS geographical directory was contacted. The selection was due in part to the resource limitations of the project, and in part to the validation- based aims of that study.

4.2.3.4 Questionnaire format

The questionnaire (refer to Appendix 3) was comprised of four distinct parts. These dealt with the respondents' details, owner-occupier properties, investment properties and attitudes to stone cleaning, respectively.

Questions **one** and **two** aimed to determine the experience that each respondent had in the valuation of the various property categories identified in the questionnaire. Should problems arise in the statistical validity of results, or statistical anomalies arise, it was hoped that the first two questions would be of some use in attempting to explain why. Likewise, question **three** was designed to allow a check between responses to later parts of the form and the background of the respondent. A necessary differentiation was made during the later stages of the questionnaire between owner occupied and leased properties, and the data gathered through question three allowed any difference in response, due to the surveyors knowledge and experience, to be identified. Question **four** allowed the analysis to assess whether the recent workload of the surveyor might affect the response given.

This initial section of the form, therefore, was aimed at building up a background profile of the respondent group, and thus allows for a certain degree of selective analysis later. Questions **five** and **six** aimed to extract, from the knowledge of the Surveyors, the percentage effect which stone cleaning was perceived to have on the market price of a property. By splitting the property types into commercial, retail and residential, a link was established with question **one**. Industrial buildings were not considered at this stage, due to the fact that most of the properties under such a category would only be cleaned after a great deal of refurbishment works had been carried out, often moving the property into another category.

A differentiation was also made between the owner occupier and investor markets, which operate under different motivations. For the purposes of the questionnaire design, the two sections were laid out in a similar fashion to one another, with the only difference being the term "open market sale value" being used for the owner occupier market as opposed to "rate/m^2" and "yield chosen" for the investor market. The rationale for this approach was that it was possible that a number of the respondents contacted would have experience of both owner occupier and investor markets, and it was desired that no confusion should arise regarding the information desired. Whilst it was essential that a difference be recognised between that two markets for the purposes of the data gathered, the nature of the question being asked essentially remained the same.

Question **seven** is similar to question **four**, but aimed at finding whether the Surveyor would be likely to have a practical knowledge of stone cleaning, rather than simply experience of how the process might affect market valuations.

Question **eight** aimed to glean from the respondent the degree of importance which he placed on a number of aesthetic or environmental factors, when calculating a market valuation. The reasons for asking this question were twofold. Firstly, the most immediate effect of stone cleaning is an aesthetic one, where the architectural character of the building or area will be altered, for better or for worse. Secondly, it must be borne in mind that this section of the research is looking at market value, which is only a constituent element of overall value. Whether the degree of success of the cleaning process which the surveyor perceives to have occurred is taken into consideration by the market valuations is extremely important, in that the variability of effect where a number of different cleaning methods are compared can be great. These variations might be regarded as subjective in the sense that an accurate measurement of difference in, for example, visual value, or colour variation over an entire facade, can be difficult. Nevertheless, such variations certainly exist, and whether or not surveyors consider them must be identified.

Space was allowed in question **nine** for any general comments which the respondent might have, and was designed to allow those who would be unavailable for interview to voice any opinions they may have on the subject of stone cleaning.

4.2.4 Discussion

The cleaning of external stonework on any building is costly to implement, so it is essential that certain gains can be expected in return. The majority of stone buildings treated will have a considerable residual life anticipated in the period following cleaning, so the effects of cleaning over that life must be considered. This chapter has identified the main variables which should be taken into account by the decision maker, and presents a model for implementation. Distributions and incidences with regard to maintenance work require further work examining the physical condition of stone post cleaning in order that existing research conclusions can be more readily applied in the field[15].

The principles of life cycle costing, as generally applicable to the property professions, relate to the total costs of producing and occupying a building (Stone 1980). Bird (1987) summarises how the overall life cycle can be represented using cost models, by considering,

- costs and performance;
- method (relating mainly to discount rates and techniques);
- data (reliability of data gathered for future estimations);
- capital / running costs relationship.

The final point concerning the relationship between capital and running costs is essential to this research. The implementation of a guide for best practice with regard to stone cleaning (Andrew 1991) requires the application of testing prior to any cleaning work, and suggests that where any doubt remains as to the expected integrity of the stone post cleaning that cleaning should not be completed. Where testing were not completed and the stone subsequently damaged, the cost of repair would likely outweigh the initial cost of testing. Conversely, where the cleaning resulted in a significant increase in the property market price realisable, this might well outweigh subsequent repair costs.

This chapter has illustrated that a number of variables contribute towards the financial effects of cleaning. These effects will manifest themselves over a number of years, following cleaning. Each of the headings used in the discussion presented above contain a number of variables, all of which will be taken into consideration in the cost model. An area lacking in previous research into the effects of cleaning has been the development of a mechanism by which such financial effects can be accurately measured for any given situation. The aim of this section is to use research results and the consensus of current expert opinion to suggest a structure for a model and how it might be used.

[15] The Masonry Conservation Research Group, RGU, Aberdeen, is currently undertaking a study concerning the long term effects of stone cleaning. The results of that study are due early 1999, and will be informed by the conclusions drawn here.

The variables which must be considered are as follows:

- Property market values;
  potential change in market value
- Initial cost of cleaning;
  cleaning process
  scaffolding costs
  other temporary works
- Long term maintenance costs;
  application of biocide treatment
  regular survey of stone condition
  possible stone repair work
- Re-cleaning costs.
  will be similar to initial cleaning costs, but might vary in magnitude.

The Monte Carlo simulation method was chosen for the current study as it allows for the incorporation of uncertainty and risk into the decision making process. Due to the uncertain nature of many of the variables and concepts discussed in this section, a great deal of risk is inherent in the financial assessment. Predictions for some variables can to a large extent be expressed using only a range of possible outcomes, and the Monte Carlo method allows for their full incorporation in the model.

A potential investor in the cleaning process would be eager to understand the likely financial implications. Of the variables discussed, the effect on property market values and the initial costs of cleaning are to be investigated within this study. The longer term costs, such as maintenance works and the incidence of re- cleaning will be predicted using slightly more wide-reaching assumptions, whilst taking care to base any conjecture in both expert opinion and knowledge.

For example, opinion regarding the appropriateness of re-cleaning stone facades varies considerably between parties, and has been influenced in recent years by research findings. Controls on the cleaning of Listed properties are far greater now than a decade ago, and these will continue to evolve. Any prediction as to the likely future demand (and supply) for re-cleaning, and any associated changes in property value and maintenance costs, will therefore by necessity exist over a range. By arriving at reliable financial predictors for each variable, these can be combined using the Monte Carlo simulation method to produce an indication of the holistic long-term outcome. Only once this process has been completed will it be possible to properly relate the likely financial gains and losses which can be attributed to cleaning.

For the purposes of a Monte Carlo simulation, before any figures can be introduced into the procedure, it is first necessary to establish suitable distribution curves for each of the variables. It is important that these curves represent whatever change might be expected in value as a result of cleaning, as opposed to a total cost which might accrue over the residual life span. For example, weathering of stonework is inevitable, regardless of any intervention such as cleaning. Therefore a certain degree of repair and maintenance will be required. If the amount of maintenance is varied by cleaning of that building, only this change should be included in the cost model. Each variable, however, must be considered differently, as the aims of the long term repair and maintenance cycle must be to preserve the building at as high a standard as possible with regard to structure, aesthetic value, heritage value and so on.

Each case of stone cleaning is unique, as the combination of stone type; orientation; degree of soiling; location; cleaning method used and area to be treated will be unique. Life cycle costing techniques and cost prediction models, by their very nature, rely to some extent upon generalisation of effect so as to allow the drawing up of generic models. For the current project, it was inappropriate to produce one model which could then be used to predict the cost or benefits of cleaning for all buildings as the individual situation would differ greatly between examples. What was appropriate, though, was to develop a model which could then be used as a foundation for all cost predictions.

4.3 Environmental value

4.3.1 Introduction

The previous section considered the effects of stone cleaning on the financial value of individual buildings. Most properties exist as discrete entities within property markets, this fact driving the financial value methodology. The analysis of individual properties is therefore useful both in that it provides an indication of the effects which might be manifested in the financial terms (i.e. the impact on whole life cost), and thus in it's close relation to the realities of stone cleaning practice.

Stone cleaning, however, has tended to change the appearance of larger areas of Scotland's major cities (e.g. Edinburgh's New Town district, Glasgow's Merchant City), as opposed to just single buildings. The townscape environment as a whole cannot be clearly delineated using simple market boundaries, as for the occupants of a city the space in which they dwell is defined by the wider built landscape.

> "The streets can be compared to rooms whose walls are the buildings on either side. In cities where the buildings form continuous rows, this conception is very clear. The experience of standing in a narrow street is quite different from a broad one."
>
> (Intersave 1995)

The townscape is in this thesis regarded as an environment in which society lives and works. Any major change in the appearance of such an environment could well have a correspondingly major effect on the value of experience within, and should be monitored carefully.

A number of studies have been completed examining the effect which conservation and redevelopment projects can have on values of the natural environment (Garrod and Willis 1990, Hanley *et al.* 1997), but a great deal fewer studies have been completed concentrating on changes in the built environment. The most notable example of environmental valuations in the urban context are studies investigating the relationship between market prices and air pollutants[16](Anderson and Crocker 1971, Atkinson *et al.* 1985, Freeman 1974, Ridker and Henning 1967, Wieand 1974), and a study exploring the value of Durham Cathedral (using

[16] Which were really exploring the value of controlling air pollution, rather than the value of buildings.

the contingent valuation method - Willis 1994). The Durham Cathedral study centred around an assessment of the entrance charge which would be acceptable to visitors, and the methodology was found acceptable to that end, due mainly to the fact that visitors were used to paying entrance charges at other similar buildings, thus easing visualisation of the "hypothetical market". It was found also that the potential amounts raised through the introduction of entrance charges would not be significantly different to the amounts already raised through visitors voluntary contributions, suggesting again that the method and payment vehicle were acceptable[17].

Many factors considered through studies of the natural environment remain valid for the built (e.g. respondent knowledge, maintenance costs and requirements, location of the site considered), amended where appropriate. Differences though do exist relating to the various uses to which the built environment might be put, and the manner in which it is perceived. Additional determinants which must be considered relating to the built environment include:

- historical significance of a building or buildings;
- location of a building or buildings;
- predominant use of buildings in any given area;
- any planned changes to the buildings concerned;
- policy regarding maintenance of an area.

The correct selection of an environmental valuation technique was essential to the success of the project, and the selection process is described below.

4.3.2 Selection of valuation method

The hedonic pricing method requires that an environmental change is measured using a recognisable and reliable scale. Determining a scale that adequately represents the variety and range of stone cleaning results and which can be related to an actual market is difficult. In addition, the financial methodology in the previous section illustrated how a building's use and location can influence the effects of cleaning on that market. Where buildings are to be considered in isolation, for modelling purposes such variations can be controlled. Linking environmental changes over an area would, however, require an extremely high quality and

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[17] It is, of course, quite possible that respondents were simply offering a willingness to pay in line with the amount they were going to donate anyway. If this were the case, it is possible that the maximum willingness to pay was not recorded, due to existing procedures for donation collection inadvertently introducing bias into the bidding process.

depth of data to be collected. This suggested an unduly harsh risk that the use of hedonic pricing would produce inconclusive results.

With regard to the travel cost method, the importance of non-use and intrinsic values might well be overlooked (reference could be made to the definitions in chapter 2). In addition, the reasons for individuals travelling to an area of the built landscape will be many, as opposed perhaps to natural landscapes (although the difference between built and natural landscapes in this respect will not always in reality be borne out). In was determined that the complexities in terms of both the financial cost of travel, and the rationale behind travel were sufficiently great to make use of the travel cost method extremely difficult[18].

The contingent valuation method was seen to have potential with regard to this project[19].

- no objective measure of the effects of cleaning was required;
- the consideration of areas is made possible through the use of hypothetical markets;
- the method allows for the collection of useful socio economic data;
- the elements of motivation and effect could be identified through the questionnaire design.

For these reasons, the contingent valuation method was identified has having the potential for use within the built environment (see also Allison *et al.* 1996, Willis *et al.* 1993), although a number of potential methodological problems had to be addressed.

4.3.3 Possible problems with contingent valuation method

Garrod and Willis (1990) review the unbiasedness, efficiency and consistency of the contingent valuation method, and consider the method in terms of how it might be viewed by economists, psychologists and statisticians respectively. They indicate that considerable overlap exists between the concerns of the various groups, but that methodological decisions serve to illustrate different approaches which may be taken to the method, and how various approaches might influence it's success. Each area of concern is discussed below, and the implications of each in relation to this study described and considered fully.

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[18] Reference should be made to chapter 9 - recommendations for further work.
[19] This is in agreement with Allison *et al.* (1996), who recommend the contingent valuation method as having potential for use in relation to urban conservation.

The main aim of most economists working within the field of contingent valuation is to, "*elicit a bid or valuation from a respondent, which coincides with some unknown 'true' measurement of benefit*" (Garrod and Willis 1990). It is possible that some degree of error or bias may be detected within the methodology or results of any contingent valuation study, and an effort must be made to reduce such error.

Section 4.3.3 takes its structure from Garrod and Willis (1990) with regard to the main list of factors to be considered. Each point is expanded upon where necessary, both in terms of the literature and the focus being placed on the subject of stone cleaning.

4.3.3.1 Strategic bias

Strategic bias may be present where the respondent uses the contingent valuation bidding format to further their own interests. In the field of stone cleaning, interested parties have often exhibited extremely positive or negative views on the subject, and strategic bias could be manifested through respondents giving artificially high or low bids to influence the study findings. Methods have been developed to identify cases where strategic bias has occurred (Schultze *et al.* 1981, Mitchell and Carson 1981, Rowe *et al.* 1980), through an analysis of the relationship between attitudes and levels of either willingness to pay or accept compensation (WTP or WTA). However, the relationship between attitudes and level of bid might be expected to differ according to the situation, and a strong link between the two could simply indicate strongly held values in many cases. Questionnaire design can however be geared towards the minimisation or detection of strategic behaviour, so as to identify those respondents providing outlying or unreliable bids. By first ascertaining a respondent's views on a subject, for example, the decision to use strategic bias may be reduced, or at least be more readily identifiable.

4.3.3.2 Starting point bias

The contingent valuation method can employ an iterative bidding process. This involves an initial bid being suggested to the respondent as a dichotomous (i.e. Yes/No) question. If the respondent answers that "Yes, they would be willing to pay that amount", a further increased figure is then suggested. This continues until the respondent answers "No".

Where a process of iterative bidding is employed in a contingent valuation study, a problem can arise regarding the position of the starting point used for the bidding process. The starting point should be selected at random, and the process continued until a "maximum" point is reached. Problems can emerge, however, where the respondent presumes the starting point to be indicative in some way of existing market conditions, and adjusts subsequent bids accordingly. Several reports have indicated that starting point bias has been problematic in previous studies (Rowe *et al.* 1980, Thayer 1981, Cummings *et al.* 1986), and where systematic bias can be shown, methods to remove the effect such bias must be employed.

Kahnemann (1986) suggests that where starting point bias is found to exist, the respondent is simply exhibiting a lack of knowledge of the commodity and market experience. However, since the contingent valuation method will most often be used to value items where no real market exists, the reality is that few respondents can be expected to have had any market experience, or had any prior need or desire to place an exact "figure" on their valuation of that good. Therefore, a contingent valuation study must attempt to reduce the effects of starting point bias, whilst recognising that the iterative process will by its very nature be influenced by the bid initially suggested.

A desirable outcome for this study was that not only the level of bid, but also the underlying reasons for that level, would become clear. It was essential, therefore, that respondents were able to state their valuation as freely as possible, whilst bearing in mind the desirability of a concise interview. Evidence from previous work (Ready *et al.* 1996) suggests that where respondents are presented with a dichotomous choice in relation to one possible level of bid that an element of "yea-saying" has taken place. The environmental valuation of stone cleaning has not previously been explored in depth, and the possibility that respondents might agree to a suggested bid was unacceptable, and a continuous (i.e. respondents allowed to state any amount) bidding mechanism appeared to be more acceptable for this reason.

The main reason for employing an iterative method to ascertain the bid is so the respondent is allowed to properly consider the final bid, as opposed to being asked for a once and for all answer in an open-ended forum. If the iterative method generates problems of its own, however, especially where the respondent is being asked to quantify his or her views on a subject which has not been previously considered in any great depth, the reliability of the gathered data will be questionable.

4.3.3.3 Payment vehicle or instrument bias

The method by which respondents are asked to bid for the goods being considered can have an effect on the bid received. A number of studies (Boyle *et al.* 1985, Cummings *et al.* 1986, Loomis 1990) have shown that a change in payment vehicle can effect the amount quoted.

Different payment methods can produce different willingness to pay estimates. However, some studies have shown little effect as a result, while Kahnemann (1986) put forward the argument that the payment method chosen was in fact an intrinsic part of the good, and that any changes in value as a result were indicative of this fact. For example, were the respondent asked to value stone cleaning using an increase in local taxation as the payment method, this would mean visitors to the area being excluded from the equation. In addition, the respondent may already have well-developed views regarding the use of local taxes, and partially base his decision on these opinions. Similarly, were a voluntary trust fund to be suggested as the payment mechanism, the respondent may begin to regard the bid in a similar way to a that of charitable donation, and make adjustments to his bid as a result.

Therefore, the payment vehicle might have some effect on the amount stated by the respondent as the maximum willingness to pay figure, and this should be given full and proper consideration in the concluding discussion.

4.3.3.4 Hypothetical bias

Respondents may be unable to respond to hypothetical scenarios in the way the researcher desires. For example, the bidding mechanism used for contingent valuation surveys may play an important part in the respondents' ability to assess his or her willingness to pay figure. It is normally the case that money raised by Local Authorities through the use of local taxes is done so using set figures, which will be determined by the Authority itself. By asking the respondent to estimate the increment in tax that he or she would be willing to pay is extremely hypothetical. Where a Local Authority collects a tax, failure to pay cannot usually be defended by the argument that the debtor disagreed with the amount, or method of collection.

Similarly, the use of a Trust Fund as a hypothetical payment mechanism also has problems associated with it, in terms of the validity of the derived results.

4.3.3.5 Mental-account bias

Mental account bias occurs where the respondent either under- or over-estimates the extent of the good being considered. In the case of stone cleaning this could be manifested by the poor visualisation of the townscape area to be considered, or the respondent failing to separate the effects of cleaning from the effects of general improvement works. Tversky and Kahnemann (1981) reported that respondents may have a tendency to value groups of commodities, as opposed to individual commodities, as well as in certain circumstances allocating more of their income to a commodity than is rational. Kneese (1984) suggested that where people are asked to measure one particular environmental factor, they may respond by allocating their entire "environmental valuation".

In the case of stone cleaning, for example, this could manifest itself with the respondent having a combined valuation for improvements such as stone cleaning, refurbishment of derelict properties, street lighting, and so on, but in the context of a contingent valuation survey valuing each constituent part with the total for the group. A certain amount of preliminary information should be elicited from the respondent, therefore, in order that the latent attitudes towards the subject area may be ascertained.

4.3.3.6 Information bias

Stone cleaning has associated with it an extremely complex system of participating bodies; possible results in both the long and short term; legislation; and sources of finance. The supply of information to the respondent group through the questionnaire format must therefore reflect this complexity. Many of the physical effects of stone cleaning will not be immediately apparent to the naked eye, and it could potentially be a number of years after cleaning before some effects became obvious. The depth of information required by the public to enable them to produce judgements similar to those of experts was examined by Kenyon and Edwards-Jones (1998), who found that respondents given only limited information (photographs and text) were able to formulate realistic judgements.

Whilst there is clearly a need to provide respondents with information so they are able to make a realistic decision (conceivably similar to if the market were non-hypothetical), there is a danger also that respondents may base bid levels upon information provided at the time of interview (Gregory *et al.* 1993). A difficult balance must be struck in this respect.

Hanley *et al.* (1991) employed the contingent valuation technique to consider the possible future cleaning of buildings within the Grassmarket area of Edinburgh. The respondent group was asked to identify their willingness to pay for the cleaning work, and were shown an artists impression of the area after cleaning as the sole source of information. A number of methodological problems exist here, in that the accurate prediction of a buildings appearance post-cleaning is extremely difficult, and that none of the possible negative effects of the cleaning process have been described. The results of the survey indicated extremely large bids from the respondent group, although an extremely weak correlation existed between the bids and the respondent groups' social profile.

By ignoring the complexity of the situation and presenting the scenario instead as one where the only possible effect is to lighten the colour of the stonework extremely weakens the methodology's validity. Although a large amount of research has been completed in the relation to stone cleaning, opinion is still very much divided as to the benefits and losses which can be associated with the subject. The contingent valuation method provides a mechanism by which subjects otherwise lacking a market structure may be valued by the respondent group. The respondent must, however, be given sufficient information regarding the lesser-known possible negative effects if he or she can make a realistic and balanced decision.

The process of stone cleaning results in a complex structure of gains and losses, and the contingent valuation technique, where properly planned, can help to clarify the situation.

4.3.3.7 Aggregation bias

In order that the total benefits available from a good may be measured, it is necessary upon completion of a study to aggregate the data gathered to arrive at a population measurement of value. A number of problems are present in this part of the study, which should be addressed. Where a subject such as stone cleaning is considered, the problem arises that stone cleaning in different areas will produce various degrees of success or failure. An attempt therefore to use the contingent valuation method to produce a total benefit for the whole country would be extremely difficult to control. For example, residents of a particular area will value work carried out in other parts of the country, to varying degrees.

Previous studies (Tolley *et al.* 1983) have shown that asking respondents to rate a number of subjects and then summing the ratings is not appropriate, as the respondent group will frequently be influenced by the isolation of each individual subject. It may be the case where valuing the potential benefit from stone cleaning that the contingent valuation method will be useful in obtaining further data on the public reaction to the stone cleaning of townscapes, but may be of limited use where attempting to derive an estimate of total value. The main purpose of using a technique such as contingent valuation in the field of environmental intervention however must surely be to gain a better understanding of public opinion in regard to the chosen subject. The subject and views surrounding any subject can be extremely complex, and the use of an aggregation technique would tend to imply that an artificial simplification was possible.

The use of aggregation methods and their results must be treated with care as the foremost aim should be to clarify the inherent complexity of the situation without suggesting that an impossible simplification was possible.

4.3.3.8 Framing, questionnaire and interviewer biases

The manner in which questions are posed through a questionnaire survey must be considered in such a way that the chances of the questions influencing the respondents bid response are minimised, and so that the respondent is given sufficient realistic information on which to base his decision.

In the context of stone cleaning for example, this should mean that efforts are made to reflect the negative as well as the positive aspects of cleaning whilst allowing the respondent to form their own opinions as to the relative importance and merits of each.

4.3.3.9 Heuristics and respondents ability

The variable ability of a respondent group to perceive the effects of an environmental alteration accurately can lead to severe and systematic errors (Garrod and Willis 1990). The subject of stone cleaning must be considered carefully in this respect, as a number of possible effects might not be immediately obvious[20] (Webster *et al.* 1991). Where a respondent were aware of aesthetic change, in either a positive of negative sense, but unaware of any other potential effects of cleaning, the bid received must be understood to reflect the value attached to an incomplete knowledge base. In reality, of course, value as it experienced relates not to a detailed scientific analysis, but to a subjective assessment by the individual. Where an environmental valuation gathers information relating to knowledge

[20] Refer to Appendix 1.

base as well as level of bid, an assessment of the influence of one on the other can be included in the analysis, thus avoiding unchecked bias in the results.

Hanley *et al.* (1991) investigated the extent to which respondents valued a general upgrading of Victoria Street in Edinburgh, which would include stone cleaning works. The effects of such work might include:

- changes in the financial profile of the area;
- alterations in the state of the stone itself and;
- a change in the perception of the area.

Webster *et al.* (1991) recorded the comments of a resident of Wardlaw Street in Edinburgh, regarding stone cleaning and upgrading work recently completed. *"I know it's only an optical illusion but the street looks wider and brighter... it's given people a pride which wasn't there before*".

Hanley failed to communicate the complexity of these possible effects to the respondent group, however, as the only communication of likely effect was via an artists impression of the visual change. The fact that the appearance of post-cleaning stonework is at present (and certainly in 1992) extremely difficult to predict means that the general deficiency is that the information might have been compounded by a misleading inaccuracy in the method chosen to communicate the likely visual change. This deficiency in the method used must be regarded as reducing the reliability of the data gathered, as the potential for response error has been greatly increased.

Great care is required when assessing the overall importance of any change caused by stone cleaning works, as the range of effect is great. The relative importance of the constituent parts of this change will also vary depending on the knowledge and views of the individual.

4.3.3.10 Errors in the sampling frame

It is of particular importance that the respondent sample used is appropriate for the survey itself. For example, lists of residents may be incomplete or contain duplications, making the reliable random selection of respondents extremely difficult. In the case of stone cleaning, with the consequent requirement respondents are aware of the range of potential effects of cleaning, the survey itself would probably be best completed within view of the townscape to be considered. Therefore, the respondents used will be either visitors to the area, working in the area, or resident of the area being considered for the study. The likelihood of an unrepresentative sample being used is thus reduced, but not removed. The profile of the respondent group must be analysed in all cases, to ensure that any unrepresentative skewing within the population has been recorded and recognised.

4.3.3.11 Vehicle bias

Garrod and Willis (1990) state that the researcher must decide upon the method which will be used to gather information. The use of mail surveys might be regarded as unsuitable for contingent valuation studies concerned with stone cleaning, as the information available to the respondent at the time of completion will be difficult to control. Kreisal and Randall (1986) and Loomis (1990) conclude that mail-based surveys and individual interviews can be regarded as having comparable reliability. The appropriateness of the method to the current situation must be properly considered, however, and problems regarding information and questionnaire bias controlled.

The method by which respondents are asked to place a value on environmental change should be properly considered also. Cummings *et al.* (1986) and Boyle (1985) discuss the merits of open-ended valuations, as opposed to iterative bidding procedures, Boyle placing doubt on the efficacy of iterative bidding. A problem may exist with the treatment of stone cleaning, in this respect, as the process has been heavily financed in recent years using public funds (Hanley *et al.* 1991 used a payment card to suggest possible bids). Possible difficulties exist in determining suitable suggestions, bearing in mind that the population affected by the cleaning will be difficult to judge. The use of a closed-ended format places a great deal of pressure on the accuracy of the original amount presented within the questionnaire, and leaves less room for an expression of value magnitude by the respondent.

Cummings *et al.* (1986) felt that "*starting point problems should be amenable to control through care in the design of the CVM* [contingent valuation method] *payment card*". Whilst the author is in agreement with the sentiment expressed, with the subject of cleaning it must be understood that most respondents will be unlikely to have considered the subject in such objective terms prior to the study. It is essential that an adequate range of data be gathered to ensure that where the situation presents comprehension difficulties for the respondent that the possible influences underlying the bid (i.e. prior knowledge, opinions) are gathered also.

4.3.3.12 Failure of the questionnaire

The questionnaire is the prime mechanism through which the researcher can ascertain the views and willingness to pay of the respondent. If the questionnaire format is flawed or is seen by the respondent as boring (Boyle *et al.* 1985), the data gathered will be far less reliable. The questionnaire must be designed so that all the information that may be required during the later stages of analysis is gathered using a minimal amount of time, and in such a way that the respondent is able to provide useful information without having to expend unnecessary mental effort.

With regard to stone cleaning, as well as the willingness to pay of the respondent, the respondent's prior knowledge of the subject, the personal interests regarding the area and the subject, must all be ascertained by the survey. Therefore, although an effort should be made to minimise the time taken to complete the survey form, care should also be taken to ensure that vital information is not missed.

4.3.3.13 Non-response

The incidence of non-response can have an effect on the perceived validity of the data gathered. The group of respondents who fail to respond to the survey may have different views from those who supply the required information, and thus, by not responding, skew the data set. Garrod and Willis (1990) indicate that non-response can arise from a number of sources:

- **i.** outright refusal to co-operate;
- **ii.** respondents being unavailable, even after repeated calls;
- **iii.** failure to return questionnaires or keep appointments;
- **iv.** inability to give the required information.

Items (ii) and (iii) do not apply in the case of street interview style surveys, which would be more likely where the value of a very visual environmental good like stone cleaning were the subject. Items (i) and (iv), however, may well have an effect on the methodology adopted, and the data set recorded. A pilot study will be completed prior to the main data gathering phase, the prime focus of this being the reduction of any problems which may be identified regarding the design of the questionnaire, in terms of length, content and style. Garrod and Willis (1990) state that the, "*key factor is perseverance, a CV study is only as* *good as the data it gathers and it is well worth the extra effort...to make that data as accurate and representative as possible*".

Time should be taken, therefore, to reduce the incidence of non-response, without unduly influencing the data collected.

4.3.3.14 Selection biases

The removal of outliers from a sampling frame to identify a greater consensual opinion may be misleading in itself (Heckman 1979). With regard to the subject of stone cleaning, this might be of great importance, as the subject has produced a wide range of often conflicting opinion. A removal of "outliers" might well produce an apparently solid agreement, but fail to properly reflect true diversity of opinion.

Arndt and Crane (1975) identify the potential problem of "yea-saying", where respondents introduce bias into their responses, due to a sympathy being felt towards the organisation or subject being researched. With regard to stone cleaning, a number of parties have voiced their opinions on the subject in a rather emotive manner. This could well lead to respondents giving artificially high or low answers, in order to give an artificially high profile to their own views. This problem can be partially overcome by gathering supplementary data on the respondents' prior knowledge of the subject, including information regarding their strength of feeling.

4.3.4 Confirmation of selection

Any current work must consider fully the implications of the research completed in the past, in order that the results derived from new work build properly on established theoretical foundations. Stone cleaning has potentially wide ranging effects that must be properly represented by the method chosen. Use of the contingent valuation technique contributes a new and greatly needed sense of objectivity to the discussion, and suggests a path towards the establishment of a conceptual model for the assessment and measurement of environmental value in the built environment.

4.3.5 Questionnaire design

The purpose of the questionnaire is to gather information, thus allowing an evaluation of changes in environmental value. It was essential that the design of the questionnaire provided a sufficient amount and depth of information to respondents to ensure that bids would be based realistically in a certain amount of knowledge about the subject, which it could then be assumed was known to all. In the event of the hypothetical market being tested using real donations or finances, it would be unlikely that many respondents would contribute without first being supplied with a suitable range of information regarding the likely outcomes. This supply of information was incorporated into the method itself to help increase the realism of the bid levels elicited[21].

As described in section 4.3.3, the minimisation of protest bids or questionnaire biases is an essential step towards the gathering of reliable data, and the questionnaire was designed so as to allow a range of opinion (both positive and negative) to be recorded. For example, the recording of a zero bid in some studies might be regarded as being a protest bid, and unrepresentative of the true feelings or values of the respondent. For this project, due to the potential for negative impact on the physical state of the building facade, it would be possible that low or zero bids gave a true reflection of the situation. A number of preliminary questions were included to recording any prior knowledge, views and background of each respondent to be recorded, allowing a richer picture of the overall situation to be drawn.

The questionnaire in its final form is shown in Appendix 6.

It was necessary that the research accumulated a data base profiling the respondent group, as well as gathering data regarding the range of bids received. The motivations and background of the group might well have an effect on the level of bid received, and it was essential that sufficient data was gathered to allow the detection of any bias in response. The initial part of the form (questions one to twelve) dealt with the familiarity of the respondent with the city area and topic being considered.

Questions one to four were concerned with the proximity of the respondents home to the area, whilst questions five and six explored the reasons for any visits by the respondent to the area. Question seven ascertained whether the respondent had been aware of cleaning being completed prior to the survey taking place, allowing the opportunity to expand upon this answer in questions eight and nine. Question ten tested for possible bias in the response of the respondent, resulting from views regarding links between public expenditure and stone cleaning. Questions eleven and twelve tested the prior knowledge of the respondent regarding research findings in the field, and imparted knowledge where certain facts were

[21] Refer to questions 11 and 12.

unknown. In this way, a criticism that could be levelled at the methodology regarding unrealistically positive bias on the part of the payment vehicle is countered by the insertion of a number of potentially problematic effects of cleaning. Care was taken with this part of the form to ensure that the effects were clearly labelled and stated as possible effects, and any comments by the respondents regarding their own views on these effects were recorded.

Question twelve was aimed at levelling the knowledge to the respondent group, through the simultaneous testing for prior knowledge and imparting of pertinent fact. The use of photographic images to impart this information was considered but rejected due to the potential for resultant questionnaire bias. It was felt, for example, that where respondents were unfamiliar with the potential for lack of aesthetic continuity due to a variety of cleaning methods used on a terrace that the location chosen for the survey should itself be used as an example (likewise with erosion of the stone face and algal growth). The use of a tangible real life example was thought to be a better illustration than a photograph which could be argued to be unrepresentative (either inflating or deflating the reality of any likely possible effect).

Section one of the form was designed to gather a sufficient degree of knowledge regarding the respondent group to allow any links between background, knowledge, age, home location or other views to be identified at the data analysis stage. An anticipation of that analysis during the questionnaire design allowed for a wide range of factors to be included in the later consideration of the subject, and prevented an unrealistic simplification of the situation.

Section two of the questionnaire was aimed specifically at the elicitation of a bid for the value of the cleaning. The contingent valuation method depends upon the level of bids received being later related to general respondent information. In this way, a "bid curve" can be derived illustrating the relationships detected, and allowing for those variables which might have a bearing on the decision making process to be identified and taken account of in future projects.

A potential failure of the questionnaire to produce reliable results was anticipated were the payment vehicle to relate a hypothetical market which would be unlikely were the project described actually realised. For this study, the use of a trust fund depending on voluntary once and for all donations from members of the public was described. Respondents were asked to estimate their own level of donation towards the fund, expanding upon the rationale for their level of bid in the questions following. Where in reality such a fund were set up, before individuals were to donate towards the fund, certain information would be required by the respondents themselves regarding the overall likely effects of the project, both in terms of any anticipated visual changes immediately following the cleaning and any effects expected in the longer term.

Question thirteen described the payment vehicle for the survey, and allowed the respondent to bid using an open ended question. The method of payment best suited to this project was unclear on a conceptual level due to the complexity of the situation. Many buildings not yet be cleaned are in the private sector, meaning that the use of public funds might result in biases

A method by which bidding can be completed with as little bias as possible is essential to the success of a contingent valuation study. For this project, the options were as follows:

- open-ended format;
- referendum format ("closed-ended");
- payment card;
- pair wise choice.

The open-ended format requires that the respondent supplies a bid without the questionnaire format offering any possible "answers". In this way, it could be argued that as little bias as possible will be introduced by the form itself, and that a truer reflection of actual value will be recorded. In fact, studies (Loomis 1990) have shown that dichotomous choice and open-ended bidding methods can produce equally reliable and apparently meaningful results. Conversely, as the form depends on the establishment of a hypothetical market, it could also be argued that the use of open ended bidding questions requires the respondent to consider a good in financial terms which will most probably have been regarded in purely intangible terms in the past, if at all.

A possible solution to this problem would be the use of the referendum format, where a possible bid is suggested, and the respondent required to state either "Yes" they would be willing to pay that amount, or "No", that amount would be too high (Bishop *et al.* 1983, Cameron and James 1987, Sellar *et al.* 1985,1986). Cummings *et al.* (1995) suggest that, where hypothetical markets are considered, respondents will find a dichotomous choice easier to answer, as it mirrors to a great extent the choice faced the market realised[22]. Results from that study show, however, that a significantly lower "yes" response was recorded when respondents actually had to pay if they answered "yes" to the value suggested. Due to limitations of the survey, it was further not possible to identify from this response those variables which might have contributed to the problem of "yea-saying". A significant problem with this method regards the motivations for either response being concerned with the concepts involved, as well as the actual WTP value.

The survey could also have used a payment card suggesting a range of possible WTP figures, from which the respondent must select a bid. Again, where the respondent wished to record a strong support or dislike for stone cleaning, the temptation to pick unrealistically high or low WTP figures could well skew the survey results. The "pair-wise" choice involves presenting a pair of possible outcomes from the proposed project, in terms of both WTP and physical/aesthetic/environmental change, from which the respondent must select the more favoured. This method requires each respondent to make a number of such choices.

For this project, the referendum and payment card formats both required that figures be presented to the respondent which might reflect likely WTP responses. Previous studies have concluded that referendum style bidding tends to result in artificially high responses, when compared with open ended questioning, although some success has been experienced using the referendum format provided the subject and level of bid are well suited to the method and the realistic (duVair and Loomis 1993). The actual cost of cleaning the areas considered would in reality depend upon a range of factors including current ownership and grant availability, making the production of "likely" costs per head difficult. It was also desired that the WTP bid received should reflect the respondent themselves, and not some imagined overall cost per head figure.

The use of a "pair-wise" choice method was rejected due to the decided method of questioning. The survey was to be completed in the areas to be considered, with respondents selected randomly from people walking through. The dangers of questionnaire fatigue leading to meaningless responses were acute, and the demands for a "lean" questionnaire great. For these reasons, it was decided to use an open ended, face-to-face format for data gathering, with notes taken where respondents commented on the reliability of the bid. Arrow *et al.* (1993) noted that a minimisation of non-response was essential, and face-to-

[22] An obvious problem with the logic here is that a real market would after time adjust price levels to meet the supply/ demand curve. Such an adjustment is not possible here.

face interviewing offered the most appropriate approach in that respect. Although potential difficulties were inevitable, on balance this was felt to be the most appropriate selection given the circumstances. Table 4.3 summarises the strengths and weaknesses of methods available.

Table 4.3 - comparison of bidding formats

Format	Description	Strength	Weakness
Face to face interviews	Respondents are interviewed face to face, preferably at the site being considered.	Clarification of information possible; response rate predicable.	Time consuming; interviewers preferably trained in subject area.
Telephone interviews	Respondents are interviewed by telephone, either through prior arrangement or "cold".	Non weather-dependant; respondents may be better selected than with "random" face to face format. Can be useful in piloting studies (Arrow *et al.* 1993).	Difficult to gauge ability of respondent to understand subject area; complex issues may require unsuitable simplification.
Postal surveys	Either through "random" mail shots or by selection, questionnaire forms distributed, preferably with postage paid reply envelopes.	High numbers of respondents can be contacted rapidly.	High non-response rates; difficult to ensure the respondent understands the subject; seriousness of answers difficult to gauge.
Bidding game	Higher and higher possible bids are suggested until the respondent replies they would not be willing to pay an amount.	Respondent does not have to suggest a bid at the beginning, which may be unclear in a hypothetical market.	Dangers of starting point and subsequent yea-saying bias.
Payment card	A card is prepared showing a range of possible responses, allowing respondents to gauge their own bid.	In a hypothetical market, respondents may need guidance as to likely "costs". These could be linked to overall cost or income levels.	Where a hypothetical market is being considered, amounts on the payment card may be misleading or produce bias in themselves.
Open-ended question	Respondents asked for their WTP without suggestion of a likely level.	No danger of bias due to the format suggesting a figure or figures which may or may not be valid or realistic.	Some respondents may find the question difficult to answer.
Dichotomous choice (referendum format)	Respondents presented with a WTP level and asked if they would/ would not be prepared to pay that amount.	Respondents presented with a straightforward question.	May be difficult to link bid level with socio-economic indicators; starting point bias; what amount should be suggested in a market previously untested?; danger of yea-saying.

The major factors which must be addressed during the questionnaire design stage for a contingent valuation study are as follows:

- ensure that a sufficient amount of qualitative data is gathered;
- ensure that an understanding of the respondent background and knowledge is reached;
- ensure that the suitability of the payment mechanism is established.

The first two points are extremely important with regard to cleaning as it deals with factors such as the geographical relationship between the respondent and the buildings to be considered, and allows the researcher to gauge to some extent how any prior knowledge of the subject might affect the bid. The knowledge base from which research in the field of stone cleaning is now derived has grown considerably in recent years, and the complexity of issues surrounding the subject has similarly expanded. The extent to which these findings have been absorbed into the general knowledge of the respondent group was an essential part of the survey, however. The level of bid elicited through any contingent valuation study would be influenced by prior knowledge of the respondent. For example, were the method used to derive a value for as-yet undiscovered species of natural vegetation, it is likely that the bid received would be very different to that received after species had been recorded and monitored. Whether or not the actual value would change, however, is another matter. As mentioned earlier, the most immediately obvious effect of cleaning is that of a change in colour. Especially in the case of stone types where the change in colour is from an extremely dark soiling layer to a much lighter stone surface (e.g. sandstone or limestone), the stone cleaning process might be regarded as causing only positive changes in value. A number of the possible negative effects of cleaning might well require time to manifest themselves, by which point a respondent unfamiliar with the research findings of studies into the effects might well reasonably make no connection between the cause and effect. Therefore, a section of the survey form was dedicated to both assessing the prior knowledge of the respondent group, and also ensuring that a certain balance was achieved between positive and negative effect prior to the bid itself.

A potential problem when using the contingent valuation method to value stone cleaning lies in the fact that although value changes exist in both positive and negative senses, it is difficult to build a bidding mechanism where it is possible to allow both positive (WTP) and negative (WTA) bids. The cost of implementing cleaning can be calculated, but the cost of not cleaning a building is zero. For this reason, the usual definitions for protest bids may not be applicable. Far from being able to simply ignore or remove from calculations any zero bids received from respondents expressing a dislike for the process, such bids must be regarded as valid statistical returns. A further problem surrounds the choice of payment vehicle itself. For the questionnaire used for the study a voluntary trust fund, paid for through one-off donations, was used for a number of reasons. An alternative, the use of increases to local taxation as another possible mechanism was rejected due to the fact that the increase in taxation which might be required to be obtained by a council to pay for wide scale cleaning of a city centre might be difficult for the respondent group to estimate accurately. A compulsory tax percentage increase would affect every resident to an area equally, regardless of their views of the subject of stone cleaning. In addition, the appearance of notable areas of the Scottish built environment, such as those areas targeted by the study, might well be of interest and importance to non-residents. Any non-resident, however, would be unaffected by changes to local taxes. With the use of a voluntary trust fund, however, this problem is overcome to a certain extent. Any respondent not valuing the effects of cleaning to any great extent was free to report a zero bid. Conversely, and respondent strongly in favour of cleaning would be able to reflect this through a higher bid, without having to consider how such bids might manifest themselves as a taxation increase.

Another potential problem for the study concerned the fact that many of the buildings as yet uncleaned in the areas targeted are not publicly owned or maintained Therefore, although a great deal of public funds are currently available in the form of grants to assist with future cleaning, the survey was asking the respondent group to estimate the extent to which they would personally donate towards a fund to pay for privately owned properties to be upgraded. The current situation, as stated, operates in such a way that money raised through general taxes are partially directed towards cleaning anyway. However, the number of steps between the actual tax collection and the cleaning taking place is sufficiently large as to diminish the magnitude of each individuals contribution towards the cleaning. However, the current study by necessity had to focus on the link between bid and cleaning. The magnitude of any bids received might therefore be substantially different to those currently given through mandatory taxation.

It was anticipated at the survey design stage that the questionnaire should be used to gather both monetary and social data, so as to establish if the implementation of cleaning works is indeed valued by the respondent group, or indeed if finances directed towards the process might be more effectively spent elsewhere. A major aim was to establish the knowledge, opinions and value which the general population regard the effects of cleaning. The questionnaire, therefore, was designed to allow the maximum possible amounts of information to be gathered so that this aims might be realised.

It was decided at the questionnaire design stage that the bidding question should be left open- ended. Previous work has shown that the use of suggested amounts through the use of either payment cards or dichotomous choice questions leads to higher bids being received due to the respondent wishing to appear generous (i.e. the "yea-saying" effect) (Kealy and Turner 1993, Brown *et al.* 1996), and that the open ended approach produces reliable and meaningful results (McLeod *et al.* 1994).

4.3.6 Aesthetic perception of stone-cleaned granite

4.3.6.1 Introduction

Data for the contingent valuation study was to be gathered in Aberdeen, Edinburgh and Glasgow, and it was anticipated there may be differences due to stone type, and the following hypothesised:

> "Aberdeen responses to an environmental valuation of stone cleaning may differ from those Edinburgh and Glasgow due to different perceptions of aesthetic change in granite and sandstone."

The most immediate effect of cleaning is the change induced in the appearance of the building. The extent to which such a change should be regarded as positive or negative has been investigated previously (Andrew 1992, Webster *et al.* 1991), but remains a complex subject. Nasar (1994) discusses the features of buildings that may evoke favourable evaluative responses. Evaluative responses have been found to consist of three components, namely pleasantness, excitement and calmness (Nasar 1988, Russell 1988, Russell and Ward 1981). It is also indicated that the evaluative response might be affected by a number of factors, such as shape, proportion, scale complexity, colour, illumination, shadowing, order and meanings which the individual may associate with that building, and that these criteria remain stable across cultural boundaries (Nasar 1984). "*Most studies confirm an increase in interest associated with complexity*", and most studies, "*...confirm preference for organising variables*" (Nasar 1988). This agrees with a number of statements made by Andrew (1992) regarding a study examining the effects of stone cleaning on the perceived aesthetic (i.e. visual) value of the built environment.

Webster *et al.* (1991) included a study of the effects of stone cleaning on building aesthetics. That study concluded that whether a building had been cleaned or not was indeed a criteria by which the respondent group compared buildings. In addition, the survey considered a number of building pairs where architectural similarity allowed for the effects of cleaning to be assessed. Through the use of semantic differential based experimentation, it was concluded in the majority of cases that cleaning resulted in an increased aesthetic[23] value. It

[23] Refer to chapter 2 for a full definition of aesthetic value, as used throughout this thesis. The visual attractiveness or beauty of a building is referred to, as opposed to any general social value.

was also hypothesised that the degree of soiling effects such change, with a small amount of soiling capable of producing gains in aesthetic value[24].

The main focus of the Masonry Conservation Research Group study was to examine the cleaning of sandstone buildings in Scotland. Therefore, all but one of the building pairs chosen for that study involved sandstone faced buildings, where the colour change involved was from the dark soiled exterior to a lighter cream/white or red. In essence, the colour of the underlying stone strata will have some effect the outcome of any aesthetic assessment. A large number of Scottish buildings are constructed from stone types other than sandstone, however, and it is possible that the aesthetic effects of cleaning non-sandstone buildings are perceived as being different to sandstone[25]. The aesthetic model proposed by Andrew suggests that cleaning will result in an immediate gain in aesthetic value, followed by a number of variations to that value during the residual lifespan. Although Andrew made no attempt to place units on the three axis (time, aesthetic value, complexity), the manner in which the model is applied or referred to will depend on the stone material used. Therefore, the effects of cleaning on granite buildings might differ from sandstone buildings.

The main aims of this part of the research were:

- i. to replicate Andrew's method to value elicitation;
- ii. to expand the results of Andrew's study to encompass a range of four further pairs of granite buildings;
- iii. to determine the aesthetic perception of the cleaning of granite buildings as an appendix to the environmental value model.

Aim (iii) is included to allow a deeper understanding of why differences in environmental effect might be influenced by aesthetic change. This study was to be completed simultaneously with the environmental valuation and aimed to inform that study. If this chapter concluded that the aesthetic effect of cleaning on granite buildings was greater, similar or less to that on sandstone buildings, would this be matched by the findings of the environmental valuation?

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[24] The relationship between the complexity of the stone surface and soiling levels is vital. Where complexity is high (i.e. stone carving work present) soiling might add depth and contrast. Where the surface is flat, however, even marginal soiling build up might result in significant losses in aesthetic value. Again, generalisation is made difficult, and each building must be considered individually.

[25] Reference to the results from the survey of General Practice Surveyors, presented in chapter four, indicates that Surveyors from Aberdeen felt the effect of cleaning on property markets would be greater in cities where non-

The pairs chosen for the study, and the rationale underlying their choice, are discussed below.

4.3.6.2 Methodology

Pairs of buildings were selected within Aberdeen which met a number of basic criteria, these being:

- the building facades were constructed from granite;
- the pairs were as similar architecturally as possible;
- one of the buildings had been stone cleaned, with the soiling layer on the other intact.

In meeting the second criteria, it was found that adjacent buildings within a terrace (or two buildings from the same terrace) offered a reliable solution. This mirrors the method adopted by Andrew. Care was taken also to ensure that the pairs had similar arrangements of windows, doors, and so on, and were not "mirror images" of each other, as lateral preferences could have led to bias (Valentino *et al.* 1988).

4.3.6.3 Photographic method

Photographs were taken using an architectural shift lens, allowing the removal of any keystoning effect from the images. The effect of this is illustrated in figures 4.6 and 4.7.

granite buildings were predominant. A perception that the effect on sandstone buildings was more marked than that on granite buildings was apparent.

Figure 4.6 - Photograph taken without shift lens

Figure 4.7 - Photograph taken with shift lens

It can be seen that without the use of the shift lens the building appears wider at the horizontal level of the photographer, and that the true shape of the facade is therefore not represented. An important factor to be considered here is that those areas further from the camera (i.e. towards the top of the building) appear smaller and therefore convey less detail information to the viewer. The architectural shift lens allows for this effect to be corrected to a great extent.

In order that the lens, which had a fixed focal length of 50mm could view the entire facade, it was necessary that photographs were taken some considerable distance from the building (up to 20-30 metres, depending on the building height). Film with a speed of no more than 200ASA was used to ensure that film grain size did not interfere with detail on the final print. Photographs would be manipulated subsequently by electronic means, and it was anticipated that a small loss of definition would result at that point. An inspection of the images selected for use in the final study uncovered no discernible problems regarding focus or detail.

4.3.6.4 Photograph manipulation

Before the pairs selected could be used for the study, it was essential that differences other than those caused by cleaning were minimised. It was essential that any data gathered, and conclusions reached, would be attributable to cleaning (as opposed to differences in paint colour, standard of joinerwork, etc.).

The method to be used to gather data, and the respondent group, were considered closely in relation to the image selected and manipulation. This should be regarded as being of similar importance to the choice of bid mechanism, and avoidance of questionnaire bias in the contingent valuation study. The responses of a group should relate to the question to hand, and be affected to as small an extent as possible by factors such as image quality or the angle to the subject from which a photograph has been taken. Therefore, images of the building pairs required to be manipulated to reduce differences other than stone colour and condition.

For each photograph pairing, although only one of the photos was to be changed, both were scanned into the computer and two images printed as an end point. Although the standard of printing could be expected to be near-original in quality, the process of scanning the image into digital format and later printing that image would almost inevitably introduce variations in the brightness and coloration of the image. These variations could be minimised, but it was essential that both halves of the pair were treated equally (i.e. if a change did take place, the effects of this would be reflected in data for both images, meaning that no effect would be felt when analysing for differences between the two).

The aim of the digital imaging process was to minimise differences between photograph pairings due to differences other than the stonework. This involved altering the pairs to ensure that the windows and doors were similar, and to remove any items from an image which might detract form the aesthetics (e.g. Estate Agents notices, lamp standards, cars). The software used for the imaging was Adobe Photoshop for the Apple Macintosh. Images were initially scanned, and stored as .tif files. Following these, table 4.4 summarises the significant differences which were to be removed.

Following the implementation of these changes digitally, the files were printed using the di-sublimation process, producing photograph quality images shown. For reference purposes, the original photographs were supplied to the graphics company along with the files, to allow a reference for brightness and colour. A comparison of the photographs and printed images reveals a slight reduction in resolution, but no significant change in image colour of brightness.

Table 4.4 - differences between paired photographs requiring treatment

Photographs paired	Alteration	Notes
3 and 4	No changes made.	
9 and 10	Roof from 9 superimposed over 10.	The original roof space windows on picture 10 were significantly different to those on picture 9. It was felt that this might affect evaluations. In addition, the presence of the lamp standard in picture 9 was removed from the roof on picture 10, to ensure that the alteration was as discrete as possible.
	Windows altered.	The windows present in the buildings photographed were different. Of particular note was the presence of a "for sale" sign in the window of picture 10. As far as possible, the reflections in the windows of each property were made similar.
	Door to picture 10 altered.	The door from picture 9 was superimposed over that of picture 10.
11 and 12	Windows altered.	The ground floor windows on picture 11 were replaced with those from picture 12.
	Door to picture 11 altered.	The door from picture 11 was superimposed over that of picture 12.
		The balance between light and dark on the final printouts proved difficult in relation to this pair of images. Both images were treated equally to ensure that any alteration was consistent to each.
13 and 14	Windows altered.	All windows on picture 14 were replaced with those from picture 13.
	Door to picture 11 altered.	The entrance door from picture 14 was replaced with that from picture 13.
		Due to problems concerning the maintaining of realistic shadow details, difficulty was encountered in the standardisation of the shop frontage. Rather than risk drawing the attention of respondents to the imaging process, and thus away from the experiment itself, the shop frontages were left unaltered for the final experiment.

4.3.6.5 Initial observations of four pairs

Initial observation of the pairs of images suggested a number of problems, in comparison with the earlier sandstone study. Due to the natural colour of the granites being considered, the colour change experienced is less dramatic than with sandstone. Rather than a change from grey/black to a cream or white, with granite the change is more subtle. Indeed, the photographs of the soiled buildings after electronic manipulation have perhaps greater aesthetic appeal than the originals. As the manipulation involved changing the standard of doors and windows (for perhaps a more attractive finish) it can be hypothesised that the aesthetic with granite buildings can be as affected by a general upgrading as by cleaning.

The later analysis of data to establish if a significant difference is recorded between cleaned and uncleaned granite properties would establish if aesthetic gains were notable.

4.3.6.6 Respondent group

The respondent group used for a previous study (Webster *et al.* 1991, Andrew 1992) consisted of students mainly attending evening classes. The study reported here attempted to broaden the range of respondent to include a wider range of background and age, thus perhaps better representing the reaction of the wider society. The respondent group included post graduate students, employees from with The Robert Gordon University (with little or no prior knowledge of the work of the Masonry Conservation Research Group, and based outwith the Faculty of Design), visitors to University open days and individuals approached by the researcher. In all cases care was taken to ensure that the prior knowledge of the respondent regarding the subject of stone cleaning would be unlikely to influence results.

4.3.6.7 Data collection form

In order that the results of this study could be compared directly with the sandstone results, it was decided that the same semantic differentials[26] would be used. The differentials were selected by a respondent group through the sorting of images through criteria of their own free choice (Andrew 1992[27]), the experiment itself having been developed from work by Oostendorp and Berlyne (1978). These criteria were translated into differentials for use in the data gathering exercise. It was felt for this study that the same set of differentials should be used to determine whether or not any changes or similarities noted between the two projects were due to the images, as opposed to changes in the methodology. A sample return sheet is show in appendix 8.

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[26] Semantic differentials are pairs of antonyms. Each pair is considered in turn in relation to each image. Over a scale 1-7, the respondent indicates where the building portrayed in the image should be placed (e.g. light/dark, clean/dirty).
[27] Golton (1996) asked respondents to sort houses into "construct" areas, with five core areas (type, age, style, uniqueness and character) in agreement with the results from Andrew.

4.4 Stone cleaning and its effect on heritage value

4.4.1 Introduction

Heritage value of the built environment is rooted in history, yet continues evolving and contributing to current and future generations. The extent to which the heritage value of a building or area can be embodied in building facades, and methods through which decision makers can assess that value, are the central points covered in this chapter. A major aim is to ensure that a less objective or numeric approach towards value assessment should not result in a loss of reliability.

Stone cleaning has been completed on a wide range of buildings, and that range has extended over architectural design, stone type, location, age of building and listing category. The heritage value of a building, as discussed in chapter three, can be linked with a number of factors, as hypothesised in Figure 4.8 (based on criteria used previously in Kalman 1980, Nijkamp 1987, Fusco Girard 1987).

Figure 4.8: The heritage value system associated with all buildings

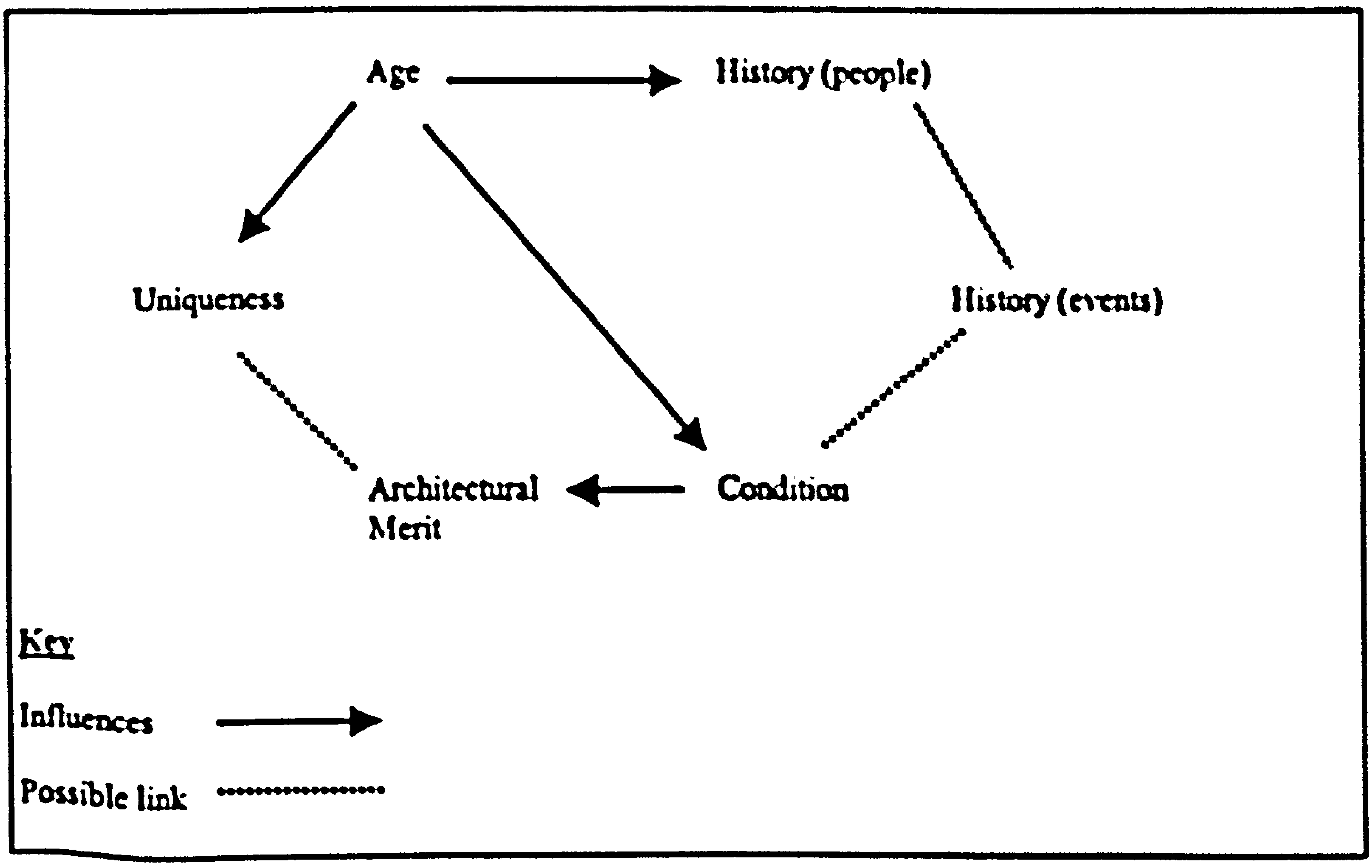

Figure 4.8 is useful in that we can see how the heritage value of a building is influenced by the past (e.g. historical events which may have taken place, or the original design) and the extent to which those factors might have (or will have) a bearing on the present or future (e.g. how well details have been preserved, the uniqueness of the design or craft skills used). Society has already formally attached a degree of historic worth to many buildings (in particular, through the Listed Building Regulations in Scotland). Where such an identification has been made, that will inevitably have a bearing on the value assessment, and lend weight to the importance of considering heritage values. It is argued here that all buildings should be so considered prior to cleaning, as un-Listed buildings may still make an important contribution to heritage (even if as part of a larger built area).

Rather than approaching a "valuation" of the built cultural heritage from the perspective of a wholly quantitative methodology (as with financial value), it is important that a range of subjective issues are considered. Methods such as the contingent valuation technique are useful indicators of economic potential (and relevant public opinion), but bring into sharp focus the dangers of concentrating on financial gain at the expense of other parts of the value system. The purpose of this section is to explore how we can be assured that heritage values will not also be lost over the longer term, or that heritage loss will not be masked by short term temporal gains. Where properly managed, it could be the case that stone cleaning has the potential to enhance heritage value, although the reasons underlying heritage value must be understood if reliable decisions can be reached.

When considering heritage value, it is difficult to utilise objective measurement units other than broad ranging bands, for example as used for Listed Building purposes. Indeed, much of the research completed to date has clearly avoided producing a discrete measurement scale, instead presenting methodologies for the "ranking" of alternatives (for example, Kalman 1980, Lichfield 1988, Melhorn and Kellor 1973, Nijkamp 1995). Heritage value lies in the richness and complexity of the value system, and relates to the architecture, history, integrity, period style, setting, region and material of a building. A straightforward economic cost/ benefit analysis would inevitably mean a simplification of these issues, with essentially non-monetary aspects of heritage difficult to identify in many cases (Coccossis and Nijkamp 1995). The nature of heritage value as attached to a building will depend very much on the individual building, or group of buildings.

Even within a designated conservation area, as protected by statute, there may be a rich variety of designs and materials, and this should be reflected in the assessment method.

When considering heritage value, concerns such as the cost of work or market operations should be of little concern (a full consideration is made through a separate financial assessment). In addition, much of the heritage value associated with a building will originate from the design (such as information or artistic work contained within stone carvings) or from social meaning attributed to a building, where it is clear that the building(s) is valuable, regardless of an "economic" contribution.

4.4.2 Heritage Value

Financial and environmental value are perhaps easier than heritage value to assess because units and reliable methodologies to help in their evaluation have been established and developed over the course of a number of decades. As made clear in earlier sections however, the units available should not be seen necessarily as being measurements of value as such, but as useful benchmarks for the decision process to use as a point of reference[21]. Although financial and environmental value have both been measured using currency as the scale, the "financial" scale could have been work-hours or resources required. Likewise, the environmental valuation could have asked respondents to nominate goods they might equate with the effects of cleaning, or to rank cleaning against other environmental changes. The important factor is that the methodology used in whatever case in appropriate, robust and reliable.

The extent to which the value system associated with stone cleaning is of use to the decision process relies on the ability of variables considered by the decision maker to reflect that value system. The aim of this section, therefore, is to illustrate complexities in the heritage value system related to cleaning, thus completing a picture of the overall value system began through the consideration of financial and heritage value.

[21] Indeed, with regard to those methods of environmental evaluation used here, the magnitude of effect has been measured making use of currency, but the rationale for this is determined by the presumed familiarity of the respondent with such a unit, thus assisting in the simplification of the method. The market used for that study (and most studies concerning non- market goods) was a hypothetical one, used to provide a useful benchmark.

4.4.3 Development of assessment framework

The literature deals with the objective and repeatable assessment of heritage in a number of ways, and to widely varying depths. For this project, it was observed that two factors were important:

- connections between the physical effects of cleaning and heritage value;
- the assessment of those connections in relation to individual buildings.

Although some work has been completed concerning the assessment of heritage, that work has often focused on the ranking of various objects of heritage worth (such as monuments), to enable a prioritisation of funding and effort. Defining the position of artefacts within the rank is the desired goal, and forms the basis for discussion and conclusions. Where the possible outcomes are to either clean or leave a building untouched[29], the application of a "ranking" approach, where a number of buildings are compared, is of little use. In addition, individuals owning one such property will normally carry the financing of cleaning, rather than a party with interests in a number of possible buildings. The requirement for this project then was a framework through which an assessment of risk to heritage value could be completed for an individual building. As with the financial and environmental models presented earlier, judgement may be still required on the part of the model user, the model providing a safeguard that all factors of importance will be included in that judgement.

The theoretical background to the assessment of heritage often involves the use of a range of criteria, through which a semi-objective conclusion can be approached. An unavoidable subjectivity prevails in parts of the assessment process (in particular with regard to the choice and definition of criterion).

4.4.4 Decision making with regard to heritage

Central to the aims of this project are the mechanisms by which decisions regarding cleaning are made, and methods by which such decisions might be influenced to properly consider research findings to date and established knowledge. The discussion thus far has illustrated how a richness exists within the value system through which decisions are made, and that

[29] In addition, the choice for each building is not as clearly dichotomous as presented here. The choice of cleaning method may have an impact on the physical outcomes, but the choice of cleaning method should be determined by the analysis of test panels rather than a consideration of value. For this project, ranges of possible methods are considered, with the implications for heritage discussed.

the constituents of that system will not necessarily benefit or suffer at similar rates or magnitudes. Therefore, by attempting to maximise value, certain trade-offs between these constituents will be necessary. Methodologies have been presented which allow an optimisation of multi- variable equations through vector optimisation[30]. Through such approaches, the extent to which trade-offs are both likely and acceptable can be uncovered. This study allows for the major variables involved to be identified and even, "measured", to a certain degree. However, the extent to which these measures can be directly compared with one another provides a problem in itself, making the direct application of many decision methodologies problematic.

Nevertheless, the balance between pairs of variables is vital, providing additional information with which a larger whole can be better understood. For the current study, an additional problem existed in that the, "variables", being analysed are, as discussed in chapter two, in reality nominal groupings of parts of the value system. Were the groupings to be altered, the points at which optimisations could be achieved would be altered also.

Soft systems methodologies, as applied within the project's overall methodology, also suggests an approach to controlling the heritage assessment process. The "CATWOE" breakdown was used to formulate definitions for the heritage assessment, broken down as follows.

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[30] Lakshminarayan *et al.* (1991) present a methodology using vector optimisation to assist economic-environmental decisions in relation to agricultural problems. The case studies presented allowed for an optimisation analysis concerning soil yield and fertility, varying till and soil type. It was illustrated how the balance between financial cost and sediment damage could be optimised.

The author's concern as to the robustness of approaches heritage value assessment was at least partially eased by the monitoring procedures included in the root definition as modelled here.

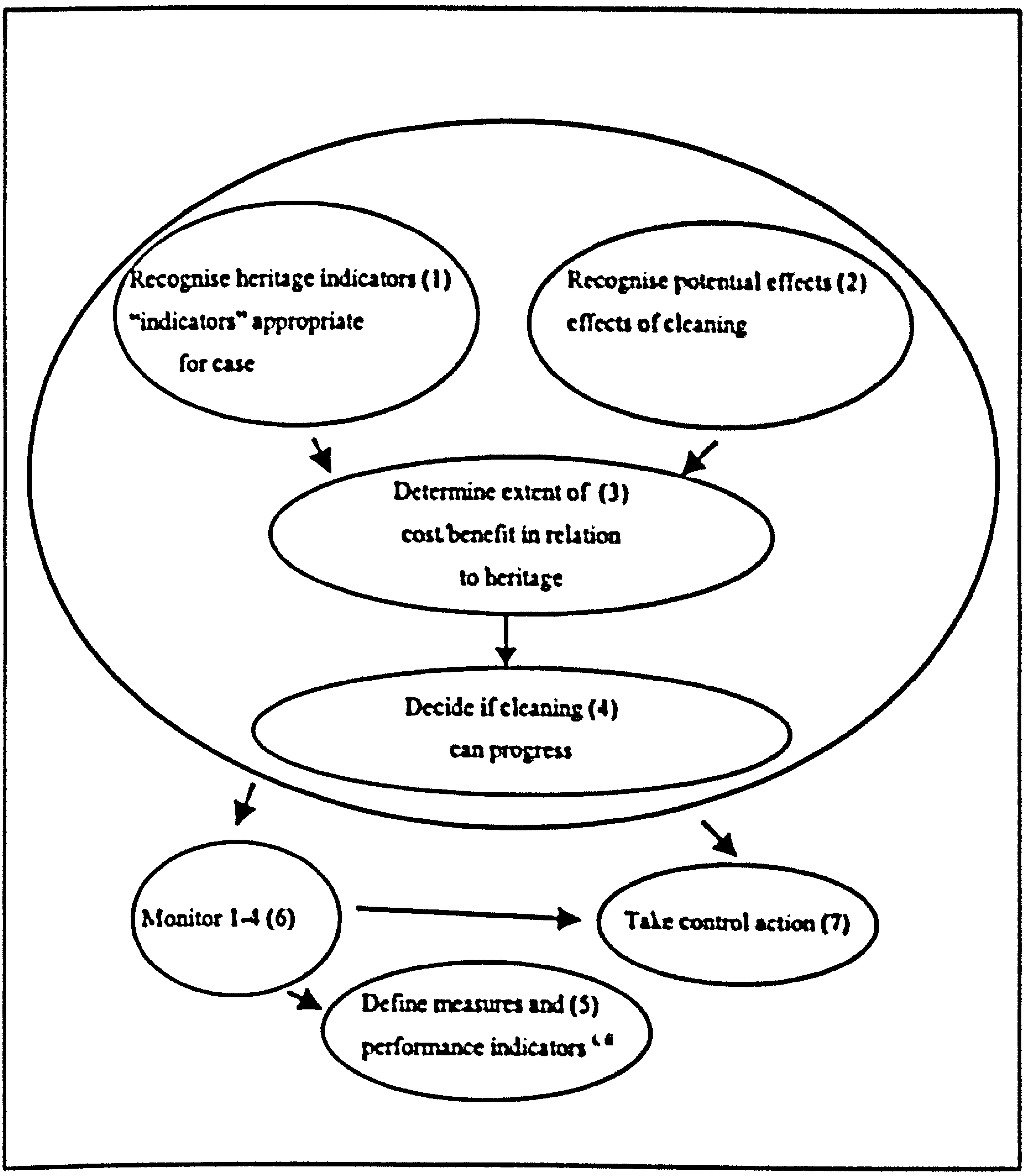
C	"customers" - parties involved with, or affected by, the transformation
A	"actors" - stone cleaners, specifier of method
T	"transformation process" - removal of soiling from facade
W	"Weltanschauung" - "world view" - removal of soiling can lead to aesthetic benefits (possibly more far reaching benefits also).
O	"owner(s)" - building owner, occupant, perhaps wider population
E	"environmental constraints" - planning controls over completion of stone cleaning. Completion of test panels where building listed, to protect against possibility of damage.

This approach can then be used to ensure that the relevant factors and parties are included in a "root definition" of the system or problem. A root definition developed in connection with the CATWOE breakdown, in relation to a privately owned property, would read:

> "A heritage protection mechanism, where soiling may be removed from the stone facade of an owner-occupied building, in order to realise aesthetic and other benefits, whilst avoiding the potential for damage to the stone itself or loss of heritage value."

Figure 4.9 illustrates the structure of the decision system which can be developed for an assessment of heritage value changes resulting from cleaning, applicable as a constituent part of an overall value assessment.

Figure 4.9 - heritage value decision system



Previous work in the field of heritage evaluation has tended to suggest that "expert opinion"-generated assessment criteria, without the control mechanism to ensure that approaches are monitored, revised and appraised for prior to future interventions, are sufficient to ensure a reliable decision. It is surely essential that the criteria and method are under a system of continual revision and development, risking otherwise that changing attitudes and knowledge are under-represented.

The mechanisms for heritage evaluation discussed in section 3.4.3 fit clearly into steps 3 and possibly 4 of the process shown in figure 4.9. The advance represented by the current project was to link the known physical effects of cleaning with heritage indicators, thus suggesting an approach to be followed in the future. The monitor and control features of figure 4.9 represent work described in chapter 9, recommendations for further work. An obvious fault in current heritage legislation is that not only is the process of evaluation and designation rather "hidden", the effects of that process have not been monitored, expressed, analysed and acted upon. Application of the above on a wide scale, with adequate data logging, would provide an excellent reference for the future.

The literature offers a number of methods through which criteria can be assessed and amalgamated once chosen, though, so the tasks to be undertaken fell into two sections:

- the selection and definition of criteria;
- the establishment of an assessment mechanism.

These stages are detailed in sections 4.4.5 and 4.4.6.

4.4.5 Assessment criteria

4.4.5.1 Introduction

Although a number of models and approaches have been developed in the past to allow the assessment of heritage (Anselin and Talin 1984, Kalman 1980, Lichfield 1962 and 1987, Melhorn and Kellor 1973, Nijkamp 1995), a common difficulty facing all was that of the assessment criteria. Should the criteria reflect the built environment as a whole or just the building or monument to hand. If only one building is being considered, should the criteria reflect the whole building or just those parts which are at risk?

For example, where a study is considering the effects of air pollutants on stone monuments, should an assessment of the risk to heritage value consider all aspects in which the monument is of heritage worth or just those aspects which may be placed at risk? This is of particular importance with regard to stone cleaning, as the manner in which buildings can provide "heritage value" will often be unaffected by the cleaning itself. A criteria through which buildings in Scotland may be listed is that of age. Even if great damage is done to a facade through cleaning, the age of that facade remains the same. If, on the other hand, heritage value lies in the detail on a facade, damage through cleaning will greatly reduce that value.

It is useful to consider heritage value from the following perspectives:

- For a given case, what portion of overall heritage value can conceivably be affected by stone cleaning?
- For the same given situation, how will that identified portion most likely be affected?

4.4.5.2 Criteria from the literature

Assessment criteria suggested by the literature concerning assessment of heritage tends to concentrate on the "entire" building. This is useful in that it is in line with listed building legislation[31], but of little value where a change to a building is being considered. As discussed earlier, there is a danger that an "overall" evaluation may mask problems in relation to significant elements. For example, were the interior of a building judged to be of great heritage worth, damage to the facade through stone cleaning might be proportionally diminished (heritage benefits could be similarly hidden).

Reference to the work of Kalman (1980), in relation to compound scoring, suggests the following set of criteria for an entire building. The author highlights those criteria affected by stone cleaning.

[31] Reference, for example, could be made to the practice of English Heritage (ref), where a *listing* may only mention the facade, but this is for identification purposes. The entire building is listed, not a component

Criteria Suggested by Kalman (1980) for use with the compound scoring method

Table 4.5 - heritage criteria relating to stone cleaning

	Affected by stone cleaning
A. Architecture	
1. style	
2. construction	
3. age	
4. Architect	
5. design	
6. interior	
B. History	
1. person	
2. event	
3. context	x
C. Environment	
1. continuity	x
2. setting	x
3. landmark	x
D. Usability	
1. compatibility	
2. adaptability	
3. public	
4. services	
5. cost	x
E. Integrity	
1. site	
2. alterations	x
3. condition	x

What we are left with, following the removal of unaffected factors, is a list of seven criteria, as follows. Kalman's suggested definitions are shown in italics.

B. History

- *context*

Associated with, and effectively illustrative of, broad patterns of cultural, social, political, military, economic or industrial history.

The "context" criteria is interesting in that the context is not the physical but the historical. This immediately forges a link between the assessment mechanism and the process through which heritage was created, that is the built environment mirroring patterns of social change, and cultural development (Pearce 1998, Snickars 1997, Zancheti and Jokilehto 1997). Where a building embodied such historical patterns of change, damage to the facade could be regarded as having a detrimental effect on the heritage value attached to the building, as the condition and quality of the historical record would be reduced.

C. Environment

- *continuity*
- *setting*
- *landmark*

Continuity: contributes to the continuity or character of the street, neighbourhood or area.

Setting: setting and/or landscaping contributes to the continuity or character of the street, neighbourhood or area

Landmark: A particularly important visual landmark.

The "environment" criteria are each of great importance, but will be influenced by stone cleaning in different ways.

The "continuity" and "setting" aspects relate to different sides of the same subject matter. Where a building contributes to harmony in a streetscape, the potential for loss of harmony exists. Likewise, a single building also relies on surrounding buildings to protect harmony where it exists, so a state of equilibrium will exist between a range of buildings. Stone cleaning *"will have a major effect on the appearance not only of the building but also of its immediate surroundings"* (Historic Scotland 1993). Therefore, the implications of cleaning for the maintenance of an aesthetic continuity must be considered, and the longer term implications dealt with. A variety of available cleaning methods can produce a range of "cleaned" finishes, with variation in terms of colour and stone surface characteristics. It would most likely be impossible to recover from a loss of continuity due to cleaning in isolation.

The "landmark" criteria refers to the physical importance of a building to a neighbourhood or larger area. A "landmark" building can be deemed so due to its size, historical background, materials used or apparent craftsmanship. Where the stature of the building could be potentially diminished by the effects of cleaning, the implications for it's heritage value are catastrophic. The primary aim of the heritage assessment is to ensure that such loss is not allowed to occur. Conversely, where cleaning enabled a building to regain stature and prestige through the heightening of it's visual impact (or visible detailing), it would be the case that stone cleaning improved the "environmental" heritage value.

D. Usability

- *cost*

Cost of preservation, restoration, maintenance, and/or interpretation is reasonable.

The cost of maintaining and running any building should be of great importance to the owner and user. "Cost" in this context can be taken to refer to financial repercussions of cleaning. Whilst an estimating mechanism for these costs will be developed elsewhere in the thesis, this section must consider the implications also[12]. Where financial costs resulting from cleaning are not met by corresponding benefits, might it be the case that heritage value is placed at risk (i.e. diminishing resources)?. Likewise, where the results of cleaning led to financial benefits (e.g. increased entrance receipts to an exhibition building), this might allow addition funds for other aspects of the heritage value to be consolidated (e.g. interior space).

[12] This can be taken to be, therefore, an example of a variable influencing all three areas of value. In addition to straight financial modelling, environmental returns might be influenced were, for example, longer term costs greater than expected. The concept of financial variables influencing cost is important, in that the three areas of value reflect that influence in three different, but equally valid and important, ways.

The way in which this variable relates to a given case will be influenced heavily by the building's use, location and aspects of heritage value not influenced by cleaning.

E. Integrity

- *alterations*
- *condition*

Alterations: has suffered little alteration, and retains most of its original materials and design features.

Condition: building is in good structural condition.

Under legislation in Scotland, the completion of stone cleaning work is deemed an "alteration", and listed building consent must be sought where the building is protected by legislation. Following this, the condition of a facade can be changed quite significantly by cleaning, in terms of both short and long term appearance, and physical state. Therefore, a building that embodies heritage value due to its integrity might have that value compromised through cleaning. An argument put forward might be that soiling itself indicates age, and therefore leads directly to value in itself[13]. Of perhaps greater concern is the thought that a building which has managed to survive relatively unchanged since construction might be forever changed and open to possible damage and decay, for the sake of essentially short term benefits. Whilst it is accepted that buildings are used in the present, where buildings are of heritage worth, we have a duty of protection for future generations. Feilden and Jokilehto (1993) state that the management and care of heritage must consider the historical time line which led to the creation of heritage in the first instance. That time line runs from the creation of an object, building or site, through the time until the present day, up to and including current perception. "*Historical authenticity should generally reflect the significant phases of construction and utilisation in different phases of its historical time line*". Were such an approach applied here, it could be argued that where is cleaning rejected on financial or environmental grounds that the soiling itself could be taken to reflect a significant period in the building's history. As soiling will return over time, that argument, should it also reduce a danger of damage to the building fabric, is important.

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[13] For example, Edinburgh Castle exhibits a medium to heavy layer of soiling, but has not been cleaned. Indeed, the local council

Clearly, of the original twenty criteria, we are left with a much smaller sub-set of indicators. If we were to approach the scoring method used by Kalman using the full set of criteria, approximately 60% of the possible scoring area would be unchanged by stone cleaning. The repercussions of this are twofold, and present three possible courses of action:

- Accept that stone cleaning is capable of only minority impacts on heritage value, and use a full set of "entire building" criteria.
- Use only those criteria that might be affected, thus providing an indication of *possible effect*, where a 100% gain or loss would represent the gain or loss possible through cleaning alone. This, it could be argued, would tend to over state the potential effect, and misguide the assessment.
- Apply both approaches, thus allowing the assessment to appreciate potential effects fully, but see that effect in context.

The selection of suitable criteria must be linked with both established practice and the known physical effects of cleaning. The use of weightings within the model itself was rejected for two reasons:

- the selection and measurement of weightings was thought to be unduly arbitrary, and would be influenced by knowledge and goals. In addition, the criteria are greatly interdependent (for example, condition and alterations) within overall variable groupings, as well as across the value system (for example, history and integrity).
- the model operates by structuring an assessment of the building, with the outputs indicating the likely impact on heritage. Weightings or client preference might well influence decisions taken after that stage, but are best applied to the basic data set.

It should be noted that although Listed buildings have an attached "weighting" - A, B and C(S), these are used for a categorisation rather than objectification of the heritage.

4.4.5.3 Criteria and physical effects of cleaning

As indicated in chapter three, the physical effects of cleaning can be hypothesised to potentially influence value (in all respects). The degree to which that effect will happen is highly dependant on the

- cleaning method used;
- stone type;
- environment in which the building is located.

Comparing the list of criteria suggested in section 8.8.1 with the range of physical effect, it is possible to draw up a plan of possible effect against likely magnitude. Of great importance is the link between the way in which a building is of heritage value prior to cleaning, and the manner in which cleaning might affect that value. It is inevitable that a certain amount of subjectivity will enter into the assessment mechanism itself, but a constant range of criteria will go some way to providing an adequate reliability.

A direct linking between physical effect and the criteria identified is presented in table 4.6.

Table 4.6 - Links between physical effects of cleaning and heritage criteria

Cleaning method	Potential physical effects	Heritage criteria (potentially affected)
Sandstone		
Low pressure water washing	• "heavy" soiling not removed	c1, b3, c3
	• potential for discolouration	b3, c1, c2, c3, e2
	• potential for efflorescence	b3, c1, c2, c3, e2
	• potential for freeze/thaw damage	c1, c3, d5, e3
High pressure water washing	• "severely" soiled areas not cleaned	c1, b3, c3
	• erosion of stone	c1, c3, d5, e3
	• potential for discolouration	b3, c1, c2, c3, e2
	• potential for efflorescence	b3, c1, c2, c3, e2
	• potential for freeze/thaw damage	c1, c3, d5, e3
Dry grit blasting	• loss of stone layers	c1, c3, d5, e3
	• success of cleaning depends on stone porosity	b3, c3
	• erosion of stone	c1, c3, d5, e2, e3
	• surface roughening (re-soiling)	b3, c1, c3, d5

Wet grit blasting	• loss of stone layers • erosion of stone • surface roughening (re-soiling) • potential for freeze/thaw damage	c1, c3, d5, e3 c1, c3, d5, e2, e3 b3, c1, c3, d5 c1, c3, d5, e3
Low pressure dry grit blasting	• low impact on stone • all soiling may not be removed • stone detailing may be uncovered	d5, e3 b3, c3 b3, c1, e2, e3
Chemical cleaning	• loss of grains • bleaching • potential for colour change • staining • efflorescence • hydration/ dehydration decay • potential for increased algal growth • surface pitting (acid cleaners)	c1, c3, d5, e3 b3, c1, c2, c3, e2 b3, c1, c2, c3, e2 b3, c1, c2, c3, e2 b3, c1, c2, c3, e2 c1, c3, d5, e3 b3, c1, c2, c3, d5, e2 c1, c3, d5, e2, e3
Granite		
Water washing	• unable of removing substantial soiling, even at high pressures • potential for freeze/thaw damage	c1, b3, c3 c1, c3, d5, e3
Dry and wet grit blasting	• erosion of stone • surface loss may result on softer or weathered granites • surface roughening (re-soiling)	c1, c3, d5, e2, e3 c1, c3, d5, e3 b3, c1, c3, d5
Low pressure dry grit blasting	• Less danger of erosion, surface loss or roughening than other blasting methods	b3, c1, c3, d5, e2, e3
Dry brushing	• Removes little soiling, but causes little damage	c1, b3, c3
Acid cleaning	• surface staining possible due to acids dissolving iron in the stone (not suitable for use with weathered or decayed granite)	b3, c1, c2, c3, e2
Poultice alkaline pre-cleaning	• danger of chemicals remaining in the stone leading to decay • potential for colour change • staining • efflorescence • hydration/ dehydration decay • potential for increased algal growth	c1, c3, d5, e3 b3, c1, c2, c3, e2 b3, c1, c2, c3, e2 b3, c1, c2, c3, e2 c1, c3, d5, e3 b3, c1, c2, c3, d5, e2

The criteria references given in the third column relate to similar references in table 4.5. The intention is to indicate how links between heritage and physical change can be achieved through the suitable selection of criteria. Clearly, all methods which achieve the basic aim of cleaning (that is, the removal of soiling) have the potential to influence categories "b" to "d", the extent to which this would be the case depending on the method and situation.

For any building where cleaning is proposed, the range of cleaning methods to be considered will be limited by current practitioner's guidelines, working constraints (e.g. noise) and cost. In addition, where test panels are carried out, the range of possible methods will be reduced further. Thus, table 4.6 should be referred to as part of the assessment, by way of a reference link between the physical change and heritage value.

4.4.6 Assessment mechanism

4.4.6.1 Introduction

The assessment mechanisms described and discussed through the literature review serve to provide a picture of the current state practice and knowledge. What becomes apparent through such reading is that the main thrust of work has tended to focus on a ranking of heritage artefacts, rather than an objectification as such. Rankings are of great use where resources are scarce and an allocation is required, but of little use where policy decisions are required, or where one building must be considered in isolation. A model is required, therefore, which provides a framework within which the heritage criteria and physical effects identified can be related, producing a structured value judgement.

4.4.6.2 Selection of model

The compound score method of assessment (Kalman 1980) suggests a route by which this project was able to progress. The criteria suggested within that project are broadly reflective of both national and international guidelines as to the consideration of heritage, and the physical effects of cleaning potentially have an influence across a range of criteria.

A two stage process was required to allow for meaningful data to be produced.

Stage 1

A pre-cleaning assessment of the heritage value of the building under consideration should be completed. This provides a benchmark for the study. It is also possible at that stage to isolate those variables which could possibly be affected by cleaning, and produce an assessment is relation to those only.

Stage 2

A predicted post-cleaning change to heritage value can be indicated. The range of criteria to be considered and assessed limits the amount of cardinal "scoring" required, and provides a standard framework for the assessment of all buildings. Stage 2 of the assessment should be related closely to Stage 1 in that the "adjustment" of points should be derived from that original appraisal.

4.4.7 Operation of assessment

An assessment of the potential effects of cleaning heritage in practice would relate to:

- current Listing status;
- a current evaluation of heritage worth;
- potential for change (links with cleaning method/ physical effect/ criteria.

As discussed, the implications of a building being Listed in Scotland are that planning permission must be granted prior to any cleaning work being allowed. In such a case, the decision-maker must decide whether progressing further with a value assessment is worthwhile. It could be argued that a preliminary consideration of the value effect would allow a judgement to be made regarding the likely chance of a planning application being successful. Where a building is not Listed, but forms part of a well defined townscape, the implications of cleaning for surrounding properties should be considered, also.

An evaluation of current heritage worth against the five main criteria groups should be completed. Reference to the literature suggests a number of possible approaches.

Kalman (1980) states that "*the use of numbers is the most accurate and most flexible manner of reaching a meaningful evaluation*". Whilst it is agreed that scoring each criteria to arrive at a total, the extent to which the answer is "meaningful" is unclear. For example, Kalman suggests that each building could potentially score a maximum of 100. Where a large number of buildings are "scored", a ranking or sorts will be produced, suggesting an ordering broadly similar to the Listing bands in Scotland. The point at which a building should score 20 as opposed to 18 (or any other score) for "architectural style" is unclear, however, and it is argued that a greater clarity would prove to be counterproductive. The importance of one criteria over another will vary depending on the situation, society, historical perspective, and so on. From the perspective of this project, it is also important to realise that a large proportion of the criteria applicable to an entire building will be unaffected by stone cleaning[34].

Kalman's further suggestions as to how "scoring" might be completed are interesting, though, in that clear links can be recognised with approaches to heritage assessment elsewhere. "Bandings" are shown in table 4.7.

[34] Indeed, the rationale for Listing or protecting many buildings will be due to particular aspects, rather than the whole. Where the exterior of a building contributes greatly to the townscape, and has done so historically, attaching a lower "score" because the interior is of little interest would indicate a failure to recognise the essentially social focus of heritage.

Table 4.7 - banding for the assessment of heritage

Criteria	Highest			Lowest
Architecture	perfect example	excellent example	good example	no interest
	designer of particular importance	designer of considerable importance	designer known	unknown
	excellent	very good	good	fair/ poor
History	primary importance	Secondary importance	secondary importance, loosely connected with building	no connections
Environment	particular importance	important	comparable with dominant character of area	incomparable with dominant character of area
Usability	compatible with current land use	compatible with proposed land use	present use unique to area	present use incompatible with area
	cost significantly lower than new build	cost lower than new build	cost same as new build	cost higher than new build
Integrity	unchanged, excellent condition	unchanged, good condition	changed, but character retained	character destroyed

A comparison can be made with conservation guidelines, to assess whether the *rationale* (if not the "scoring") employed by Kalman is appropriate.

Table 4.8 - banding used for Listing purposes

Guideline	Highest		Lowest
Scotland - Listed Buildings	national or international importance	regional importance	local importance
	architectural/ historic/ little altered	somewhat altered	altered
	fine examples of period, style or type	major examples of period, style or type	lesser examples of period, style or type

ICOMOS (1966 and 1988) concord that the importance of regional variation, cultural significance, fabric, complexity, setting, place, maintenance, use, conservation, adaptation and restoration works will all have a bearing on heritage value. The criteria identified as being potentially influenced by cleaning, falling under the broad categories of architecture, history, environment, usability and integrity are in accordance with the ICOMOS charters, and the suggested approaches toward grading are in line with "Listing" approaches (in that a progressive movement from national, little altered, fine example towards local, altered, lesser example can be observed.

For an actual application of this assessment in practice, the choice of cleaning method would be determined not only by the physical effect, but also by cost, availability and past experience. For the purposes of all assessments completed here, it will be assumed that low pressure dry grit blasting is to be used, as it has been identified as having the lowest potential for damage to the stone itself (although the initial costs may be greater).

For each of the criteria bands, the following approaches will be taken in the assessment of how stone cleaning could influence heritage value. Against each criteria, the current situation(s) should be noted. Reference to table 4.6 indicates the extent to which any particular cleaning method might affect each criteria, and the implications should be considered. A range between greatly reduced, reduced, unchanged, increased and greatly increased should be set out, and the likely effects of cleaning noted.

Architecture	perfect example	excellent example	good example	no interest
	designer of particular importance	designer of considerable importance	designer known	unknown
	excellent	very good	good	fair/ poor

History (context)	primary importance	Secondary importance	secondary importance, loosely connected with building	no connections

Environment (continuity; setting; landmark)	particular importance	important	comparable with dominant character of area	incomparable with dominant character of area

Usability (cost)	compatible with current land use	compatible with proposed land use	present use unique to area	present use incompatible with

				area
	cost significantly lower than new build	cost lower than new build	cost same as new build	cost higher than new build

Integrity (alterations; condition)	unchanged, excellent condition	unchanged, good condition	changed, but character retained	character destroyed

Clearly, the assessment attached to each criterion is largely subjective, but should be related in all cases to the likely physical change. In this way, the subjective nature of the model becomes a strength, in comparison to in Kalman's original model, where the "objective" scoring of building led to an artificial and unrealistic measurement of effect. The "result" of this assessment is twofold:

- The assessor is forced to consider the building from a heritage perspective. Regardless of the building's current Listed status, this helps ensure that a vital part of the value system be considered. Where a building is Listed, knowledge of the rationale for that listing will inform the assessment here (perhaps prior to an application for Listed Building consent).
- Rather than being faced with an unwieldy decision in relation to the heritage implications of cleaning, the contributing factors are reduced to a series of indicator bars, from which a conclusion can be drawn.

As with the other value assessment mechanisms to be used (i.e. financial, environmental), a complex subject area with many constituent variables and considerations has been structured to allow the decision-maker a clearer picture of the likely outcomes. A strong and lucid value judgement should result.

4.5 Summary

This chapter has set out the approaches to be taken with regard to data gathering and analysis for the research.

An objective approach towards the assessment of **financial value** requires that data be gathered relating to the effects of stone cleaning on property market prices. The "unknown" element of the financial system, being the extent of decay which can be expected to result from cleaning, has been isolated as such, and no attempt will be made to place an arbitrary or non-justifiable cost on that element.

The contingent valuation method has been selected for the assessment of **environmental values**. The potential for inaccuracy through use of the method was discussed, and fully considered at the questionnaire design stage. The environmental valuation will be completed in cities with both sandstone and granite buildings. The hypothesis that a change in material can influence valuation has been addressed, and a study examining the perceived aesthetic effects of stone cleaning on granite will be completed simultaneously with the main environmental survey. Environmental values are largely subject oriented, although the mechanisms available for assessment take an objective approach. The potential difficulties this raises for the methodology have been addressed in the survey design, and any problems experienced in the field will be noted.

The assessment of **heritage value** requires a consideration of a range of issues concerned with cultural and social attitudes, and how these have been reflected in legislation and suggested guidelines. The assessment of heritage value must address and appreciate the fact that heritage value exists due to the values placed on certain objects, buildings and monuments by society. Heritage is recognised as having a base in the historical "inheritance", but only through certain aspects of that inheritance being valued by current societies. The assessment mechanism presented aims to reflect the structure of established practice, whilst recognising that all buildings are part of the overall built environment, and hence could potentially contribute towards an overall, society-based, heritage value.

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5. *Financial value assessment*

5.1 Introduction

This section considers each of the major variables in greater depth, and where appropriate provides data for use in the model. Consideration of variables here informs the construction of the cost model in section 5.6.

5.2 Cost of stone cleaning

The initial cost of stone cleaning will be the most obvious and pertinent expense incurred by a person wishing to have their property cleaned, although as described earlier, that initial cost is just one part of the overall financial equation which should be balanced. As with any construction work, a range of associated costs must be met, as the work requires preliminary setting up procedures. Among these will be:

- any test cleaning required (including costs of analysis);
- the provision of scaffolding;
- the adequate provision of protection to the public;
- Contractors setting up charges which might be required (such as site facilities, etc.).

Where cleaning is completed as part of a larger works, a number of these charges will be met by the overall contract, with an allocation apportioned to the cleaning works themselves.

The completion of a probable cost study in the construction industry would normally make use of information from the practitioner to determine the likely cost of cleaning. Approaches made to three prominent stone cleaning firms in Scotland produced the range of cost data shown in table 5.1.

Table 5.1 - current costs of stone cleaning methods[1] (excluding any associated costs)

Method	Cost 1 (£)	Mean cost (£)
Low pressure water wash	3-5	4.00
Micro particle blasting	3-22	7.67
Low pressure dry grit blasting	3-12	7.00
Chemical alkali	5-24	13.00
Chemical acid	5-28	14.75

These costs relate to only the cleaning part of the work, and make no allowance for any other costs that may be incurred, depending on the situation. The costs of any temporary works are additional to these rates[2].

If the cost of temporary works can be spread between a number of building elements, or between a number of work stages, the proportional cost of any one stage (such as stone cleaning) is reduced, and this practical uncertainty is reflected in the model presented. By recognising that the estimate must exist over a range, the estimation process itself can better represent actual processes.

5.3 Cost of re-cleaning

The cleaning of a stone facade will rarely if ever produce permanent results that will remain constant for the remaining life span. Building facades in Scotland became soiled for a number of reasons, and these reasons will, in many cases, still exist (although in perhaps different proportions and quantities compared with past centuries). Due to re- soiling, the benefits of cleaning, therefore, have only a finite life span. Although a soiling layer formed over a short period would be unlikely to equal in mass and appearance that formed over a century or more, a point would, in due time, be reached where the aesthetic value of the facade had been significantly reduced (Andrew 1992). When such a point was reached, re-cleaning of the stone surface might be considered. It should be noted that developing controls over air pollution levels make it likely that the time between cleaning and a desire for re-cleaning will increase.

Where listed buildings or buildings within a conservation area are being considered, the re-cleaning process might be regarded as unacceptable, as the cleaning process in every case

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1 Please note that these costs were obtained for work currently ongoing with The Masonry Conservation Research Group, RGU, concerning the future consequences of stone cleaning. The rates are in line with current construction industry cost data relating to stone cleaning work, and have a base date of March 1999

2 Later examples concerning the operation of a financial cost model use a flat rate of £6.00 per m2 for cleaning. Were the model to run in relation to real- life projects, the rate should be verified against current costs, cleaning method and the outcome of test panels.

changes the characteristics of the stone surface. Indeed, if the benefits of the initial cleaning disappear rapidly, one should question the merits of undertaking the process at all. Where prominent parts of the built heritage are likely to have a long remaining life span, the re-cleaning process might be desired a correspondingly large number of times, meaning that the cumulative damage to the stone surface would certainly be greater than that envisaged originally. In addition, as a certain depth of stone might be removed along with the soiling layer at each cleaning phase, the visual and physical character of the stone exposed will change with each round of cleaning. The extent to which this point is pertinent will vary between stone types (for example, sandstone as a substance reacts to chemical cleaning agents differently to granite), and indeed between situations (i.e. the location, orientation and architectural design will affect the degree of post cleaning soiling or erosion), but cannot be ignored.

Nevertheless, it is the case that a stone facade will re- soil following cleaning, and that re-cleaning is the most effective method of returning the facade to an approximation of the immediate post cleaning colour. Therefore, the cost of completing such work should be considered fully as part of any deliberation as to the cost that should be considered prior to the first round of cleaning. As with the cost of initial cleaning, associated costs might vary the overall cost upwards, and should be properly combined into any modelling of the likely cost. It would appear to be the case that the possibly negative effects of stone cleaning are not being reflected in a number of valuations (see section 5.4.5.8). It is therefore doubly important that the costs of any resultant maintenance costs are reflected in any predictive mechanism for financial costing, and realised that the estimate might well vary for each round of cleaning. For example, the provision of scaffolding might be shared between elements at certain rounds of cleaning, but future cleaning phases might also be completed in isolation to any other construction work, meaning the proportion of scaffolding costs attached to cleaning would be increased. The potential for re cleaning could be incorporated in the model, although uncertainties regarding the extent of decay following each round make the formulation of absolute conclusions difficult.

As regards the prediction of the costs of re cleaning it is necessary that a certain amount of uncertainty be recognised in the equation. The frequency of re-cleaning will depend on a number of factors including:

- the rate of re soiling;
- the condition of the stonework;
- the status of the property (with regard to it being Listed);
- the current state of public opinion towards cleaning.

Therefore, any assessment of frequency or extent must recognise that these factors will each reduce the reliability of discrete predictions. It should be recognised also that the nature of particulate matter in the atmosphere which could lead to the build up of soiling layers in the future are likely to be of a different nature to those present in the past. Due to environmental controls being set in place over the past three decades, certain gases and emissions are no longer acceptable or tolerated (and levels present in the atmosphere are reduced). However, vehicular traffic continues to increase, so reductions in some potential soiling matter will be offset by increases in others. Decay processes will continue regardless of re-soiling. It should also be borne in mind that definite distinctions must be made between particulate soiling and biological colonisation of stonework. Both types of soiling can lead to changes in the appearance and aesthetic value, with the extent of each influenced by different sets of criteria including stone type, cleaning method, application, location, prevailing weather conditions and orientation.

The incorporation of re-cleaning should make allowance for the fact that maximum gains in property market selling prices might well be reached after the first round, and that gains anticipated at various stages in the future may be lower. This should be regarded at present as conjecture, and future work regarding both the aesthetic and physical effects of cleaning in the longer term should investigate its validity.

As with many cleaning methods the surface exposed after cleaning is newly exposed to the elements, and will be different to the freshly quarried stone, the behaviour of post cleaning stone might well be unpredictable. Coupled with the recommendation that biocide treatments be applied to the face of the post cleaned stonework (Urquhart *et al.* 1995), visual changes to a buildings facade post- cleaning should be considered prior to any work being completed. If soiling levels had reached a point where they had led to a significant reduction in aesthetic value, then the nature of the soiling layer should be examined to determine whether any biological colonisation had taken place. If so, then the failure to apply regular biocide treatments could be identified as a major cause of perceived aesthetic failure, thus suggesting a possible method of aesthetic rejuvenation other than re- cleaning. By its very nature, the likely incidence of re cleaning will be affected by a large number of different factors, including the current situation regarding listed building consent for such works, the current owner of the building, and the degree of re soiling recorded.

Continuing to clean a stone surface as part of a repeatable cleaning programme, in an attempt to recapture the initial results of the first round of cleaning is inevitably doomed to failure. With each round of cleaning, it is likely that further layers of a stone will be removed, however carefully the cleaning is implemented. The concepts of heritage value, discussed earlier in chapter two will be examined further in chapter seven. Where the heritage value of a building is embodied in the condition of a stone itself, the benefits of cleaning for aesthetic reasons are outweighed surely by a reduction in heritage value. Whilst repeated cleaning will produce repeated costs, where those costs might well lead to increased maintenance, the inclusion of this variable in a cost model sits uncomfortably with much recommended practice. If cleaning has the potential to cause permanent damage to stonework, and carries only temporary benefits, can even the initial cleaning be justified?.

Much of the foregoing discussion has concentrated on the immediate changes in the market value of a property as a result of cleaning. It should be appreciated that any initial changes in market value would be unlikely to accrue to the same extent after re- cleaning. Verhoef (1988) suggests that the maximum aesthetic value achievable through stone cleaning will decrease with each round. Although none of the complexity inherent in the subject is addressed (e.g. re-soiling particulate type, stone type, owner, stone decay), motivations behind a possible desire to re-clean should be challenged. The incorporation of this variable into a cost model is difficult therefore to place with reference to timing, magnitude and the repercussions.

5.4 Property market prices

5.4.1 Introduction

The questionnaire developed in the methodology to investigate the effects of stone cleaning on property market prices was distributed, and the results are presented in this section.

5.4.2 Analysis and discussion of results

50 questionnaires were returned, as shown in Table 5.2, below.

Table 5.2 - distribution of the respondent group

Location	No. of forms distributed	No. of forms received
Aberdeen	19	5 (26%)
Dundee	6	5 (83%)
Edinburgh	66	18 (27%)
Glasgow	59	16 (27%)
Inverness	5	2 (40%)
Kirkcaldy	4	2 (50%)
Perth	5	1 (20%)
Stirling	6	1 (17%)
Overall	170	50 (30%)

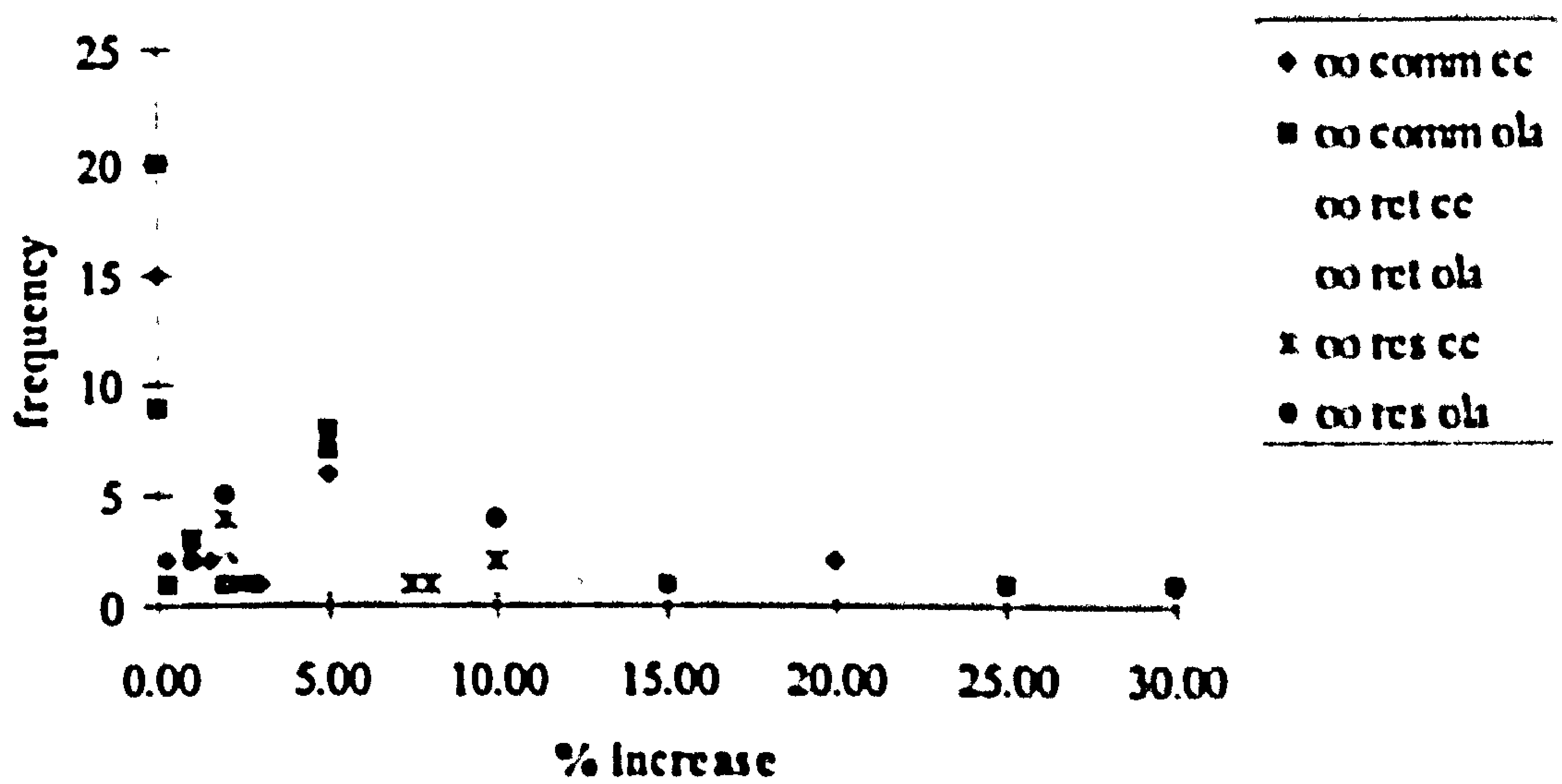
Results elicited from the questionnaire are presented in Appendix 4. As can be observed from table 5.2, the overall response rate for the survey was 30%, with all incomplete returns omitted from any analyses made. Of those surveys returned, 40.4% (19 respondents) indicated that they would be willing to be interviewed, if required, for the later stages of the study.

5.4.5.1 Predictable effect of stone cleaning on property market selling prices

The most interesting results, from the point of view of incorporation into a predictive model, are the adjustments that the respondents felt should be made to selling price as a result of stone cleaning.

A definite skewing towards zero was recorded in all twelve property categories, as shown in figures 5.1 and 5.2. Although the magnitude of skew varies between categories, it is clear that the shape of distribution remains constant. This fact is useful with regard to the definition of a possible cost model, as sampling across a range of properties will be possible, without having to necessarily redefine the model for each category.

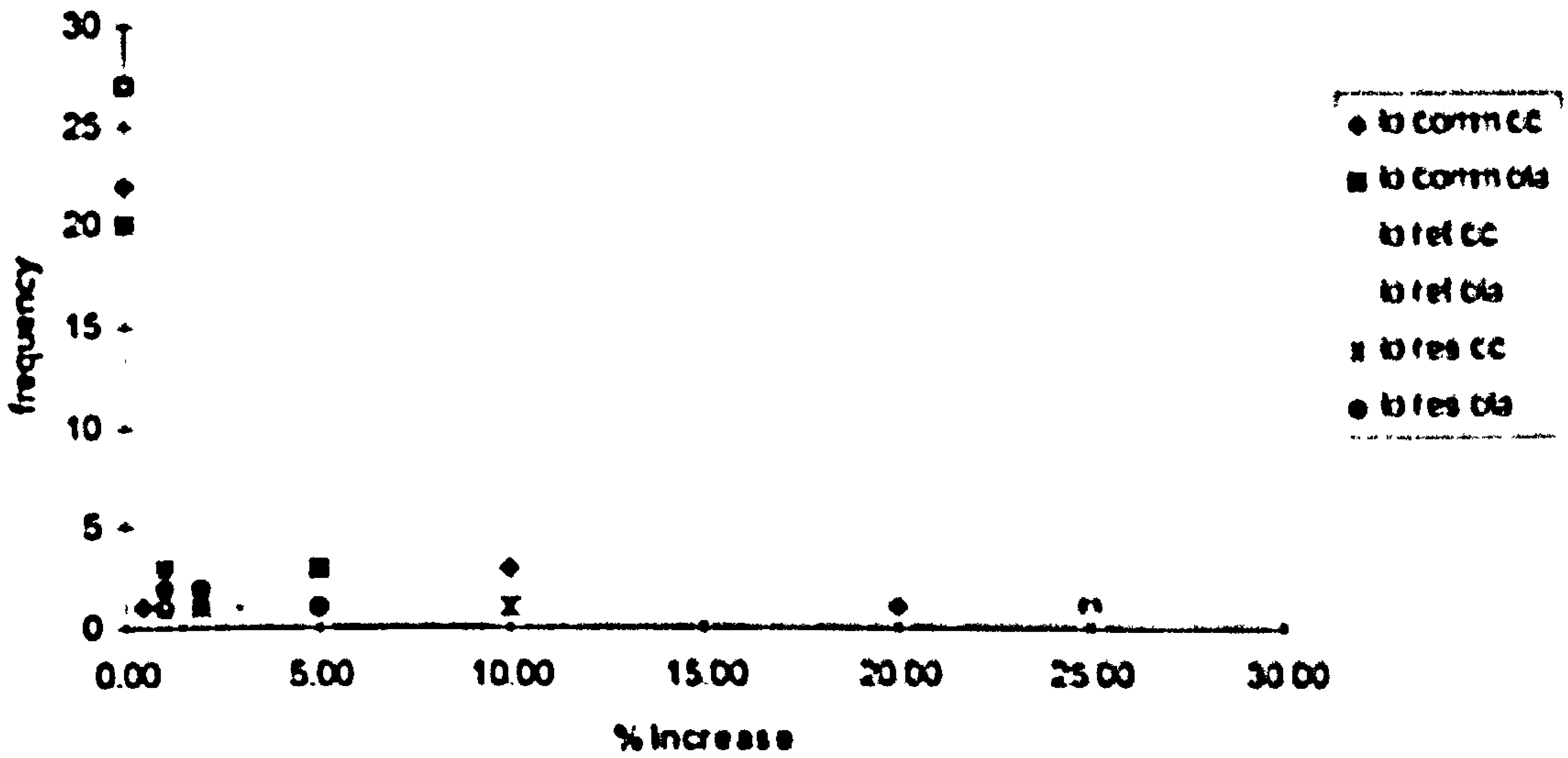
Figure 5.1 - Percentage increase in open market sale value of owner occupied properties, due to stone cleaning



Key

oo comm cc:	owner occupied commercial properties, city centre
oo comm ola:	owner occupied commercial properties, outlying areas
oo ret cc:	owner occupied retail properties, city centre
oo ret cc:	owner occupied retail properties, outlying areas
oo res cc:	owner occupied residential properties, city centre
oo res ola:	owner occupied residential properties, outlying areas

Figure 5.2- Percentage increase in yield of investor owned properties, due to stone cleaning



Key

io comm cc:	investor owned commercial properties, city centre
io comm ola:	investor owned commercial properties, outlying areas
io ret cc:	investor owned retail properties, city centre, outlying areas
io ret ola:	investor owned retail properties, outlying areas
io res cc:	investor owned residential properties, city centre
io res ola:	investor owned residential properties, outlying areas

Also of great importance were the different effects which stone cleaning is likely to have with regard to different property types, and different client groups. In Table 5.3 it is notable that, although the results are clustered around zero, a number of larger figures were also recorded.

Table 5.3 - Respondent groups' estimate of the percentage increase in property selling and letting prices which might be expected following stone cleaning works

Client type	Property type	Area	Mean %	Median %	Standard Deviation %
Owner-occ.	Commercial	City	3.66	1.5	5.65
		Outlying	2.73	0	6.70
	Retail	City	2.25	0	4.60
		Outlying	2.02	0	5.72
	Residential	City	3.04	2	3.73
		Outlying	3.01	2	3.46
Investor	Commercial	City	2.44	0	5.86
		Outlying	1.28	0	4.50
	Retail	City	1.22	0	4.70
		Outlying	0.97	0	4.43
	Residential	City	0.56	0	1.95
		Outlying	0.41	0	1.08

It may be seen that the mean predicted effect of stone cleaning on property selling price and letting cost tends to increase where the property concerned is in the city centre (the figures show an increased mean effect in every category, where the property is located within the city centre, as opposed to an outlying area). It is interesting to note at this stage that, although the mean effect on value is as high as 3.66%, the median effect in nine out of the twelve categories is zero. Where the trimmed mean was calculated, for residential properties in the owner-occupier market, the figure was much less than that calculated for the mean. The trimmed mean, which is less affected by outlying values than either the mean or the median, serves in this case to illustrate how there exists a skewing towards zero in even those categories where a number of larger responses have been recorded. In the category dealing with commercial properties in the city centre, where the client will be an owner-occupier, it may be seen that there is a cluster of responses around a median of 1.5%, indicating perhaps that this property category's market values are more reactive to stone cleaning than the others. Certainly, anecdotal evidence collected during the later interview stage would seem to support such a claim.

Extremely high skewness measures have been recorded (especially for the investor market), with high kurtosis figures indicating a strong cluster of values at the lower end of the scale. The fact that owner-occupier properties have registered a slightly higher estimate of effect on value than the other categories can be hypothesised as being due to a desire to reside in a building which is felt to be attractive, rather than for any hard financial reason, which the other categories operate under.

5.4.5.2 Effect of geographical location

A number of experts in the field of property valuation, approached prior to the dissemination of questionnaires, indicated that they felt Surveyors from the Aberdeen area would return lower estimates, due to the general perception that stone cleaning had a less dramatic effect on granite buildings than those constructed from sandstone, and this would seem to be a widely held belief. Analysis of the data collected via the questionnaire survey would seem to support such a claim, with estimates of effect from Surveyors in Aberdeen being considerably less than the national average in ten out of twelve categories. Only where the property being considered was residential in the investor market did the Aberdeen estimates exceed the national (0.75% in both city centre and outlying locations, as opposed to 0.60% and 0.44%, respectively, nationally). The buoyancy of the Aberdeen housing market at the time of the survey could have been a possible reason for this occurrence (the mean figures for Aberdeen's owner-occupied residential properties were higher than in other Aberdeen categories). The effects of stone cleaning on the aesthetic value of granite buildings in Aberdeen are examined further in chapter six.

Table 5.4 indicates the number of categories in which each of the targeted cities gave the highest estimate for percentage increase in property value as a result of stone cleaning work.

Table 5.4 - The number of categories in which the respondents from each city returned the highest estimate of effect on property selling and letting prices

City	Number of property types
Aberdeen	1
Dundee	3
Edinburgh	1
Glasgow	6
Kirkcaldy	1

It can be seen that Surveyors from Glasgow returned the highest estimates of effect in six of the property type/client categories. Further analysis of the returns indicated that estimates from the Glasgow respondent group were higher than the mean estimate in ten out of the twelve categories. Glasgow has been cleaned widely over the past two decades, and this has had a significant effect on the appearance of the city with many red sandstone buildings that had taken on an extremely dark soiled appearance visually transformed. Due to the large scale of the cleaning implemented, in terms of surface area at least, the generally more positive response of those respondents from Glasgow might be taken to indicate that the scale of the work has had a correspondingly great effect on the property markets.

Analysis of the data with regard to the geographical base of the respondent has indicated that this is a factor that should be considered in a predictive exercise.

5.4.5.3 The significance of the standard of cleaning achieved to the increase in market value or yield

Later sections in the questionnaire were included so as to allow a richer understanding of the rationale behind the responses to the percentage estimate questions (questions five and six) to be reached. The statistical significance of the relationship between the responses to questions five and six, and the importance of the standard of cleaning achieved, was examined using the t-test[3]. The respondent group was asked in question eight to indicate on a seven-point scale the importance that they felt the standard of cleaning would have on their estimate. The results are shown in Table 5.5.

Table 5.5 - significance of the standard of cleaning achieved with regards to property selling value and yield

Property type			Absolute t-test result	Significant
Owner occupier	commercial	city centre	1.56	
		other areas	1.77	YES
	retail	city centre	1.59	
		other areas	1.62	
	residential	city centre	0.58	
		other areas	0.53	
Investor	commercial	city centre	1.09	
		other areas	1.27	
	retail	city centre	2.27	YES
		other areas	2.21	YES
	residential	city centre	0.72	
		other areas	0.82	

The results of the t-test analysis[4] indicate that for retail properties in the investor market the standard of cleaning achieved is significant with regard to the effect on yield. The impact of stone cleaning on the marketability of properties was referred to by a number of respondents during the written questionnaire round. The importance of the marketability of retail

[3] The t-test is used to determine whether a variable is useful when trying to determine the value of another. In the case of this study, the t-test was used to analyse the relationship between individual variables and the predicted change in market selling value or yield.

[4] For a t-distribution at a 95% confidence level, with between 43 and 46 degrees of freedom, the t-test result must be greater than 1.68.

properties (in the rented sector) should be recognised, and the results shown in Table 5.5, suggest a rationale for the cleaning of properties within that category.

5.4.5.4 The significance of the prestige value of a building with regards to property selling value and yield

The statistical significance of the relationship between the predicted change in selling value and yield obtainable, and the respondents' judgement of the buildings prestige'[5] value, was tested using the t-test hypothesis test. The results of this are given in Table 5.6.

Table 5.6 - Significance of prestige value to property selling value and yield (cleaned buildings)

Property type			Absolute t-test result (cleaned buildings)	Absolute t-test result (non-cleaned buildings)
Owner-occupier	commercial	city centre	**3.30**	**3.63**
		other areas	**4.30**	**4.23**
	retail	city centre	**3.07**	**3.40**
		other areas	**3.82**	**3.69**
	residential	city centre	0.02	0.23
		other areas	0.36	0.22
Investor	commercial	city centre	**3.60**	**3.58**
		other areas	**5.18**	**4.96**
	retail	city centre	**5.13**	**5.50**
		other areas	**5.28**	**5.43**
	residential	city centre	0.29	0.89
		other areas	0.68	0.77

(Significant results of the t-test are indicated in bold.)

The results shown identify clearly that the respondent group felt the prestige value of the building is of significance in all categories except residential, and that this relationship exists regardless of soiling levels. The heritage value that might be attached to a building or group of buildings was discussed in chapter two, and it was considered possible that stone cleaning could potentially enhance or reduce such value. Where buildings are subject to the mechanisms of the property markets (i.e. non-publicly owned properties), however, this relationship is not reflected in the responses gathered.

5.4.5.5 The significance of the aesthetic appeal of a building with regards to property selling values and yield

Question eight investigated the importance of a building's aesthetic appeal to the valuation of cleaned and un-cleaned buildings, respectively. The statistical significance of the

[5] No definition of "prestige" was incorporated into the questionnaire itself. The accepted dictionary definition was, therefore, assumed. No respondents noted any lack of understanding with regard to this variable.

relationship between the responses to questions five and six (estimate of the magnitude of effect on value), and the surveyors judgement of the buildings aesthetic appeal, was tested using the t-test hypothesis test. As explained in chapter two, the definition of aesthetic used by the writer when developing the questionnaire was synonymous with that found in a dictionary, and the meaning of aesthetic understood as it is used in everyday life. Therefore although the term if so directed and defined could be used to conceivably encompass such factors as historical or prestige value, that is not the case in this study. As will be discussed in chapter six, the aesthetic value of a building is, to a great extent extremely variable between respondents. The relationship between selling value or yield, and the importance of aesthetic appeal was analysed, and the results are given in table 5.7.

Table 5.7 - the significance of aesthetic appeal to the market valuation of buildings

Property type			Absolute t-test result (cleaned buildings)	Absolute t-test result (non-cleaned buildings)
Owner occupier	commercial	city centre	0.84	**1.85**
		other areas	1.06	**2.39**
	retail	city centre	0.59	1.70
		other areas	0.65	**1.84**
	residential	city centre	**1.98**	1.01
		other areas	**2.81**	**1.82**
Investor	commercial	city centre	0.64	**2.01**
		other areas	0.11	**3.04**
	retail	city centre	0.35	**3.82**
		other areas	0.38	**3.69**
	residential	city centre	0.27	1.56
		other areas	0.17	1.70

(Significant results of the t-test are indicated in bold.)

Results here indicate that the respondent group regards the aesthetic appeal of a building as being distinct from the standard of cleaning achieved. For cleaned buildings, the results indicate that only where a building is being bought as the residence of an owner-occupier will the aesthetic appeal be significantly related to the overall selling price. With non-cleaned properties, mainly commercial and retail properties in the investor markets might benefit from greater aesthetic appeal, resulting in higher rental levels.

5.4.5.6 The significance of a building's surrounding environment with regards to property selling values and yield

The statistical significance of the relationship between a property's selling value or yield and the surrounding environment of that building was tested using the t-test hypothesis test. The results of this analysis are given in Table 5.8.

Table 5.8 - The significance of a building's surrounding environment with regard to property selling values and yield

Property type			Absolute t-test result (cleaned buildings)	Absolute t-test result (non-cleaned buildings)
Owner occupier	commercial	city centre	**2.90**	**2.59**
		other areas	**3.16**	**2.19**
	retail	city centre	**1.92**	1.58
		other areas	**2.13**	1.57
	residential	city centre	1.46	1.29
		other areas	**2.08**	**1.85**
Investor	commercial	city centre	**2.77**	**2.20**
		other areas	**2.88**	**1.83**
	retail	city centre	**2.72**	**1.76**
		other areas	**2.81**	1.65
	residential	city centre	0.78	0.54
		other areas	0.85	0.63

(Significant results of the t-test are indicated in bold.)

It has been suggested by Andrew (1992) that the environment surrounding a building can have an effect on the change in aesthetic value attributable to cleaning. In particular, the unity of terraces can be disrupted to a great extent through either the indiscriminate use of a number of cleaning methods, or the cleaning of only selected properties, leaving what could be termed a patchwork appearance. It can be seen from the analysis that the surrounding environment of a building, in the opinion of the respondent group, is of significance with regard to market worth. In addition, the number of categories affected increases from three to eight following cleaning. This serves to illustrate that cleaning can tend to amplify the importance of the setting of a building with regard to the property markets, and partially supports Andrew's suggestion that visual value reverberates through all aspects of the value system. It is extremely important, therefore, that this aspect of the financial equation is known to the decision-maker involved in the possible application of cleaning. It has been shown that the decision making process must consider properly the implications of treating properties as being individual where in fact there is a need to respect that the built environment has developed to form a largely continuous and well defined whole.

5.4.5.7 General data regarding respondent sample

Of the 50 respondents replying to the questionnaire, 63% had been involved in the valuation of a property that had been cleaned within the last twelve months. In addition, 36% had been involved personally in the execution of a stone cleaning contract at some point in the past[6]. These figures lend support to the argument that the respondents had a reasonable degree of knowledge regarding the stone cleaning process (and/or it's results), to give estimates of effect with a satisfactory degree of authority.

The data indicated that there was a general trend for the respondent group to be involved more heavily in the valuation of properties for sale, although both properties for sale and rent had a mode involvement figure of 50%, as shown below.

Table 5.9 - general workload of respondent group

Property	Mean	Median	Mode
Rent	32%	25%	50%
Sale	63%	70%	50%

It could be argued that estimates provided for investment (rental) purposes are of a slightly less reliable nature than those for the owner-occupier markets. However, a certain number of properties valued for sale will subsequently be available for lease, so that may not be true in reality. The position of the mode, and the high standard deviation figures, (23% and 26% for rent and sale, respectively), could in fact lend weight to the argument that both valuation categories may be regarded as having equal reliability.

5.4.5.8 Interviews

A follow-up round of face-to-face structured interviews with eight selected respondents was completed, making reference to both sandstone and granite, in order that any queries arising from the questionnaire data could be clarified. A number of questions that by their very nature were made difficult to ask via the questionnaire format were also addressed. The format and results of the interviews is shown in table 5.10. Note that only questions 1,2,3 and 9 were asked directly at every interview, the remaining questions arising through the course of discussion.

6 Reference should be made to Appendix 4 for further details of the example applications.

Table 5.10 - Structured interviews completed with Surveyors

Question	Question	Response
1	Do you feel that stone cleaning has any effect on property market prices?	None on granite buildings (1 resp.) Will influence sandstone prices (5 resp.) Yes, but very minor (1 resp.) Yes, very much so (1 resp.)
2	If so, what is the nature of that effect?	Possibly used for "end" adjustments to a calculation - minor (2 resp.)
3	Might stone cleaning affect marketability?	Yes, it is useful in this respect. Therefore, cash flow is improved, improving profitability (3 resp.) Initial impression vital (2 resp.) Improves image (1 resp.) If over an area, might create value (1 resp.) No opinion (1 resp.)
4	What role might grants play in the stone cleaning market?	Grants are available mainly because stone cleaning has only a minor effect on market price (1 resp.) Since grant aiding lowers the initial cost, an expected effect on marketability will encourage cleaning (1 resp.)
5	Does stone cleaning have a different effect on market price if part of a package of measures?	If carried out in isolation, then it will have little or no effect (2 resp.) If a package is of a high quality, then cleaning may influence value (2 resp)
6	Which factors are mentioned as being important to clients?	Functionality - everything else subsidiary (1 resp.)
7	Is the uniformity of a streetscape of importance?	No (1 resp.)
8	Will the results of poorly implemented cleaning be likely to affect market values?	Possibly, but not at time of cleaning (1 resp.)
9	Any general points? (1 resp. each)	If stone cleaning were to expose poor quality stonework, anticipated repair costs might reduce value. The perceived degree of soiling is less with granite buildings. Most clients will clean first, and refurbish later. An investor prefers to have "clean" buildings in the portfolio

An important question concerned how, even with most of the respondents giving a maximum effect of stone cleaning of less than 5% in almost all categories, a number of respondents felt that the effect on value could be as high as 25 or 30% in some cases. The statistics were presented to all respondents interviewed, using the graphs shown earlier[7] (figures 5.1 and 5.2). All those interviewed were then asked for their views on the higher figures submitted. Rather than any of the respondents revising their answers in the face of popular opinion, this question led to respondents giving more information as to how they

[7] This method was used to impart the analysis of the data gathered in a clear and convenient manner, which allowed the estimates of the respondent group to be assimilated rapidly and precisely.

arrived at their own replies, and questioning the validity of respondents with whom they were in disagreement.

The most frequent reply from surveyors claiming a very low effect of stone cleaning on market value was that, whilst the cash figure placed on the property's value may not change noticeably as a result of cleaning, the marketability of the property would most certainly be enhanced, perhaps reducing the period between the property being put on the market and a buyer or tenant being found. The resulting improvement to cash flow from the sellers point of view, combined with the reduced need for advertising (in the case of larger properties only) or "bridging" capital, would result in a much more desirable financial situation. That is, where two properties are identical in all respects other than that one had been cleaned and the other left soiled, the eventual price obtained in the market would be the same for each, but the cleaned property would sell before the soiled building. The respondent group was generally unwilling to place exact estimates on the extent of this effect, as each individual case would be different. Nevertheless, the respondent group remained adamant that such an effect would be most likely to occur.

Four of the interviewees offered an example concerning large corporations moving to Scotland looking for suitable office accommodation. In order to preserve what they regard as an elevated corporate image, the initial step is to find a property that will look attractive to both the passer by and businessman alike. Stone cleaning was cited as having the potential to secure a sale or lease in this situation. It was suggested by the respondents that such a situation could bring about an increase in profitability to the client, due to the reduced need for marketing resulting in the same revenue being collected for the sale of the property, with less preliminary expenditure being required. It should be noted that purely anecdotal evidence has been gathered to support this claim.

Such a hypothesis takes the view that, were the two properties to be identical in all respects except that one had been cleaned, there would be little or no difference at all in market selling price. When this idea was presented to those respondents of the opinion that a large increase in value could be expected following cleaning, all those questioned supported their own position, stating that they would personally add an amount to the valuation of cleaned buildings, in line with their original questionnaire response. Again, such statements were purely anecdotal, with no statistics available at present. It was also indicated by all the respondents giving higher estimates that the stone cleaning process would have an effect on value almost regardless of property type.

All of the surveyors interviewed, as indicated by responses given to the questionnaire, were of the opinion that the investor market would be almost completely unaffected by the stone cleaning process. Investors, it was suggested, are generally unconcerned about the aesthetics of their building, providing cash flow and revenue received are not negatively affected. Were such a negative effect to be noticed as a result of soiling the situation might change, but it was felt the current investor market fails to place any degree of importance on the subject.

The interviewees were asked if the detrimental effects of stone cleaning to structure and aesthetics (where work is poorly or inadvisably carried out) could have a negative effect on value, all respondents indicated that they could think of no examples of such an occurrence. The potentially damaging effects of a number of cleaning methods (both abrasive and chemical) have been well documented, and it is interesting to note this failure by the "market" to appreciate the potential for damage to the stone. Future research should therefore further examine the possibility of stone cleaning having a negative effect on financial value in the longer term.

It must be stated that the responses elicited from valuation experts were gathered during a recession in the economy, when buyers were perhaps less willing to pay extra for non-essential items. When this point was raised during the meetings, however, the view was expressed by all interviewees that their answers would not change to any great extent, if at all, in a different economic climate.

5.4.6 Conclusions from property market values study

The aim of this aspect of the project was to determine the effects which stone cleaning has within the property markets of Scotland. Table 5.3 illustrates that the resultant alteration to a valuation has a mean of less than three per cent, with the distribution throughout tending towards zero. This figure, whilst not insignificant where the property has a high valuation rating prior to cleaning, must be balanced against the cost of cleaning, and any associated costs. Therefore, it is hypothesised that the reasons underlying such a great deal of cleaning work being completed must lie in other areas. An increase in marketability as a result of stone cleaning was also indicated by a large number of respondents.

During the later interview stages it was indicated that the markets of owner-occupiers and investors must be considered separately, as the overwhelming impression given was that property investors are generally less interested in the aesthetics of a building, providing cash flow is maintained.

Data collected would suggest that at present there has been little response from the market concerning the fact that poorly implemented stone cleaning work can result in damage to the building fabric. The possible costs incurred as a result with regard to increased maintenance costs over the life span might well start to impact the valuation of properties as more buildings in a post- cleaning state weather over the coming years. It is also possible, however, that as stone cleaning techniques have developed to the point that damage to the stone can be minimal in comparison to methods used commonly in the past (e.g. disc cleaning, high pressure grit blasting, chemical cleaning), that the longer term effects of cleaning might not manifest themselves for many years.

5.5 Maintenance costs

5.5.1 Introduction

Any financial consideration of stone cleaning must take consideration of the maintenance requirements of a building. In addition to the initial costs of cleaning, it has been established by previous research that cleaning can damage stone surfaces thus altering the maintenance profile. This section is included so as to allow the maintenance requirement of a building to be incorporated into a financial model.

Throughout the life of any building, general maintenance should be completed on the stone facing work as required. Any major work completed on the stone surface, of whatever nature, would inevitably have a corresponding impact on the extent of such maintenance requirements. These requirements include:

- re- pointing of joints in the stonework;
- maintenance work including replacement and repair of stone;
- application of biocide treatments.

With regard to the re-pointing of joints in the stonework, established practice (Andrew 1991) recommends the facade should be re-pointed prior to any cleaning being completed. The rationale behind this is that such re-pointing will reduce the risk of chemical cleaning agents being driven into the stone. Such re-pointing work must be considered along with other maintenance measures, when attempting to identify the financial effects of cleaning.

Stone repair work should only result from cleaning in circumstances where the cleaning method has been improperly specified and tested in the first instance, or where inadequate quality control supervision is available on site. Part of this item, however, concerning the use of plastic stone repair materials, is pertinent to the question of visual change resulting from cleaning (and re- cleaning) of the stone surface. Plastic materials used to repair stone surfaces would normally be matched in colour to that of the stone at the time of repair. Where cleaning is subsequently completed on that surface, changes in the colour of the main wall area will not be mirrored by a change in the appearance of the plastic material. Similarly, it is unlikely that the soiling rate of the stone will be similar to that of plastic materials, meaning that in order to arrive at a re unified surface in terms of colour and appearance, a further round of stone repair works might be required to re match colours and tones of the entire wall.

It should be noted that any loss of aesthetic unity would most likely impact upon environmental and heritage value. This should be considered, again, as part of a larger consideration of financial cost. As with re- pointing, stone repair work is frequently required as a natural consequence of a stone surface' natural weathering during its life span. Therefore, any model drawn up to help predict the effects of cleaning should mirror only any changes in the cost of such work that might result from cleaning, and not simply illustrate that repair will be required.

Algal colonisation of stone leads to an often rapid and obvious change in the appearance of a building. Links between the application of some stone chemical cleaning systems and changes in the rate of colonisation have been proven (Young 1997). The main reason for stone cleaning work being implemented in most cases is to cause a change in a buildings appearance through the removal of the soiling layer. That soiling layer might well have been formed over many decades, if not centuries. Therefore the re- establishment of a soiling layer to such a degree over a relatively short time scale might reasonably be regarded as unlikely. Rather than the formation of a soiling layer composed of soot and other airborne particulate, however, the colonisation of a stone surface by algae and lichens is a distinct possibility in certain circumstances. Such vegetation might well impact upon the aesthetic value of a building, especially where the immediately post- cleaned surface was very light in colour and high in light reflectivity. The degree of colonisation that might be expected will depend on the environment in which the surface exists, namely the orientation, vertical angle and moisture present within that environment. The regular application of biocide treatments to a post cleaned stone surface would help reduce the risks of such a situation arising, but requires to be implemented as part of an ongoing maintenance programme. Conversely, the application of biocides can in itself create problems which must be addressed. Any cost model considered for this study will make full representation of such ongoing work, and will also indicate how the neglect of such work might impact costs in both the short and longer terms.

It may be seen that a great deal of uncertainty exists with regard to the frequency with which intervention will be required following cleaning. The precise types of intervention are known, however, and any decisions made should take full account of their implications and cost.

5.5.2 Stone repair

The stone surface itself will be altered in some way as a result of cleaning, depending largely on the cleaning method used. Where the cleaning process causes either direct or indirect damage to the stone, a certain amount of repair work will be required in the future. Cleaning can damage stone directly where the method leads to an unacceptably thick layer of the stone being removed along with any soiling, or where chemical retention leads to salt mobilisation or efflorescence. Indirect damage to the surface can be caused where previously covered layers of stone are exposed to the atmosphere and subsequently weather at an unacceptably high rate. Although further work is required to determine the extent to which the physical state of stonework can be affected by cleaning in the longer term[8], the financial costs of such work should be considered pre- cleaning, as the client must consider whether the costs are affordable in the long term, and whether or not the perceived benefits of cleaning outweigh any potential damage to the stone. In the worst instance, it is possible that the entire facade of a building would have to be replaced due to the surface becoming eroded to an unacceptable extent. This cost has tended to be overlooked to a great extent in past cleaning contracts, as until relatively recently the possible negative effects of cleaning had been unknown.

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8 Consideration must be given to buildings as individual cases in this respect, as decay mechanisms will be highly specific to the surface characteristics and design.

The potential magnitude of costs will vary between buildings, and the factors involved in trying to arrive at an accurate prediction inevitably rely on a number of assumptions being made. If the cleaning process were to have the worst case scenario results in most cases, it is unlikely that very much cleaning would ever take place. On the other hand, were cleaning to produce results which were universally non- damaging to the stone, there would be no need for the research which has already taken place. The variables which should be considered for any property will include the pre- cleaning condition of the stone itself, the method proposed for cleaning and the results of any trial tests completed. By making structured value judgements as to the likely ranges in which each of these variables might lie, the potential exists for the incorporation of likely stone repair costs in a predictive model.

5.6 Development of the financial model

5.6.1 Introduction

So far, this chapter has considered ways in which the long-term financial requirements of a building might be varied by stone cleaning. A number of important variables have been shown to be heavily dependant on cleaning, whereas the effect on others will depend on a wide range of factors relating to building specific criteria. The predictive model presented here considers three factors for each variable:

- the likely magnitude of each application;
- the likely frequency of each application;
- the range of certainty within which decision can be rooted.

This chapter has identified a number of financial changes that will result from cleaning. These changes must be considered together so that the modelled overall financial impact is reliable and logical.

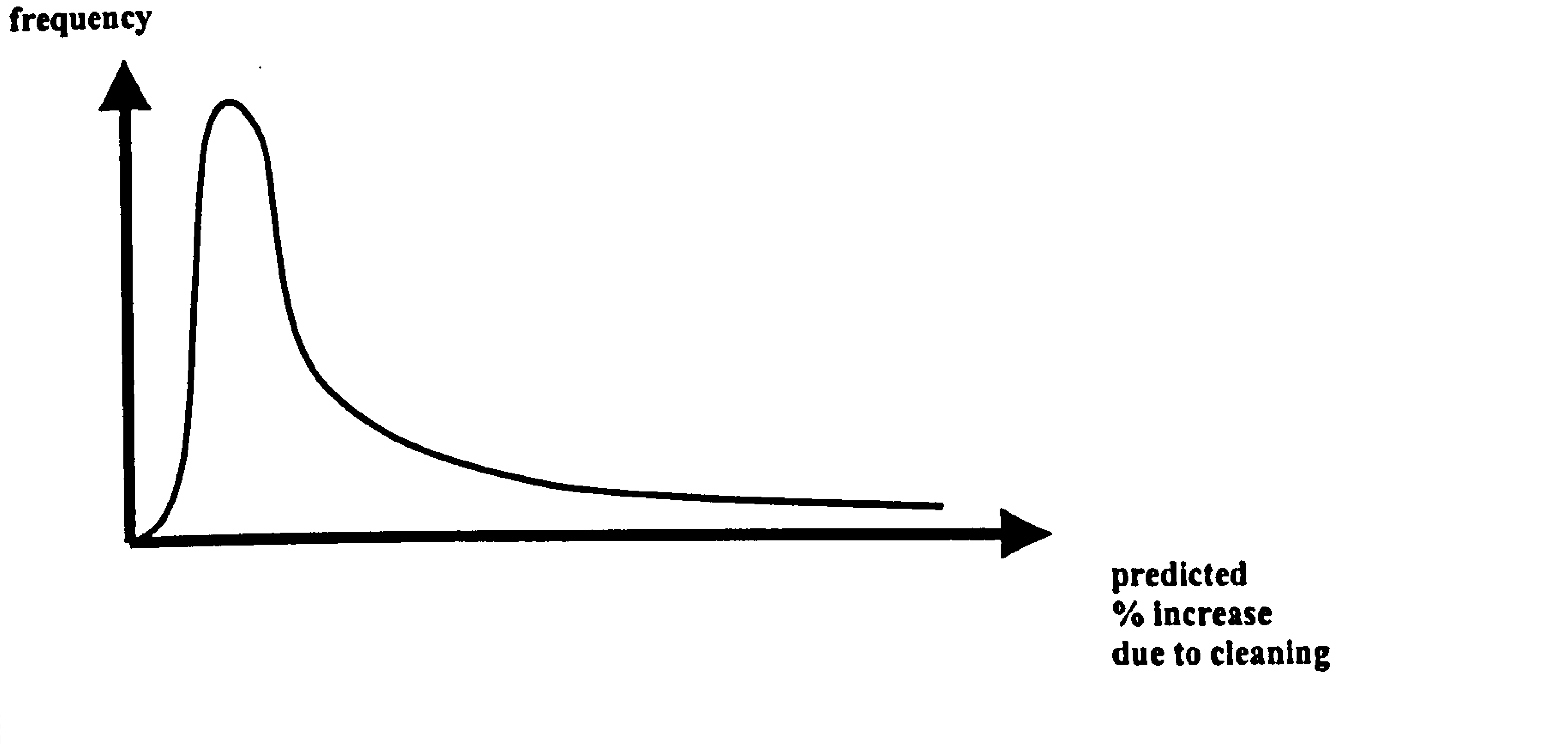
5.6.2 Property Market Value

The study completed as part of this project produced predictive figures that can be used to predict the effects of cleaning on market values. For each of the twelve property types identified, statistical indicators were identified which can be used to produce suitable distribution shapes. For each building type, the mean, median and standard deviation, coupled with a generic distribution shape can be utilised to predict the effect on building not yet cleaned. For example, for owner-occupier residential properties in the city centre, indicators were as follows.

mean =	3.04%
median =	2.00%
standard deviation =	3.73%

The corresponding distribution shape for responses for all building types was as shown in figure 5.3.

Figure 5.3 - distribution curve (change in market price)



This curve represents both the range of effect that can be anticipated, and the likelihood of each outcome being realised[9], and can be utilised for any given example, assisting in a prediction of overall economic effect. The Monte Carlo approach allows for this range to be incorporated fully into the equation, as opposed to simply calculating and incorporating a mean figure. For example, for a property with a current value of £40,000, by utilising the figures shown above, a mean increase of £1212 would be recorded, with a median figure of £800, and a standard deviation of £1492. This would provide an increase for predictive purposes of £ 1212 +/- £ 1492, with a minimum figure of £ 0 (zero). None of the complexities of the distribution have been reflected, and are difficult to represent in such a way that the non- mathematician would be able to make use of any formulae produced. This chapter presents a model that may be used as a part of the decision- making process. The incorporation of inaccuracies in the data available into that process better reflects the inexact nature of the process itself.

9 It is interesting to note that the simulation to be completed here, rather than relying on an artificial "triangular" or misrepresentative "normal" distribution, allows for the distribution shape to be represented as sampled. Chau (1995) identified this as having important implications for realistic and reliable estimations of cost or benefit.

5.6.3 Stone repair costs

The costs of stone repair over the residual life span of a building are difficult to quantify but can be estimated using a similar method to that presented for the changes in property market values. For example, the costs of repair might range from zero (no additional repair required) to complete replacement costs, in terms of a negative effect produced by stone cleaning, or reduced repair costs where the application of cleaning might be able to improve the resistance of the stone to further deterioration. The costs of complete stone replacement can be calculated by making reference to quotations available from practitioners, as could partial stone repair costs (using either stone or plastic repair alternatives), re- pointing or no intervention required (zero cost). Where a decrease in repair need can be foreseen following cleaning, any costs calculated could be regarded as savings (gains).

The major problem facing the development of a cost model at this stage is that little work has been completed focusing on the extent to which stone might be damaged over a facade. More precisely, the time scale that might elapse between cleaning and repairs being required is at present unclear, and variability between individual stones and between facades only compounds this complexity. Therefore, the necessary incorporation of timed periods between rounds of repair work requires a great deal of subjective judgement within the model. Coupled with the fact that for many buildings there exists the possibility of re-cleaning at some point during the residual life span, the complexity of the situation increases.

For the purposes of this project, a representative distribution of the possible outcomes of the cleaning in terms of future care and maintenance is included in the model tested. Future work focusing on the physical long term effects of cleaning is required before the decision process can be made to more accurately represent the current and future situations. What can be stated as this stage is the extent of repair that would cause an overall financial loss.

The maximum amount of stone repair that can be required is a complete replacement of the stonework facade. At the other extreme, the minimum scenario is where no repair work at all is required. Research to date has indicated that masonry might be damaged where cleaning is improperly carried out, but has not indicated that repair incidence can be reduced by cleaning. Therefore, it is reasonable that this study considers only possible increases in repair requirement.

Costs that can be included in the final model form are as shown in table 5.11.

Table 5.11 Costs of future maintenance, as reflected in the financial model

Maintenance	Comments
stone replacement	Costs will be manifested by a number of individual variable costs. Were the incidence or results to result in significant changes to the stone, effects might be felt in environmental and heritage value.
re pointing	Re-pointing is required at the cleaning stage. This can be estimated using rates per m^2.
re cleaning	The frequency of re-cleaning is uncertain. Although conceptual models of aesthetic value and complexity over time suggest a possible desire to re-clean, evidence as to this becoming a reality has not been found. If so desired, the model could reflect the costs of periodic re- cleaning, discounted to base date values. To reflect best practice, no such costs have been included in the examples presented.
repair costs	These costs must consider any stone repair or replacement necessary only as a direct result of stone cleaning. The method of estimation must be related to the nature of that repair work.

5.6.4 Initial costs of cleaning

Stone cleaning work is often completed alongside other work to a building, to reduce the burden of temporary works that must rest with each section of the work. For example, scaffolding erected for cleaning can be used also during the treatment of the roof and window elements. Therefore, when apportioning the costs of scaffolding, if the cleaning is to be completed as part of a larger project, the cost of any temporary works can be apportioned over a range of elements. For the purposes of the model developed for this project, it is essential that the circumstances of the cleaning be understood. For example, where the cleaning is to be completed as part of a larger general maintenance or upgrading of a building, the amount of temporary works costs to be apportioned to that cleaning should be reduced accordingly.

It is difficult therefore to generalise the costs of cleaning over a range of buildings, as the individual circumstances of each situation will directly affect the financial outcome. It is possible, though, to calculate representative greatest and least cost scenarios and base the predicted figure upon the generated range of possible outcomes.

5.7 Application of model and results

5.7.1 Introduction

This chapter has so far explored the financial variables that might be affected by stone cleaning. This section models these variables conceptually, and presents examples of practical applications. As discussed, data regarding the long-term effects of cleaning is unavailable at present, although indicative measures can be incorporated in the model to reflect the likely possibilities. It has been shown that the financial model must consider more than just the initial costs and benefits of cleaning. Although the model that can be drawn up here contains uncertain quantities, the model is appropriate as it reflects the holistic, whole life, system of cause and effect, and will thus assist in the formulation of value judgements.

5.7.2 Application of model

The financial model was applied in three sets in circumstances, to reflect how changes in the area (m^2) cleaned, stone type, use and location can influence the financial outcome. For each example, the model was run a number of times, to reflect possible variations in temporary works, testing required and the implications of the market prices study reported earlier in this chapter.

Example 1

A residential building situated in Edinburgh:

size of facade:	15 metres x 25 metres (approx.)
windows/doors:	20m2
location:	city centre
ownership:	private ownership
occupation:	owner occupied
stone type:	buff sandstone, plain.
current market price:	10 flats @ £ 45,000

The likely financial value change resulting from stone cleaning was calculated to be a financial gain of £1845. This figure takes account of a supposed cost for scaffolding (with associated hoardings, etc.) of £5000 and re- pointing amounting to £5325, but takes no account of the likely increase in market price skewing toward zero. Inaccuracies in the latter, in particular, meant that further runs of the model were required.

It is recognised, however, that the figures used within the example include a degree of uncertainty, in terms of accuracy in the general case and in terms of general applicability.

For example:

Cleaning Cost

The cost of cleaning as included here represents a mean figure as obtained from a number of stone cleaning firms. The figure was obtained for "estimating purposes", and excludes the cost of scaffolding. The figure should be seen within a 10% confidence interval due to differences between cleaning firm and method.

Scaffolding

The cost of scaffolding included here is indicative only. The actual cost, in relation to cleaning, may in fact be zero where cleaning is completed in connection with other works. Where scaffolding were erected to allow work to a roof area, cleaning might be completed at the same time. Where cleaning were completed in isolation, the proportionate cost of scaffolding would be very much increased. For an application of this model in practice, tenders should be obtained from scaffolding sub- contractors.

Testing

Testing of a stone surface prior to full scale cleaning is essential under best practice guidelines (Andrew *et al.* 1994, Urquhart *et al.* 1997), and required in Scotland where a building is Listed. Information obtained from the Masonry Conservation Research Group at The Robert Gordon University indicates costs to be as follows (although each case is calculated according to the individual circumstances and requirements).

Table 5.12 - costs of testing stone

Granite	£300 - £400 for each of two reports (pre-test and post- test) Therefore, and total of £600 - £800 (+/- 15%)
Sandstone	Reports required as above (£600 - £800 +/- 15%), plus possible increases of: £250 +/- 15% for depth profiling analysis where chemical cleaning is proposed; £100 for identification of salts in the stone.

Therefore, the figure of £ 1000 included in the example shown above is indicative of an approximate cost of testing a sandstone building, but will require some refinement depending upon the situation.

Market price

The increase in financial value for a change in market price is potentially misleading, as the effect on market price is greatly variable, and does in fact skew towards zero. This range is incorporated into the model via a Monte Carlo simulation.

Re- pointing

The cost per m^2 for re- pointing was obtained from Contractors working in the field of stone maintenance and repair. Guidelines indicate that re- pointing should be completed whenever stone cleaning is carried out (providing the existing pointing is unsound), so a cost has been included here also. Were the model to be used in circumstances where the existing pointing was sound, the cost of re- pointing could be removed from the calculation. In addition, it could be argued that re- pointing forms part of a maintenance programme which should be followed regardless of whether cleaning is completed (that is, re- pointing will most likely be required at some point in the building's lifespan anyway). The figure is included here to reflect both recommended practice (should current pointing be deficient), and the fact that both the aesthetic and maintenance implications of cleaning make the completion of re-pointing timely.

Second run of model

The model was run for a second time, incorporating the costs and benefits in a more representative manner. The "Crystal Ball" application for Microsoft Excel was used, allowing a Monte Carlo simulation. The distribution shape for the property markets variable, in particular, is skewed towards the origin, making the mean +/- standard deviation approach (i.e. normal distribution), unsuitable. It was possible to model the "true" distribution through the Monte Carlo approach.

cleaning:	cost as indicated +/- 10%
scaffolding:	cost as indicated +/- 10%. Also run with no cost allocated.
testing:	as indicated in "testing" section, above. Separate runs to include depth profiling and salts identification work.
market price:	price % increase indicated over a range.
re- pointing:	cost as indicated +/- 10%

The model was run using the assumptions noted, and the predicted financial benefit was reduced to £488[10]. A subsequent run, taking no account of scaffolding costs, produced a benefit of £5476. These figures were compared against the cost of stone repair work, to identify the points at which the benefits noted would be cancelled were the stone to decay as a result of cleaning.

The results of that comparison (appendix table A2.7) are shown in figures 5.4 and 5.4. Table A2.7 illustrates that where stone cleaning led to upwards of 2.69% of the facade requiring stone indenting (replacement) after a period of 25 years, that any financial gain is lost.

10 Where the model was run again, assuming a scaffolding cost but additional testing work, it was found that the initial benefit disappeared (see tables A2.5 and A2.6, in Appendix 2). This highlights the importance in practice

Where scaffolding (cleaning) costs are ignored, that figure rises to approximately 30%, although a figure of between 7 and 18% is more likely.

Figure 5.4 -financial benefit of cleaning against repair incidence (standard testing and scaffold required)

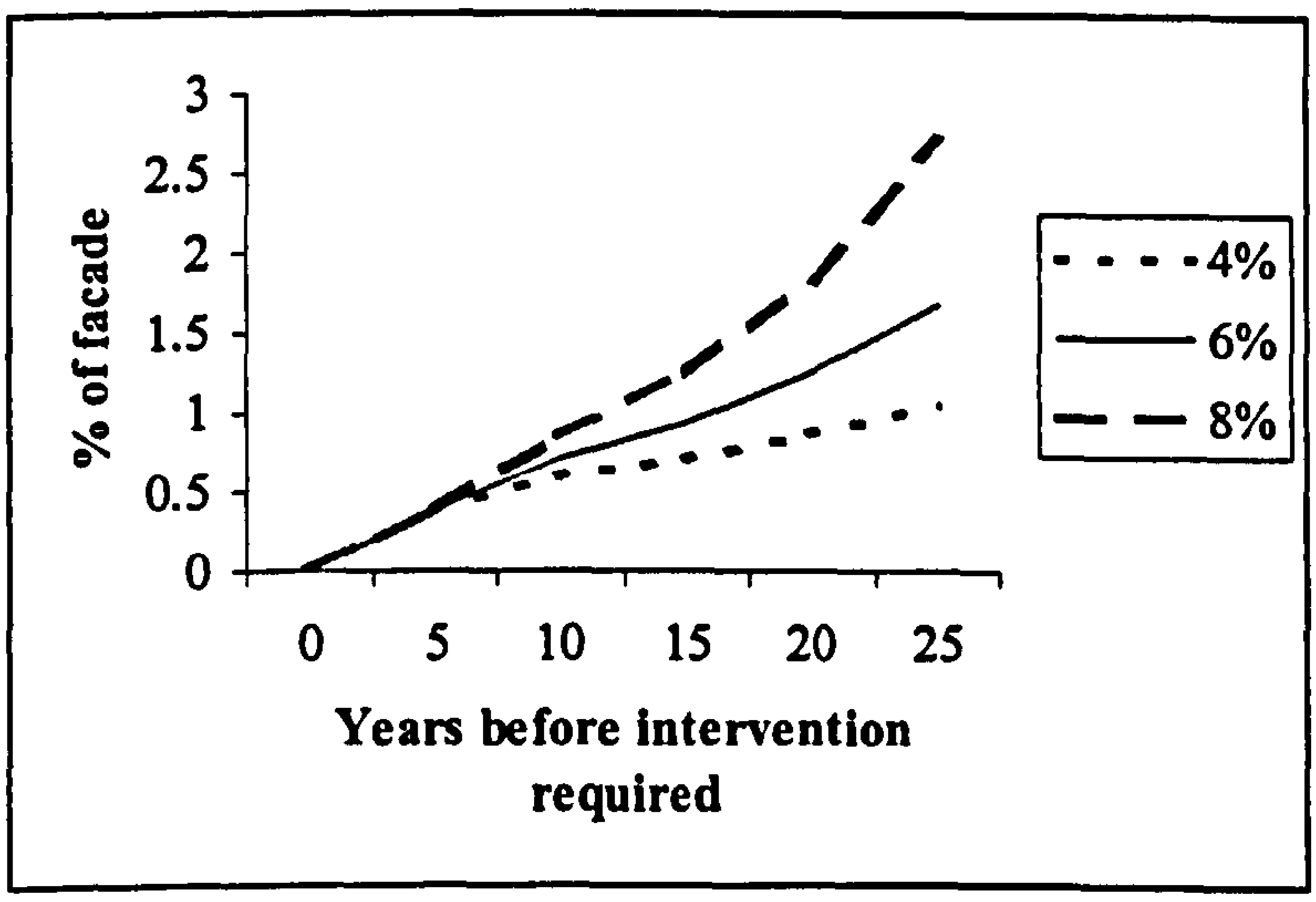
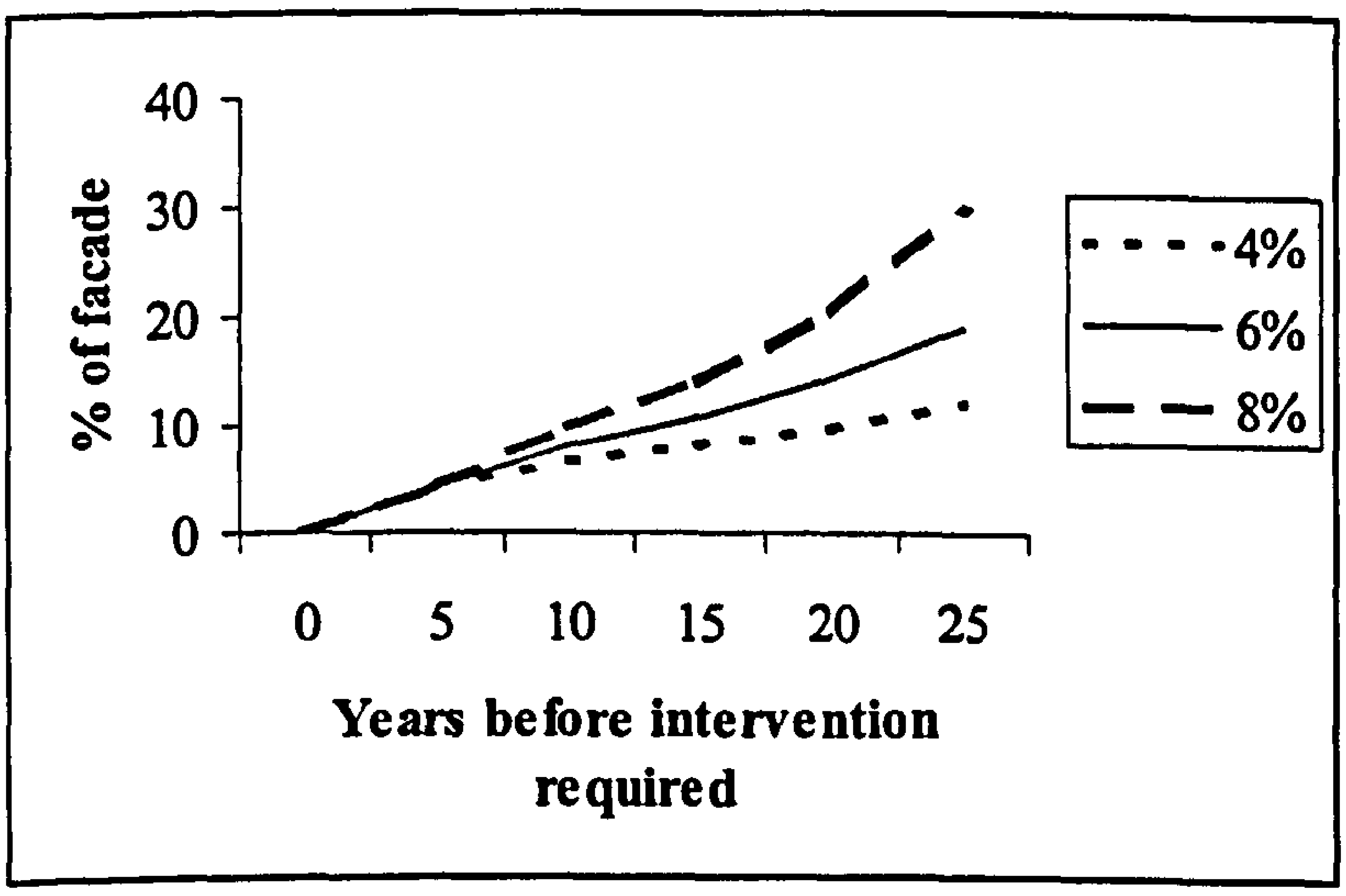


Figure 5.5 -financial benefit of cleaning against repair incidence (standard testing but no scaffold required)



of considering actual cleaning method, testing required and the cost of associated works prior to application of the model.

Clearly, removal of the scaffolding cost has significantly increased the mean result. As discussed, and as witnessed through anecdotal evidence, cleaning is often completed not in isolation but in conjunction with other work. The economic benefit attributable to cleaning can be increased through spreading of the cost of temporary works (such as scaffolding) with other elements. In practice, where cleaning were indeed completed alongside other works, the cleaning element should still be "allocated" a part cost of the temporary works (proportionate to the cost of the cleaning work). Where cleaning is completed in isolation such a spreading of the cost is not possible and temporary works should be allocated to cleaning in full.

It is clear from figures 5.4 and 5.5 that the time between cleaning and the requirement for work is of significance to the financial requirement. Considering figure 5.4, if the damage due to cleaning became apparent after 20 years, and replacement of between 0.86% and 1.83% of the facade were required (between 3.05m2 and 6.50m2), then any financial gain apparently realised immediately following cleaning would be diminished substantially[11]. Where the costs of scaffolding were completely removed from consideration, the figures rise to between 9.65% and 20.54% (between $34m^2$ and $72m^2$). In reality, of course, the actual situation would be likely to lie somewhere between the two figures, as scaffolding costs would often be partially apportioned to the costs of cleaning. The analysed results of pre-cleaning tests, for which costs have been included in the financial model, must act as an essential guide as to the likely longer-term costs[12]. It is clear that even a small amount of decay resulting from cleaning can effectively remove a financial benefit, and lead to an ultimate loss. From the perspective of an overall value assessment, this has extremely important implications.

11 It would also be likely after 20 years that the visual gains leading to increases in market price immediately following cleaning would have been reduced due to re- soiling.

12 The results of current mapping work ongoing at the Robert Gordon University will be useful in determining the likely incidences.

Example 2

A commercial building situated in Glasgow:

size of facade:	25 metres x 40 metres (approx.)
windows/doors:	300m2
location:	city centre
ownership:	private ownership
occupation:	owner occupied
stone type:	red sandstone
current market price:	£ 1,000,000 (approx.)

The likely financial value change resulting from stone cleaning was calculated to be a financial gain of £5900. This figure takes account of a supposed cost for scaffolding (with associated hoardings, etc.) of £15000 and re- pointing amounting to £10500, but takes no account of the likely increase in market price skewing toward zero. Inaccuracies in the latter, in particular, meant that further runs of the model were required.

Second run of model

The model was run for a second time, incorporating costs and benefits in a more representative manner, as with example 1.

The model was run using the assumptions noted, and the predicted financial benefit was reduced to £1835. A subsequent run, taking no account of scaffolding costs, produced a benefit of £15164. These figures were compared against the cost of stone repair work, to identify the points at which the benefits noted would be cancelled were the stone to decay as a result of cleaning.

Table A2.14 illustrates that where stone cleaning led to upwards of 5.13% of the facade requiring stone indenting (replacement) after a period of 25 years, that any financial gain is lost. Where scaffolding (cleaning) costs are ignored, that figure rises to 42%, a figure of approximately 20% being more likely (i.e. stone cleaning shouldering some of the temporary costs)[13].

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13 Note that where testing of the surface were increased, benefits were again reduced significantly.

The first example of the model in application (prior to Monte Carlo simulation) shows that the possibility of longer-term repair and maintenance costs might remove the possibility of any financial gain. It is accepted that longer-term costs should not be included at their face value, as interest and the passage of time mean the costs (in terms on their £ value) should be discounted to present day values. The number of m2 on the building surface which will require intervention due to detrimental effects of cleaning will vary according to the building itself (and will be mapped and costed by the Masonry Conservation Research Group, RGU, in 1999). The areas at which an overall loss is likely are shown in table A2.7 (present values of the costs per m2 of the various interventions are given in table A2.8). The interest rates assumed are shown against each value, and only those scenarios indicating a gain at the "initial" stage are considered.

Table A2.14 illustrates that where stone cleaning led to upwards of 5.13% of the facade requiring stone indenting (replacement) in the long term, that any financial gain is lost. Where scaffolding costs are ignored, that figure rises to approximately 42%, although a figure of between 11% and 26% is more likely.

Example 3

A retail premises situated in Aberdeen:

size of facade:	20 metres x 10 metres (approx.)
windows/doors:	30m2
location:	outskirts
ownership:	private ownership
occupation:	owner occupied
stone type:	tooled granite
current market price:	£ 500 000

The likely financial value change resulting from stone cleaning was calculated to be a financial gain of £830. This figure takes account of a supposed cost for scaffolding (with associated hoardings, etc.) of £5000 and re- pointing amounting to £2550, but takes no account of the likely increase in market price skewing toward zero. Inaccuracies in the latter, in particular, meant that further runs of the model were required.

Second run of model

The model was run for a second time, incorporating costs and benefits in a more representative manner, as with both the previous examples.

The model was run using the assumptions noted, and the predicted financial benefit was reduced to a loss of £1537. A subsequent run, taking no account of scaffolding costs, produced a benefit of £3510. The latter figure was compared against the cost of stone repair work, to identify the points at which the benefits noted would be cancelled were the stone to decay as a result of cleaning.

Table A2.20 illustrates that where stone cleaning led to upwards of 40% of the facade requiring stone indenting (replacement) after a period of 25 years, that any financial gain is lost. In this example, however, it must be borne in mind that actual costs would be crucial. Were the stone cleaning works required to carry a substantial cost of temporary works, any potential for benefit would be lost.

The first example of the model in application (prior to Monte Carlo simulation) shows that the possibility of longer-term repair and maintenance costs might remove the possibility of any financial gain. It is accepted that longer-term costs should not be included at their face value, as interest and the passage of time mean the costs (in terms on their £ value) should be discounted to present day values. The area (m^2) on the building surface that will require intervention due to detrimental effects of cleaning will vary according to the building itself (and will be mapped and costed by the Masonry Conservation Research Group, RGU, in 1999). The areas at which an overall loss is likely are shown in table A2.20 (present values of the costs per m2 of the various interventions are given in table A2.8). The interest rates assumed are shown against each value, and only those scenarios indicating a gain at the "initial" stage are considered.

5.7.3 Implications of model output

The model in application raises a number of doubts as to the financial benefits of stone cleaning. In the short term, it can be seen from the examples in Appendix 2 that, even when considering the variability of the figures used, that the probability of gains being realised immediately following cleaning is marginal. In the longer term, the likelihood of financial benefits being realised diminishes rapidly.

Against this, the effects of stone cleaning at a wider social level should be considered. Where it could be demonstrated that stone cleaning would lead to significant increases in retail performance, or levels of tourism within an area, overlooking a financial loss specific to the maintenance of individual buildings might be reasonable. From the perspective of a community or city, such an approach does indeed seem reasonable. In the absence of grant aiding to cover maintenance work, however, financial loss would be the burden of the owner, and should have important implications for long term financial planning.

5.7.4 Notes for application

Application of the financial model must be approached according to the building being considered. Factors including the ownership[14], use, stone type, location and Listed Building status will all influence the final outcome. What is clear from the results in Appendix 2 is that whilst the initial cost/ benefit cannot be guaranteed to result in a financial gain, in the longer term it would be unlikely that the financial result would be positive. Due to implications of the effects of cleaning methods on the physical condition of stonework, consideration of the longer-term costs is essential.

The major limiting factor for the model as presented here concerns a lack of available data. Conceptually, the model is sound and adequately considers those variables closest to a building in isolation. The longer-term effects of cleaning must be considered as part of the financial appraisal, yet those effects are at present difficult to quantify. The approach used in appendix 2 and section 5.7 is to first assess variables for which costs should be known[15].

14 Ownership of buildings has focused in this project on non- public buildings, where the market price is of obvious concern. Where buildings are within the public sector, or not likely to carry a "market value", the model should be adapted to consider only directly payable costs. In such cases, non- financial benefits should be considered to "balance" the equation.

15 For this project, costs used are realistic but would require revision for each application of the model. Such revisions are usual in cost estimating, and acceptable provided they connect with a reliable model structure. That structure is in place here.

From that point, the extent of remedial work required to effectively remove a financial gain can be assessed.

5.8 Conclusions

The financial model presented in this chapter raises a number of important findings. In the absence of a model such as that suggested in this chapter, a large number of decisions have in the past been made making insufficient reference to the wide range of results available from completed research and data gathered from the field. Although nominally focusing on only limited aspects of the larger value system described in chapter two, the model proposed is clearly influenced by aesthetic, environmental and heritage value changes resulting from cleaning. It represents a significant contribution to the understanding of the value exchanges taking place, as well as offering at a practical level a method which can be used to evaluate the holistic effects of any capital investment in cleaning.

1. It has been shown how those variables which are known, and can be **modelled**, can be set against the point at which damage resulting from stone cleaning would cause an overall financial loss. Guidance as to the likely physical effects of cleaning is available, and coupled with the model provides the **decision-maker** with important information.
2. The study concerning **property market prices** produced **percentage indicators** (with distribution shapes) for application within the financial cost model. Those indicators varied between property use and location, and it was found that whilst owner- occupiers would in certain circumstances be willing to pay more for a cleaned property, returns in the investor market were lower.
3. It is important to recognise that increases in **attainable market price** have been **balanced** against **cleaning cost** in the financial model, but that such increases would only be realised were the property sold. Were a property sold some time after cleaning, there would be the additional likelihood of a degree of re-soiling taking place, thus reducing the aesthetic (and hence financial) benefit.
4. Once set up and operating, the cost model can be altered to **suit any particular set of circumstances** (e.g. cost of scaffolding, cost of testing).
5. The model returns not only a financial cost or benefit, but relates that figure to the **degree of decay** (due to cleaning) which would cause an overall financial loss.

The costs associated with stone cleaning would, as part of a decision process, have previously included little more than those costs incurred at the time of cleaning (due, perhaps, to a lack of data). Research has shown clearly that the long term effects of cleaning can be wide ranging, and those effects will be better reflected through application of the financial model in practice.

5.9 References

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Young, M.E. (1997) *Biological growths and their relationship to the physical and chemical characteristics of sandstones before and after cleaning*, Ph.D. Thesis, The Robert Gordon University, Aberdeen.

6. *Environmental value assessment*

6.1 Introduction

The contingent valuation method requires a bidding mechanism that enables respondents to provide a realistic personal assessment of an environmental good, or change. Hanley *et al.* (1991) apply the contingent valuation technique to a proposed programme of upgrading (including stone cleaning) in the Grassmarket of Edinburgh. That study presented likely effects of the upgrading through an artist's impression of the final appearance, incorporating all the envisaged changes. As intimated earlier, however, cleaning can have a number of long term effects not apparent immediately post- cleaning, with visual changes in the longer term difficult to predict. It was obviously desirable that the bidding scenario for this study both avoided an over- simplification of the subject, and did not lead respondents toward a particular level of response. In Scotland, the cleaning of large areas of building frontage has meant that residents will have been aware of substantial visual changes. As shown by Andrew (1992), and further analysed by the current study, changes in the visual character of buildings leads to a change in the perceived value associated with those buildings. Many of the potential dangers regarding damage to the stone surface, or possible links with increased algal growth, however, may not be apparent from visual inspection alone, and may not obviously manifest themselves for a number of years.

It was necessary that the bidding device, method of information transfer and the associated questionnaire managed to impart a certain amount of knowledge to the respondent. In addition, it was anticipated that the reliability of bids gathered would depend on the bidding mechanism as much as the good itself, so levels of prior knowledge and the establishment of a certain base level of knowledge across the entire respondent group was desirable.

6.2 Validation - pilot study

The manner in which expert knowledge in the field of stone cleaning was communicated through the study was important, as it was essential that respondents realised the complexity of issues involved. The questionnaire used for data gathering was developed through a process of consultation with practitioners involved in the use of contingent valuation technique, and piloting of the study in Aberdeen[1].

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[1] That is, the Aberdeen phase of the data gathering was completed prior to sampling in Edinburgh and Glasgow.

The pilot study aimed to determine whether the questions being asked were easily understood by the respondent group, and that they allowed for answers which properly addressed the issues being dealt with. Potential problems foreseen at the outset included questions being misunderstood by respondents, information imparted through the form not being understood, and the inclusion of certain questions (e.g. regarding income) receiving a hostile reception. The only major finding in this respect was that, in response to the question regarding frequency of visit to the area, most replies tended to represent an average number of days per month. Therefore, question 4 was deemed to be unnecessary for the Edinburgh and Glasgow surveys (unless specifically mentioned in a response). Results from the Aberdeen survey are presented here alongside results from the later studies, as no significant difference existed between the methodologies employed.

6.3 Selection of respondent areas

The areas used for data gathering were selected due to the large number of pedestrians usually passing through, and the presence of a range of cleaning effects, either in the areas themselves, or in locations nearby. The areas selected for each city were as follows.

- Aberdeen: (main study) Union Street and streets leading from.
- Edinburgh: George Street and new town area.
- Glasgow: Bank Street and Sauchiehall Street.

Photographs of these areas, showing examples of the effects of stone cleaning and stone decay are shown in figures 6.1 to 6.12, with captions explaining the purpose of each image. The locations were chosen because both cleaned and non- cleaned properties existed at each. In George Street, for example, a number of buildings had also began to show a large degree of algal growth post cleaning, meaning that the stone in a post-cleaned condition was now partially obscured.

Illustrations

Figure 6.1 - Streetscape (1) for Aberdeen survey

Union Street, Aberdeen: The photograph shows a south-facing elevation on Union Street. To the left of the image, the spire of Gilcomston South Church can be observed rising above the surrounding properties. The spire itself was entirely rebuilt using sandstone from the Moray Firth coastline during the 1990s.

Figure 6.2 - Streetscape (2) for Aberdeen survey

Union Street, Aberdeen: The photograph shows a south-facing elevation on Union Street, viewing to the East. It can be observed in the photograph how a number of buildings in Union Street have been cleaned on one facade, but remain soiled on all other faces.

Figure 6.3 - Streetscape (3) for Aberdeen survey

Union Street, Aberdeen: The photograph shows a north-facing elevation on Union Street. There is evidence of a property-specific approach to cleaning, with sections of the facade remaining soiled and resulting in a patchwork effect. In addition, a variation in stone colour can be observed between the cleaned buildings, suggesting that a range of cleaning methods have been used.

Figure 6.4 - Detail from Aberdeen survey

Union Street, Aberdeen: The photograph shows a detail from the north-facing Langstane Kirk, near the interview location on Union Street. This building has not been cleaned, and exhibits a high level of natural algal growth. A number of respondents were unsure when asked if they had observed or were aware of the potential for stone cleaning to increase the incidence of algal growth, due to their being unsure of what was meant by "algae". This building proved useful in this respect, although it was made clear to all respondents that Langstane Kirk had not been cleaned.

Figure 6.5 - Streetscape (1) for Edinburgh survey

George Street, Edinburgh: This view of the streetscape looking to the east, illustrates how differences in stone colour on the terrace have been highlighted (or possibly caused) by past cleaning. An architecture continuity of sorts exists through the preservation of horizontal lines, and original window designs.

Figure 6.6 - Streetscape (2) for Edinburgh survey

George Street, Edinburgh: The photograph shows a section of the north-facing facade, and provides a number of examples of how stone cleaning can produce a distinctive patchwork effect where little attempt is made to preserve a unity of stone colour. In particular, the section of facade central to the image shows a property where only the first floor has been cleaned, producing a rather peculiar effect.

Figure 6.7 - Streetscape (3) for Edinburgh survey

George Street, Edinburgh: The photograph again illustrates how an architectural continuity can be disturbed through insensitive interventions. In addition to clear evidence of stone cleaning resulting in colour differences (note for example the colour variations in the upper stories), the photograph also illustrates examples of stone "indenting", which may have been required directly as a result of stone cleaning.

Figure 6.8 - Detail from Edinburgh survey

George Street, Edinburgh: The photograph shows a detail from the north-facing facade in George Street. The image is taken from a recently cleaned building, with little evidence of re-soiling by airborne particulate matter. The strong algal growth appears extremely vibrant against the otherwise pale colour of the surrounding stonework, and would certainly have been less apparent on the uncleaned facade. This building was near the interview location and was of use in explaining the meaning of "algal growth" to respondents.

Figure 6.9 - Streetscape (1) for Glasgow survey

Bath Street, Glasgow: The photograph shows a section of Bath Street. It should be noted, and it was made clear to respondents, that although some of the variation in facade colour was due to stone cleaning, that decaying paint-work was also present on the building central in the image.

Figure 6.10 - Streetscape (2) for Glasgow survey

Bath Street, Glasgow: The photograph provides a closer view of the facade to the right of figure 6.9. It is clear that a range of cleaning methods have been used, and that a degree of stone repair work has been completed on the facade to the left. It appears likely that the (indented) repairs were completed at the time of, as opposed to being due to, the cleaning.

Figure 6.11 - Streetscape (3) for Glasgow survey

Bath Street, Glasgow: The photograph illustrates a north-facing junction in Bath Street, leading to Blythswood Square. As the facade is largely sheltered from direct sunlight, variations in stone colour appear to have been accentuated by the use of a number of cleaning methods.

Figure 6.12 - Detail from Glasgow survey

Bath Street, Glasgow: The photograph shows a detail from the north-facing facade in Bath Street. As with the detail taken from George Street, Edinburgh, the image is taken from a recently cleaned building, with little evidence of re-soiling by airborne particulate matter. A degree of algal growth is apparent against the otherwise pale colour of the surrounding stonework, and appears to be related to rainwater runoff patterns.

The known effects of previously completed stone cleaning (see Appendix 1) highlight possible problems regarding likely respondent knowledge. Less obvious consequences of cleaning than the immediate changes in stone colour are most easily illustrated through first hand observation on site. The areas chosen for completion of the survey allowed for knowledge to be imparted, and ensured that all respondents had indeed observed aspects of the material explored in the questionnaire at first hand. Much danger of "information bias" identified in the methodology could thus be overcome, in particular those concerns over the presentation of the effects of stone cleaning, and the avoidance of an overly hypothetical scenario.

6.4 Results

6.4.1 Introduction

Results from the contingent valuation surveys are presented here in the following order:

- sample demographics;
- results in order of question.

The results of all three studies are shown, and the number of respondents per city were as follows:

- Aberdeen 41
- Edinburgh 47
- Glasgow 40
- Overall 128

Figures shown in the result sections are overall numbers, unless indicated otherwise.

6.4.2 Result listings

Sample Demographics

Recorded demographics of the sample are presented below. Although the sample itself was selected at random, it is important to ensure that groups within the community are represented at an appropriate level[2].

[2] Figures inserted under "census" are taken from Scottish Office (1998), Abstract of Statistics. It is notable that the figures recorded for the survey with regard to age are skewed toward a younger population than the national

Characteristic	Categories	total	abdn	edbg	glas	census
Age	16-24	28.9	24.4	31.9	30.0	15.6
	25-34	32.0	41.5	21.3	35.0	19.4
	35-44	11.7	4.9	17.0	12.5	17.9
	45-54	16.4	24.4	19.1	5.0	15.7
	55-64	4.7	zero	2.1	12.5	12.6
	over 65	6.3	4.9	8.5	5.0	18.8
Educational background	secondary school	32.8	31.7	36.2	30.0	
	ONC/HNC	12.5	9.8	8.5	20.0	
	diploma	13.3	19.5	14.9	5.0	
	degree	31.3	29.3	25.5	40.0	
	professional	8.6	9.8	12.8	2.5	
	other	1.6	zero	2.1	2.5	
Household income (£)	0 - 5000	19.5	4.9	19.1	35.0	9.8
	5001 - 10000	17.2	17.1	21.3	12.5	29.0
	10001 - 15000	14.1	24.4	10.6	7.5	11.4
	15001 - 20000	11.7	9.8	12.8	12.5	11.4
	20001 - 25000	10.2	14.6	8.5	7.5	8.4
	25001 - 30000	9.4	14.6	8.5	5.0	13.6
	30001 - 35000	3.1	zero	8.5	zero	5.5
	35001 - 40000	3.9	2.4	6.4	2.5	5.5
	over 40000	1.6	zero	2.1	2.5	5.5
	information withheld	9.4	12.2	2.1	15.0	
Sex	Male	41.4	51.2	36.2	37.5	48.5
	Female	58.6	48.8	63.8	62.5	51.5

It should be noted that the overall percentage of refused responses regarding household income is comparable with that of a contingent valuation study completed by Morey *et al.* (1997).

Question 1

Are you a resident of Aberdeen/ Edinburgh/ Glasgow?

	Yes (%)	No (%)
Aberdeen	82.9	17.1
Edinburgh	85.1	14.9
Glasgow	87.5	12.5

average. This is likely to be due to a number of factors, uppermost being the fact that all three cities contain major Universities, and the site-based nature of the survey. The advantages of on- site face to face interviews (information transfer, response rate), must always be balanced against difficulties targeting certain population groups. Income groups surveyed are less obviously different from the national statistic. Both age and income are later used as variables in a regression analysis.

Question 2

How many miles do you live from [the site proposed]?

	Mean	Median	S.D.
Aberdeen	5.88	1.00	12.96
Edinburgh	5.83	3.00	7.71
Glasgow	7.53	4.00	14.69

The response to questions one and two indicates that the overwhelming number of respondents live within 5 to 10 miles of the areas under consideration. Possible inaccuracies or unreliability in the data due to the subject being unfamiliar with the buildings are therefore reduced.

Question 3

How often have you visited [that site] in the last month?

	Mean (no. of days)	Median	S.D.
Aberdeen	16	20	10
Edinburgh	12	8	9
Glasgow	17	25	10

Although the mean figure here indicates that the average respondent visited the site only half of the possible days in the month (i.e. 30 or 31 days), the mean figure combined with the median and standard deviation indicates that regular visits to the sites are common across the respondent group. The mean is also close to the number of working days in the month.

Question 5

What is the main purpose of your visits to [the site] ?

	No. of responses		
	Aberdeen	Edinburgh	Glasgow
shops	18	22	11
work	14	7	15
access	1	4	
bank	2	1	
social	1	2	1
estate agents		1	
job hunting		1	1
education	2		2
no response		8	
home	3		
annual holiday		1	

Question 6

Where do you work in relation to [the site] ?

	same street/ area	same town	different town	not in employment
Aberdeen	14 (34.1%)	18	5	4
Edinburgh	11 (23.4%)	28	1	7
Glasgow	25 (62.5%)	5	1	9

Visiting sites for either work or shopping accounts for the majority of respondents in each locality (between 62 and 78%). In addition, 39.1% of the overall population work in the area under consideration. The extent to which use of the buildings themselves might influence willingness to pay will be determined.

Question 7

Have you been aware of any stone cleaning work being carried out in the past?

	Yes	No	Unsure
Aberdeen	66%	24%	10%
Edinburgh	79%	17%	4%
Glasgow	73%	25%	3%

Questions 8 and 9

Can you think of any examples of stone cleaning where you found the results particularly pleasing/ poor?

The results to this question were varied, but give an indication of whether or not claimed aesthetic effects are consciously recognised, and provide a link with studies focusing solely on aesthetic effect.

	Examples of "good"	Examples of "bad"
Aberdeen	Gilcomston Church (Union Street), 11 responses	Gilcomston Church (Union Street), 1 response
	Churches in Aberdeen generally, 1 response	
	Townhouse, 1 response	
	Union Street, 1 response	
	Torry, 1 response	
	Ashvale Place, 1 response	
	Salvation Army Citadel, 1 response	
	Castlegate, 1 response	Castlegate, 1 response
	House in Elgin, 1 response	
	Generally, 4 responses	Generally, 1 response
		Glasgow, 1 response
		House near home (Granite turned white), 1 response
Edinburgh	G.P.O. - 1 response	Prefers "soiled" appearance - 1 response
	Balmoral Hotel - 3 responses	Stone repair/ replacement - 1 response
	George Street - 1 response	
	Church in Princes Street - 1 response	
	Generally - 3 responses	
	Charlotte Sq. - 1 response	
Edinburgh	Marchmont - 1 response	
(cont.)	Meadowbank area - 1 response	
	Cowgate - 1 response	
	Dalrye Rd - 1 response	
	Scott Monument - 4 responses	Scott Monument - 1 response
	Northbridge - 1 response	
	Melville St - 1 response	
	National Museum - 1 response	
	St. Andrews Sq. - 1 response	
	Mound - 1 response	
	York Minster - 1 response	
	Always - 2 responses	
Glasgow	Battlefield monument - 1 response	Art School - 1 response
	Italian centre - 1 response	Frasers - 1 response
	Generally - 8 responses	"can spoil look" - 1 response
	Maryhill - 1 response	
	Great Western Road - 1 response	
	Town Cross - 1 response	
	City Chambers - 2 responses	
	Sauchiehall churches - 2 responses	
	Stirling library - 1 response	
	St Andrews Square - 1 response	
	George Square - 1 response	
	Exchange Square - 1 response	
	West End - 1 response	
	Kelvinside - 1 response	
	Merchant City	
	Mitchell library - 1 response	
	Tenements - 1 response	
	Charing Cross - 1 response	
	Gordon Street (1985) - 1 response	
	West George St - 1 response	
	All - 1 response	

Overall, 72.7% of the overall respondent group answered that they had been aware of stone cleaning being carried out.

With regard to responses in Aberdeen, the fact that Gilcomston Church has been the subject of a prominent sandstone tower replacement that took place alongside cleaning of the main walls might have been a major factor in its relatively high placing here. The church was also visible from the location at which interviews were conducted.

In Edinburgh, the Walter Scott monument was masked by scaffolding and protective sheeting for a number of years while the decision on whether or not to clean was debated. Its subsequent (non- cleaned) re- emergence has been recorded here by five respondents as being either a good or bad example of cleaning. Cleaning causes an immediate change in the appearance of an area, as did the uncovering of the monument. It could well be that a misinterpretation of the facts here signpost us towards a clearer understanding of the perceived aesthetic changes which can be afforded to cleaning[3].

Question 10

How strongly do you agree or disagree that public money should be spent on the cleaning of Scotland's historic buildings? (NB. strongly agree =1, strongly disagree = 5)

	mean	median	S.D.
Aberdeen	2.44	3.00	1.03
Edinburgh	2.14	2.00	1.19
Glasgow	1.78	2.00	0.83
Overall	2.12	2.00	1.06

This question is important in relation to the later willingness to pay scenario. The payment mechanism used is a voluntary trust fund, and a strong response to question 10 would indicate a possible validity problem for the payment mechanism. The results themselves would seem to indicate that although a slight tendency towards supporting public expenditure exists, it would not appear that a strong feeling either for or against public spending exists.

[3] Refer to Chapter 9, "Future research".

Questions 11 and 12

What negative effects of stone cleaning are you aware of?

Please note that any effects mentioned by respondents other than those suggested in question 12 are listed after the following table of results (the totals shown are percentages).

	Aberdeen	Edinburgh	Glasgow
removal of a number of layers of stone	56.1	80.1	62.5
salt staining	19.5	40.4	30.0
algal growths encouraged	19.5	29.8	22.5
patchwork appearance where a number of methods used	51.2	19.1	67.5
loss of detail on the stone surface	53.7	68.1	35.0
too clean, bleached	1 resp.		
Scott Monument	1 resp.		
degradation of buildings	1 resp.		
Annoyance while work in progress	3 resp.		
Deterioration of stone durability			1 resp.

At all locations, the public awareness figure of encouragement of algal growth by chemical cleaning agents is lowest. Conversely, knowledge that layers of the stone can be removed is highest in all locations. The length of time since these facts were established within the scientific community might account for these responses.

Regarding the ability of the group to estimate their willingness to pay for cleaning, the results of questions 7,8,9,11 and 12 would indicate a sufficient knowledge and awareness within the population to allow satisfactory decisions to be reached.

Question 13

What would be the maximum you would be prepared to pay to ensure that the project went ahead?

	mean	median	S.D.	trimmed mean (95%)
Aberdeen	3.99	1.00	8.47	2.91
Edinburgh	11.18	1.00	25.90	9.46
Glasgow	11.09	0.00	35.00	6.41
Overall	8.85	0.75	25.55	6.00

Responses to the willingness to pay bidding round are presented above. The immediately obvious difference between the locations is that the responses from Aberdeen are much lower than elsewhere. Reference to the trimmed mean indicates a difference between

Edinburgh and Glasgow, with the overall figures influenced downwards by the responses from Aberdeen. A skewing towards zero from the mean is in line with other studies completed (Hanley 1988), and due to the questionnaire design stage of the methodology is unlikely to have been due to bias on the respondents' or bidding mechanism's part.

The usefulness of socio-economic indicators became apparent only after combined consideration with the bids received. Regression analysis was employed to allow for a multiple variable x-axis, with the bid (£) on the y-axis. This analysis was useful in two respects:

- The reliability of the data set was tested to identify whether any of the socio-economic variables influenced bid levels. If this were so, it would be easier to confirm that bid levels were not simply arbitrary figures, and that respondents were able to properly consider the subject.
- Variables seen to have a significant influence on bids would be identified.

A series of regressions were completed on the overall data set (i.e. including results from all three locations) to identify the most significant variables[4]. A final regression was completed using only those variables showing the greatest significance in previous rounds:

- resident (whether or not the respondent were a resident of the city being considered);
- work (the location of the respondents workplace);
- total (the number of positive responses given in reply to the suggested negative effects of cleaning, where a maximum of 5 was possible);
- age;
- education (on a scale related to the demographics in section 6.4.2).

[4] Kunen *et al.* (1991) found that age and sex had been observed as having an impact on value judgements in adolescents. Data on sex and age was used for regressions, but no relationship between sex and bid level was found, and only a weak relationship between age and bid level.

Results of that regression were as follows:

Table 6.1 Results of regression analysis

Variable	t	significant at 95% (t=1.94)	significant at 90% (t=1.44)
education	2.10	x	
total	1.50		x
work	1.16		
resident	1.09		
age	0.80		
degrees of freedom	6		
no. of responses	128		
F observed	2.37	(significant at 2.29)	

The results of this regression are important in two respects.

Firstly, the F observed statistic is greater than the F critical for this data sample. This indicates that any significance subsequently identified between individual variables and the bid level is due not to chance, and should be duplicated were the experiment repeated. Therefore, since a relationship has been illustrated it can be concluded that respondents in relation to their own circumstance have considered the levels of bid, and have avoided problems with the bidding mechanism discussed earlier. It was of great initial concern that the subject of stone cleaning may be difficult for respondents to consider properly, but this does not seem to have been the case.

The second respect in which the analysis is important lies in the variables uncovered. The extent to which research findings have influenced knowledge about stone cleaning on a wider scale than the academic community is of great importance and interest. Variables such as the respondents age or workplace are not related directly to the results of cleaning, in that the value of results extending over an area will be of value, or otherwise, regardless. However, the depth of a respondent's knowledge of the subject would certainly affect the level of bid. Results of cleaning, after all, run deeper than changes in appearance. It is notable, therefore, that there exists a strong relationship between the expressed prior knowledge of the results of cleaning, and educational background. As academic progress increases, so does the knowledge of stone cleaning[5]. This would indicate in itself that the results of research are indeed being disseminated.

The regression analysis indicates that these results also significantly affect the bid received, indicating that knowledge of cleaning will influence the value attached to the results. This effect, it should be noted, is statistically positive, meaning that a greater knowledge led to higher bids. This can be explained in two ways:

- Those respondents expressing a wider knowledge of cleaning had simply noticed the aesthetic results, had a positive reaction to those changes, and taken an interest when faced with information relating to cleaning in the media or elsewhere.
- With a greater knowledge of the effects of cleaning came a knowledge that potential problems could be avoided or minimised where care was taken. Therefore, although it was understood that the results of cleaning were not always desirable, where good practice was observed, the potential aesthetic benefits could be made to outweigh any costs.

Either way, the responses to question 13 are extremely important and add a meaningful data set to the assessment.

Question 14

Of those respondents who indicated a bid in question 13 of greater than zero, one respondent in the Edinburgh sample indicated that less would be spent on music lessons as a result of the (£100) donation. No other respondent indicated that they would spend less on another good.

[5] A t-test comparison of total and education reveals a very strong relationship between the two. The resulting t-test statistic of 9.80 is highly significant at the 0.005 level (t critical=2.617 at 128 observations). This can be hypothesised to reveal an effective dissemination of research results. It could also be argued that a certain amount of "yea-saying" had taken place, with those respondents possessing a fuller formal education professing a greater interest in the subject. It is argued here that whilst some responses may indeed be motivated in that way, it is extremely unlikely that such a relationship would exist across the entire data set.

Question 15

If the project were extended to include ten areas, instead of just one, would the amount you were prepared to pay be multiplied by ten?

Although the majority of respondents answered "no" to this question, the following summarises those positive responses received.

	Aberdeen	Edinburgh	Glasgow
increased slightly	1	none	none
possible increase	1	none	none

The results to this question indicate two extremely important points:

- the respondent group are considering cleaning as a subject, rather than a project being applied to a discrete area;
- attempting to arrive at a total for the population of the "affected area" will be difficult based on this data. The data gathered clearly refers to cleaning as a conceptual tool of environmental intervention, and could readily be applied to similar areas of the townscape[6].

In one respect, the response to question 15 assists in the production of an overall value model. Were the results here to indicate a strong anchor to specific buildings or areas, the necessary generalisation of the model would be impossible. As things stand, the important factors emerging here can be readily applied within a general model, with only the figures requiring adjustment to meet the demands of each new situation.

[6] Although validation rounds would be recommended were new areas to be considered.

Question 16

Do you feel the information supplied about stone cleaning [see questions 12 and 13] has been sufficient to allow you to make realistic decisions about your level of bid?

	Aberdeen	Edinburgh	Glasgow
Yes	40	45	38
No	see below	see below	see below
insufficient interest in subject to make a difference	1		
impossible question		1	
cost info needed re: amount required		1	
unaware of cleaning in the past			1
unsure of subject			1

Question 17

Why did you say you were not willing to give a donation?

	Aberdeen	Edinburgh	Glasgow
OAP	1		1
Historic Scotland publicity	1		
Already pay taxes	4	2	3
Dislike results of cleaning	1		
Council or owner should pay	3	1	1
Unable to afford	1	4	2
Low priority	2	12	6
More worthy "causes"	1	4	3
Money should be found elsewhere			1
Unaware of subject			1

It can be seen that a number of respondents at each location (approximately 50% overall) recorded a willingness to pay figure of zero. Rather than regarding these as being protest bids, a closer analysis uncovers a number of interesting factors being taken into account. Indeed, of the given reasons for non-payment, only "council or owner should pay" and "money should be found elsewhere" amount to zero bids due to the payment vehicle (accounting for 4.7% overall). Rather than dismissing these responses, it is worth considering the logistical background of cleaning. Where buildings are in public ownership, the use of taxes to pay for maintenance work might be regarded as being more acceptable than with privately owned properties, where using taxes raised for the overall good to benefit a minority of building owners might be seen as improper. This factor is in accordance with similar topics discussed in the preceding chapter, where the long term financial requirements of a building are difficult to model realistically due to the likelihood in many instances of changing ownership.

A conceptual problem faced by this project has regarded the dilemma between the private use and ownership of the built environment, alongside the wider social value provided by those same buildings, regardless of use. Zero bids received with a caveat relating to payment mechanism have been left within the analysis, partially to reflect this situation.

The theory underpinning the use of willingness to pay studies concerns the additional amount which respondents would be prepared to spend. Where respondents indicated that they "already pay taxes", this was only noted as such where the respondent also indicated that the use of taxes already paid to fund cleaning was acceptable to them. This could then be taken as a valid bid of zero, although perhaps skewing the final willingness to pay analysis downwards. It is a reality that a great deal of public money is already spent funding cleaning, and that the public is aware of this fact.

Future work should consider payment mechanisms by which bias due to a knowledge of funding procedure can be removed from the process, whilst not becoming unduly hypothetical[7].

Question 18

Do you feel that using a trust fund is a suitable way for you to consider the subject of stone cleaning?

The responses were gathered as a dichotomous choice. Any further notes are summarised towards the foot of the table.

[7] It was felt at the questionnaire design stage that a payment mechanism based on additional taxation would encounter a greater number of zero bids due to feelings that sufficient taxation is already paid. In addition, it was recorded that a number of respondents felt the payment mechanism used was acceptable due to the fact that nobody was compelled to donate.

	Aberdeen	Edinburgh	Glasgow
Yes	31	25	18
No	10	22	22
Better through taxes	6	15	13
People might not donate	2	1	2
Unsure	2		1
Public building = public funds, private building = private funds	1	5	5
OK if voluntary	2		
owners should pay by *compulsory* order		1	1
other sources needed also		1	1

The results recorded here indicate that whilst 58% of the respondent group felt that a trust fund would be a suitable method of collecting funds, 27% felt that taxation would be more suitable. A number of those respondents indicating that taxation would be more suitable stated that they felt all citizens should contribute.

This introduces a problem in that many respondents appear to be bidding based on a cost per head of population, as opposed to their own heartfelt valuation of cleaning. Whilst aiding the aggregation process to some extent, this is likely to have lead to bid downgrading. Conversely, this supports the notion that cleaning is valued sufficiently highly that a significant proportion feels that the process should be supported by society, as opposed to solely by owners of individual buildings.

Question 23

Did the respondents seem to take the survey seriously, and properly consider his/ her answers?

None of the respondents were noted as having treated the survey with undue jocularity. The time taken to complete each survey form was approximately 5-6 minutes. This time appeared sufficiently long to allow a suitable degree of depth, but on the same note was sufficiently short to ensure that interviewees did not become bored.

6.5 Lower environmental valuation in Aberdeen survey: an investigation

6.5.1 Data collection

The data collection involved each respondent being shown all eight photographs in turn, care being taken to separate pairings within that sequence. Each respondent had the correct use of the data response sheet explained (i.e. 1=strongly agree with the semantic on the left, 4=no preference, 7=strongly agree with the semantic on the right), before completing any responses. The evaluation of each photograph took approximately one to two minutes, allowing the test to be completed within fifteen minutes[8]. An example of a completed response form is given in appendix 8. The data generated for analysis is indicated also. McWhinnie (1993) noted that time taken to observe an art object is an important part of the "aesthetic process" and is a key factor of "aesthetic inquiry" (see also Oostendorp and Berlyne 1978). Care was taken during the data gathering to ensure as far as possible that respondents studied the images properly both before and during completion of the return sheet, and did not begin to hasten their responses towards the later stages of the test.

A problem intrinsic with all aspects of the project relates to the fact that that the degree of soiling present on a building is only one criteria by which buildings and properties will be judged (Webster *et al.* 1991). A balance must be struck between observation of subject buildings to determine the effects of cleaning as part of a system of variables, and adequately identifying that cleaning to ensure that changes caused are not swamped in the evaluation by other changes.

[8] A methodological problem noted during data collection was that a comparatively minor change in colour where dealing with the granite facades, coupled with the similarities between images resulting from the electronic imaging process, led to respondent fatigue or confusion. In a number of cases respondents remarked that they felt the similarity of the "current" photograph to one previously evaluated was insufficiently great to allow for an unbiased response on their part. The result sections for individual pairs indicate where such remarks were common. Reference to the contingent valuation study illustrates how such difficulties can inform the discussion, however, rather than being simply negative barriers to understanding. Where confusion might arise due to any perceived over-similarity between images, this would tend to support an assertion that the effects of cleaning have been insubstantial with regard to aesthetic change.

This study differs greatly from the contingent valuation project in that

- the cleaning is not at any time presented to the respondent as the topic under investigation;
- during the contingent valuation study the effects of cleaning must be described clearly so as to allow the gathering of realistic and informed bids on that point.

In the first case, there is a possibility that the aesthetic effects of cleaning could be overlooked due to other differences (e.g. differences in paint colour, etc., removed electronically prior to data gathering). It is necessary where this is the case that the topic of stone cleaning is not given an unrealistic prominence.

With the second case there exists a possibility that the effects of cleaning will be amplified artificially, due to their necessary prominence in the methodology. Although cleaning can result in effects which will have a negative impact on the physical condition of stone, where these changes are either not apparent to the respondent from a visual inspection, or judged to be of little importance to the visual value, they should not be considered as part of an aesthetic study.

The results for each of the four photograph pairings are presented.

6.5.2 Results

6.5.2.1 Pair 1

The photographs used for pairing 1 are shown in figures 6.13 and 6.14. The buildings are located in Great Northern Road, Aberdeen, and were used to two reasons:

- A previous study (Webster *et al.* 1991) included a pairing with similar architectural features, design and location, thus allowing a link between that study and the current research;
- The pair presented a situation where few differences existed other than those caused by cleaning. The cleaning, in this case, has resulted in a noticeable change in the surface colour of the stone.

The results from this pair are shown on the following page, with an analysis of the differences shown below the graph. Reference to the question return sheet confirms that a "lower" score indicates a favourable response to the photograph. Where semantics were reversed at the sheet design stage, these have been reversed at the data collation and analysis stages.

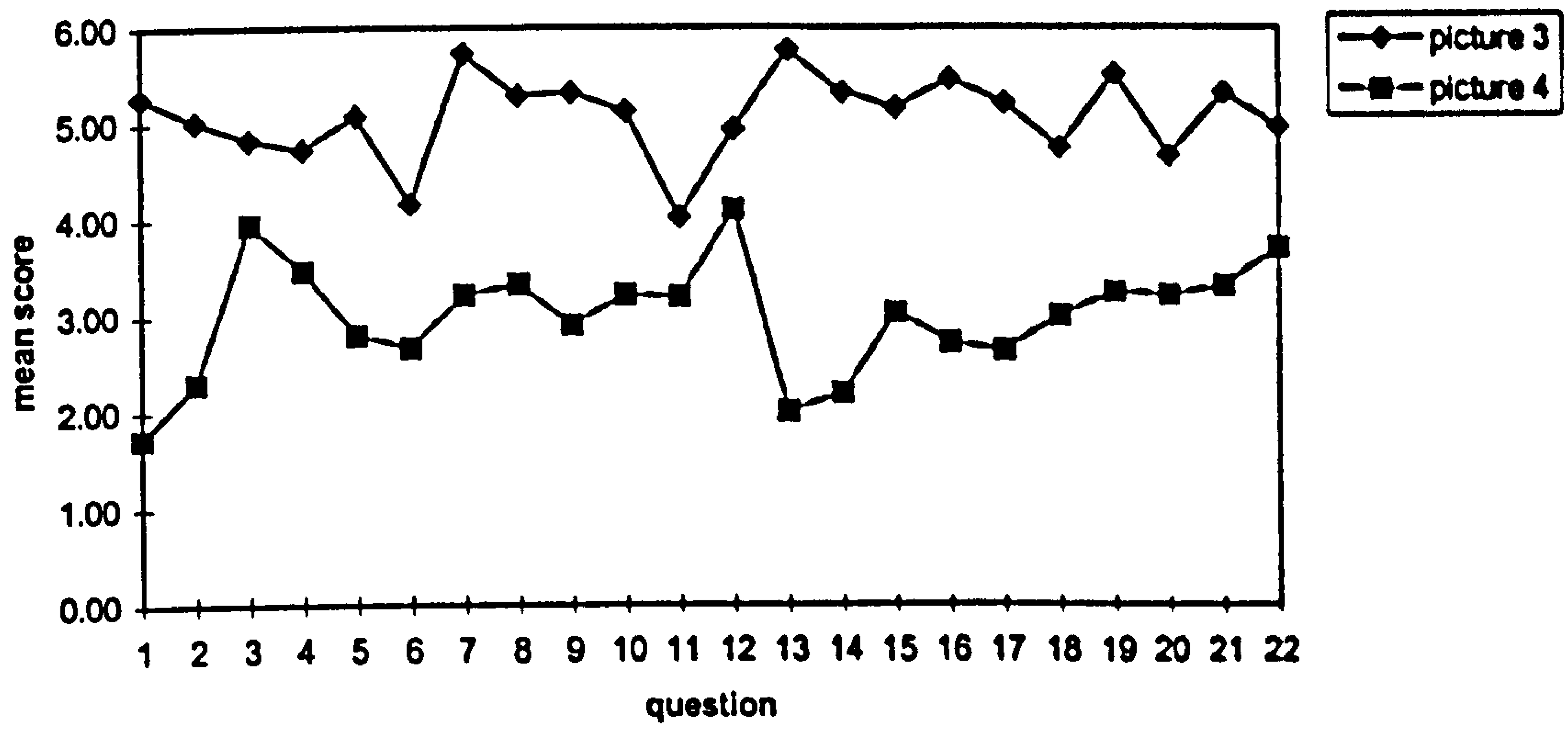
In all categories bar "has character/ has no character" and "soft/ hard" it may be observed that the cleaned property has returned significantly different results to those for the non-cleaned building. These results are in line with those gathered by Webster *et al.* (1991) for a nearby pairing with similar stone and design.

The removal of all traces of rainwater run-off and the generally more pleasing appearance on the facade of the cleaned building has produced a marked effect with regard to perception. Andrew's comment that the "*impression of a better looked after building*" is generated could equally apply to this pairing.

Cleaning has had a clear and positive effect on the visual perception of the property concerned.

3 **Figure 6.13 - Photograph 3 (first pair)**

4 **Figure 6.14 - Photograph 4 (first pair)**



Question number	diff1 (1)	diff2 (7)	p- value
1	Well looked after	Shabby	**0.000**
2	Impressive	Unimpressive	**0.000**
3	Delicate	Weighty	**0.000**
4	Distinctive	Ordinary	**0.000**
5	Inviting	Repelling	**0.000**
6	Orderly	Irregular	**0.000**
7	Cheerful	Gloomy	**0.000**
8	Warm	Cold	**0.000**
9	Attractive	Unattractive	**0.000**
10	Delightful	Dreadful	**0.000**
11	Has character	Has no character	**0.013**
12	Soft	Hard	**0.003**
13	Clean	Dirty	**0.000**
14	Tidy	Untidy	**0.000**
15	Friendly	Unfriendly	**0.000**
16	Light	Dark	**0.000**
17	Pleasing colour	Displeasing colour	**0.000**
18	Elegant	Clumsy	**0.000**
19	Uplifting	Depressing	**0.000**
20	Dignified	Undignified	**0.000**
21	High status	Low status	**0.000**
22	Unique	Common	**0.000**

Questions where a statistically significant difference between responses has been recorded are indicated where the p- value is shown in bold.

6.5.2.2 Pair 2

Results for this pairing are in marked contrast to those is section 6.5.2.1. Initial observations of the pair prior to an image manipulation suggested that the buildings appeared significantly different from each other (the initial images are shown in figures 6.17 and 6.18). However, following the manipulation of many features (including doors, windows and the entire roof element), the differences were lessened considerably[9].

In the categories "well looked after/ shabby", "attractive/ unattractive" and "clean/ dirty", a significant difference between the responses to each image was recorded. The cleaned property was favoured in all three cases. The lack of significant difference in all other categories is interesting, however.

The categories "impressive/ unimpressive", "friendly/ unfriendly" and "high status/ low status" all represent criteria which would often influence the financial value of a building, but which have here been unaffected by stone cleaning. The comparatively low responses from Aberdeen to the property market and environmental value studies can reasonably be linked with this situation. Although respondents have identified that one of the buildings is "cleaner", this has failed to influence visual preference in many respects[10].

It is suggested that the visual nature of weathered granite is such that it may take only a relatively small amount of soiling to obscure the quartz grains at the surface. Where cleaning fails to remove all soiling, or where even a small amount of re- soiling is experienced post- cleaning, the aesthetic benefits, or the time over which benefits will be maintained, will be reduced significantly.

[9] It should be noted that the image definition was reduced slightly at the printing stage. The di- sublimation process used was the most advanced available to the project at the time of the imaging (1995). Were the study to be repeated, the likelihood of this problem occurring would be less likely.

[10] It was feared prior to data collection that respondents might question the similarities between photographs 9 and 10. In practice, only 1 respondent stated they had identified that image manipulation had taken place, that respondent being a researcher dealing with the cataloguing of computer based images. This illustrates how the selection of respondent group is vital to the study's success.

9 **Figure 6.15 - Photograph 9 (second pair)**

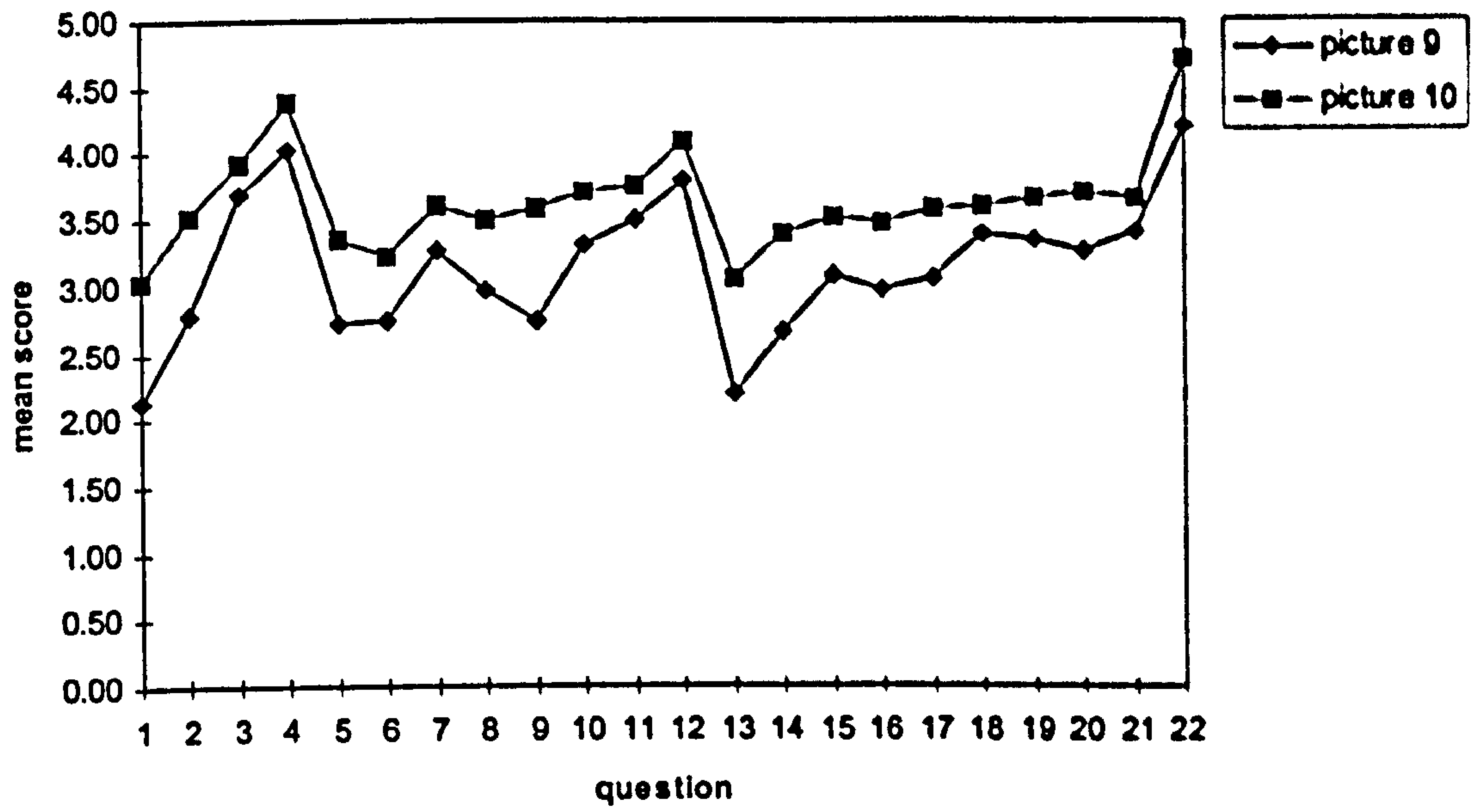
10 **Figure 6.16 - Photograph 10 (second pair)**

Figure 6.17 - Photograph 9 (second pair - before image manipulation)

Picture no. 9

Figure 6.18 - Photograph 10 (second pair - before image manipulation)

Picture no. 10



Question number	diff1 (1)	diff2 (7)	p- value
1	Well looked after	Shabby	0.000
2	Impressive	Unimpressive	0.001
3	Delicate	Weighty	0.147
4	Distinctive	Ordinary	0.186
5	Inviting	Repelling	0.001
6	Orderly	Irregular	0.048
7	Cheerful	Gloomy	0.200
8	Warm	Cold	0.005
9	Attractive	Unattractive	0.000
10	Delightful	Dreadful	0.007
11	Has character	Has no character	0.270
12	Soft	Hard	0.169
13	Clean	Dirty	0.000
14	Tidy	Untidy	0.003
15	Friendly	Unfriendly	0.030
16	Light	Dark	0.071
17	Pleasing colour	Displeasing colour	0.042
18	Elegant	Clumsy	0.282
19	Uplifting	Depressing	0.221
20	Dignified	Undignified	0.024
21	High status	Low status	0.347
22	Unique	Common	0.018

Questions where a statistically significant difference between responses has been recorded are indicated where the p- value is shown in bold.

6.5.2.3 Pair 3

Located in Holburn Street, Aberdeen, the architectural similarities between the pair of buildings are noticeable. In addition, although only one of the properties had been cleaned, the visual change this had caused was far less extreme than the typical change observed in sandstone properties, or even with pair 1 of this study. Indeed, the wide mortar joints have a yellowed appearance that has not been altered by the cleaning to any great extent.

As noted, alterations were made concerning windows and doors, although the building appearances were otherwise very similar.

The cleaning method used had not resulted in a return to the appearance of freshly quarried stone, and the colour of the granite was still obscured by some soiling. This has been reflected in the responses collected.

Of the 22 categories, responses for 13 were significantly different, with the "positive" tendency toward the cleaned building. The presence of soiling on window sills and around details (in figure 6.19) has tended to highlight shadows, and this has been greatly reduced by cleaning.

11 **Figure 6.19 - Photograph 11 (third pair)**

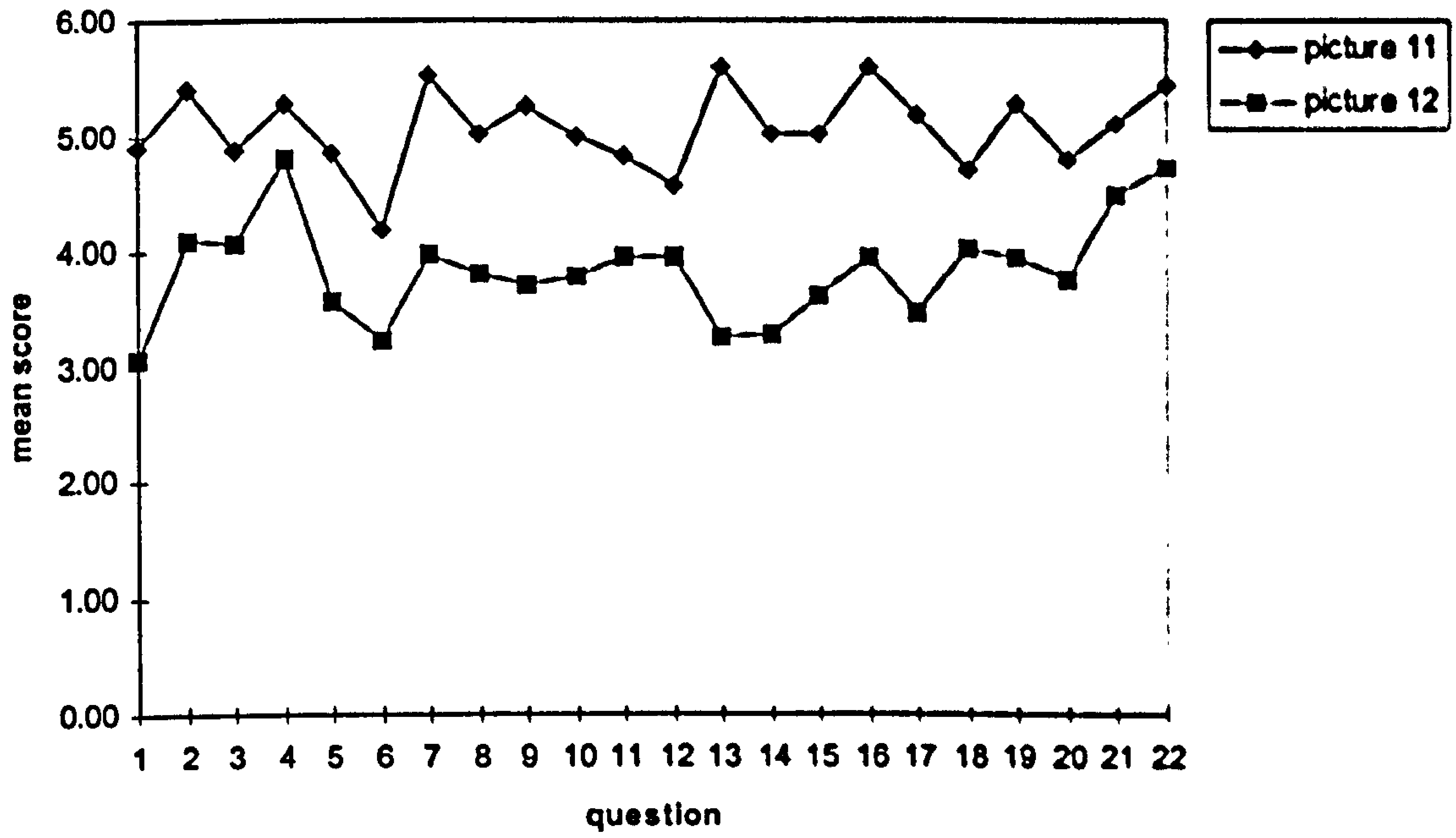
12 **Figure 6.20 - Photograph 12 (third pair)**

Figure 6.21 - Photograph 11 (third pair - before image manipulation)

Picture no. 11

Figure 6.22 - Photograph 12 (third pair - before image manipulation)

Picture no. 12



Question number	diff1 (1)	diff2 (7)	p- value
1	Well looked after	Shabby	0.000
2	Impressive	Unimpressive	0.000
3	Delicate	Weighty	0.002
4	Distinctive	Ordinary	0.077
5	Inviting	Repelling	0.000
6	Orderly	Irregular	0.012
7	Cheerful	Gloomy	0.000
8	Warm	Cold	0.000
9	Attractive	Unattractive	0.000
10	Delightful	Dreadful	0.000
11	Has character	Has no character	0.015
12	Soft	Hard	0.041
13	Clean	Dirty	0.000
14	Tidy	Untidy	0.000
15	Friendly	Unfriendly	0.000
16	Light	Dark	0.000
17	Pleasing colour	Displeasing colour	0.000
18	Elegant	Clumsy	0.027
19	Uplifting	Depressing	0.000
20	Dignified	Undignified	0.002
21	High status	Low status	0.047
22	Unique	Common	0.003

Questions where a statistically significant difference between responses has been recorded are indicated where the p- value is shown in bold.

6.5.2.4 Pair 4

Figures 6.23 and 6.24 depict properties in King Street, Aberdeen, which have much larger facades than the other three pairs. Efforts were made to standardise window and door details, although the shop frontages were left.

In addition to cleaning, figure 6.23 also shows that re- pointing has taken place. Prior to image manipulation, it was also clear that a general upgrading of windows and doors had taken place, probably at the time of cleaning.

The cleaned property obtained responses significantly "better" than the non- cleaned building in most categories. The differentials "soft/hard" and "has character/ has no character" returned no significant difference between the images, as did "orderly/ irregular".

Cleaning has led to a significant change in the colour and appearance of the stonework, here, although the effect of re- pointing should not be overlooked. With sandstone buildings, it is unlikely that such an accentuated form of pointing would be used.

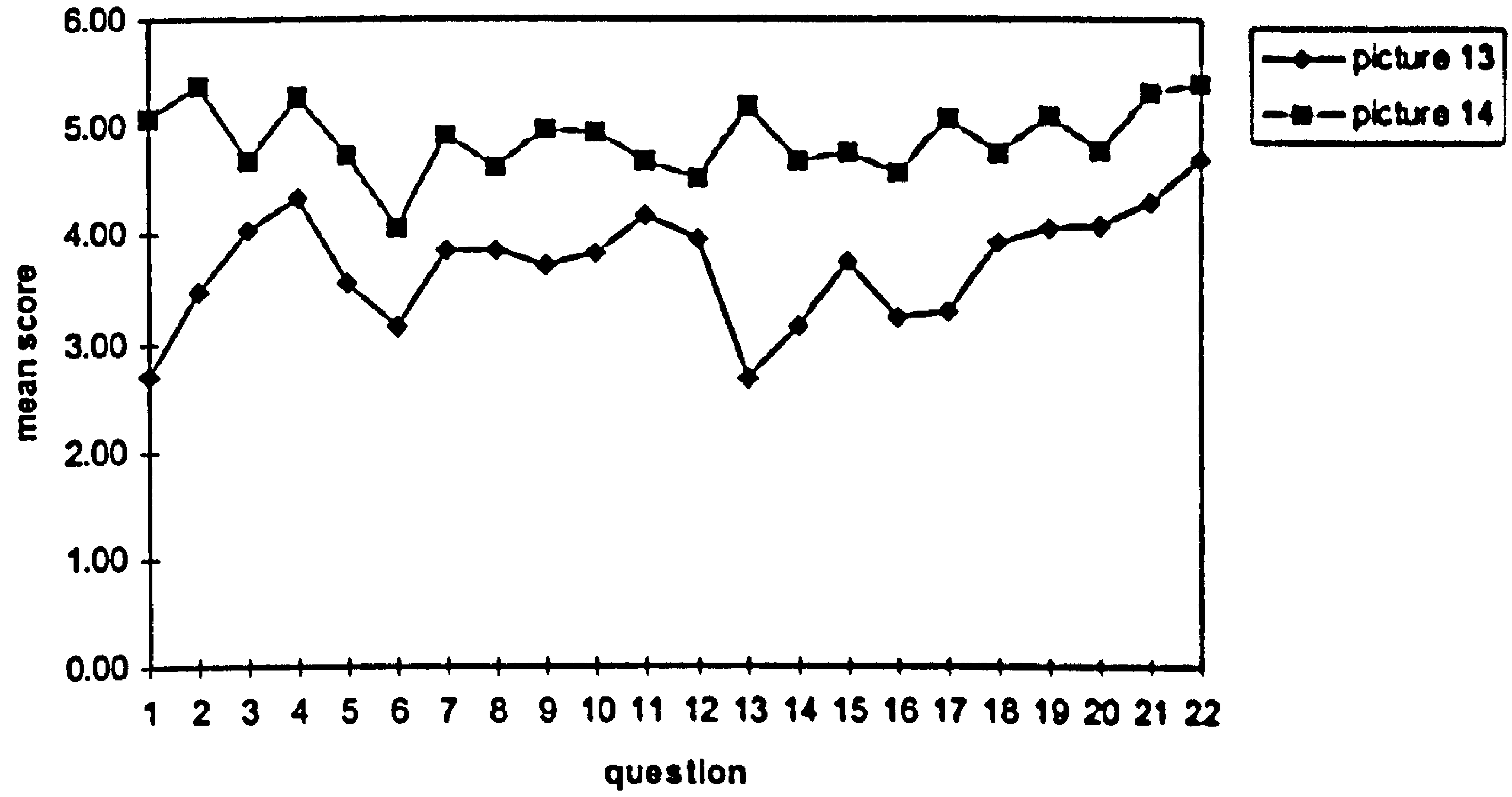
13 **Figure 6.23- Photograph 13 (fourth pair)**

14 **Figure 6.24 - Photograph 14 (fourth pair)**

Figure 6.25 - Photograph 13 (fourth pair - before image manipulation)

Picture no. 13

Figure 6.26 - Photograph 14 (fourth pair - before image manipulation)



Question number	diff1 (1)	diff2 (7)	p- value
1	Well looked after	Shabby	**0.000**
2	Impressive	Unimpressive	**0.000**
3	Delicate	Weighty	**0.001**
4	Distinctive	Ordinary	**0.000**
5	Inviting	Repelling	**0.000**
6	Orderly	Irregular	**0.003**
7	Cheerful	Gloomy	**0.000**
8	Warm	Cold	**0.000**
9	Attractive	Unattractive	**0.000**
10	Delightful	Dreadful	**0.000**
11	Has character	Has no character	**0.015**
12	Soft	Hard	**0.036**
13	Clean	Dirty	**0.000**
14	Tidy	Untidy	**0.000**
15	Friendly	Unfriendly	**0.001**
16	Light	Dark	**0.000**
17	Pleasing colour	Displeasing colour	**0.000**
18	Elegant	Clumsy	**0.000**
19	Uplifting	Depressing	**0.000**
20	Dignified	Undignified	**0.001**
21	High status	Low status	**0.000**
22	Unique	Common	**0.005**

Questions where a statistically significant difference between responses has been recorded are indicated where the p- value is shown in bold.

6.5.3 Discussion of aesthetic perception study

The previous study conducted by Andrew concerning mainly sandstone buildings returned results that indicated a significant, positive and strong effect of cleaning. The studies presented here concerning property markets and environmental value suggested that a geographical variable was important to the effects of cleaning.

Although alluded to in both studies, the results of this aesthetic study show that the effects of cleaning on granite buildings can be less marked than with sandstone. Differences between the two types of stone notably relate to the constituent materials, the weathering patterns and construction method used. The visual impact of sandstone is heavily influenced by colour and perhaps less so by light reflectance. Cleaning of sandstone leads to an often dramatic change in colour, from a near- black in many cases to a red or near-white. With granite the change tends to be a lightening of one particular colour, rather than a dramatic shift (for example dark grey or pink being lightened). Where cleaning exposes quartz grains, the capacity to reflect light may be increased greatly, leading to a perceived visual gain. This effect would in the short term be dependent on weather conditions prevailing, and in the longer term likely to fade as particulate matter obscures quartzes.

A fashion for raised mortar joints has taken hold in Aberdeen over the past decade. Where attention is drawn toward the mortar bed in this way, the visual effects of cleaning on the stone itself might be reduced. Although it was possible to reduce differences between buildings unrelated to the cleaning itself, in reality cleaning will often be completed at the same time as other work. Whether visual change is most affected by cleaning or by any associated work must be considered prior to work being completed. After all, if a desired visual uplift can be obtained through the replacement of windows or doors (with no risk of damage to the stonework), the effects of cleaning (with a finite lifespan) might well be of little additional significance.

With regard to the environmental valuation in particular, this study has given a strong indication that stone type will significantly influence the social value of cleaning. Therefore, the stone type, construction methods and location must inform any incorporation of social or environmental value into the overall consideration.

6.6 Conclusions

The contingent valuation survey produced a number of important findings, which must be considered fully. The study was designed to allow social indictors as part of the data set, in addition to the final willingness to pay figure. It was felt from the outset that past studies have shown the figure for willingness to pay to be often unreliable as an actual estimate of expenditure, due to the many influences and possible biases which might occur. The major use of the willingness to pay result to this study was to allow an identification of those social variables that influence perception of cleaning.

Although not central to the aims of the study, it should be noted that the mean willingness to pay figure, trimmed at 95%, is £6.00 per head of population. Were such a figure to be realised, a substantial sum would be produced to fund cleaning. Conceptually, it would be possible to relate the results from an environmental valuation to the financial value model produced in the preceding chapter, although the financial model relates clearly to individual buildings, as opposed to areas.

Major conclusions from the contingent valuation study are as follows:

1. The public in Scotland **value the results of cleaning**, and regard it as being important to society as a whole.
2. There exists a significant positive **relationship** between the extent to which the **results of cleaning** are **valued**, and **depth of knowledge** relating to those results. This has implications for the stone cleaning industry, as well as this project.
3. There is a **strong relationship** between the **knowledge of stone cleaning results** and **level of education**. This would suggest that the topic of stone cleaning as relating to masonry conservation is becoming known outside of the academic environment, and is influencing perceived environmental value (see point 2).
4. The **majority of respondents** had been **aware of cleaning** in the past, and many were able to cite examples. Relatively few examples of "poor" results were recorded.
5. The mechanism by which stone cleaning is paid for is of great importance. Future studies regarding the built environment through the use of environmental valuation techniques such as the contingent valuation method must take account of the fact that **buildings are seen as being commodities**, in addition to forming the

environment for the majority. Attempting to set up the necessary hypothetical markets within an existing market, such as the markets of construction, building maintenance and cleaning is extremely difficult. Regardless of the payment mechanism chosen, difficulties will arise with regard to liability for payment.

6. Results of past research into the effects of cleaning are gradually filtering through to the general public. A significant proportion of the public is now aware of general results from studies completed over five years ago. Where the maintenance costs associated with such conclusions are presented, an effect could well be felt through future environmental valuations.
7. Many respondents felt that taxes already paid should be used to fund cleaning. It is the case that public funds are indeed available to fund cleaning in certain geographical areas, but that the amounts vary depending on the attitude of the local Council. This should be borne in mind by any future work.
8. The mean valuation recorded in Aberdeen was lower than the figures for Edinburgh or Glasgow. At this stage, it was hypothesised that this was due to the magnitude of aesthetic change due to cleaning was different where granite, as opposed to sandstone, was the predominant stone type. This was explored further and results presented.
9. The aesthetic effects of cleaning on granite are less clear than with sandstone. The more subtle change in colour, and the need for all soiling matter to be removed, results in an alteration that will have mixed perceptual outcomes in the short term and only a limited life span.

The aesthetic study confirms that stone type is of great visual importance, and goes some way to explaining geographical differences in the financial (i.e. property market) and environmental data sets. In addition, meeting aesthetic preference has been shown in other sectors to be of significant importance in meeting with user needs generally (Guyer and Pollard 1997, Mosley 1989), as the environment created will often contribute more to the experience than the physical characteristics themselves. Stone cleaning completed on a large scale clearly wishes to alter perception in this way, so the completion of stone cleaning without adequate consideration of the whether wider value needs may not be satisfied will undoubtedly compromise the overall success.

The environmental valuation indicated that the respondent group gave adequate consideration to the topic, and related this to the bid received. In addition, level of education and knowledge of stone cleaning had a significant effect on the valuation[11]. Bids did not appear to be influenced significantly by other demographic factors, although the use of buildings as financial commodities might be addressed by future studies. A number of respondents indicated that they felt taxes already paid should be sufficient in themselves. The apparent link here between public responsibility and cleaning is interesting, as is the link made by some between cleaning and "charitable donations".

Clearly, consideration within any assessment must be made of stone type, location, ownership and the communication of research results to a wide audience.

[11] This result could have been hypothesised at the outset, and its (blind) emergence from the data set illustrates a self- validation on the survey's part.

6.7 References

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7. Heritage value assessment

7.1 Introduction

The assessment of heritage value in the built environment was introduced conceptually in chapter two, with assessment mechanisms developed in chapters three and four. This chapter presents applications of the assessment method, using selected examples, to illustrate the method's applicability in a suitable range of circumstances.

As identified and discussed earlier, the reasons for a building being regarded as having cultural worth are vital, as those reasons will often in themselves reflect both current society, and that society responsible for the original construction. The recognition and consideration of architectural works; sculpture and painting; place in the landscape; historical events; perceived aesthetic importance and anthropological considerations which present outstanding universal value[1] must be recognised as a vital stage in the heritage assessment process. Cultural worth can arise from the values of present-day society, in that many buildings reflect events and communities which were or are important in the formation of current views, opinions and attitudes. In addition, the reflection in buildings of those societies responsible for the original construction could be manifested in, for example, the overall design; response to functional requirements; choice of materials; detailing and level of ornamentation. The heritage worth of all buildings cannot, therefore, be rooted in the consideration of simply architectural merit, or age, or historical events, as the appropriate balance of factors is particular to the individual case.

Categories of Listing, in Scotland and elsewhere, provide some guidance as to the degree of heritage value placed on buildings and monuments and afford a degree of protection which, in themselves, both reflect and contribute to society. As stated by Feilden and Jokilehto (1993), the aim of conservation should be "*to safeguard the quality and values of the* [heritage] *resource, protect its material substance and ensure its integrity for future generations*". The built heritage is comprised of buildings representing a long time period, and which have come to symbolise and define a "setting for society". It continues to contribute towards a sense of community, and must be considered through public benefit, understanding, respect and integrity.

[1] UNESCO (1972).

The heritage value of a building may vary over time, as tastes are affected by fashion, and consensus of opinion might shift, but an assessment of heritage value must be rooted always in acknowledged and recognised indicators. The overall system of values ascribed to a building has been shown to be assessable through both objective and subjective means, and can be recognised through factors both external to and embodied in a building. The heritage value associated with any building is essentially intrinsic to the building, since it will not be generated through markets or fickle changes in fashion, but will be developed and often sustained over long periods of time. Due to associations of the built heritage with a complex range of social, historical, geographical and architectural factors, it is unlikely that stone cleaning has in itself the ability to completely remove heritage value. Indeed, it could be argued that nothing short of complete demolition can remove heritage value entirely[2]. Where cleaning has led to stone damage, or the removal of important historic or noble patina[3], it is possible that heritage value could be diluted or reduced. In addition, heritage value is clearly attached to identifiable aspects of the built environment such as monuments, buildings (or parts of), and once lost cannot be regained (Feilden and Jokilehto 1993).

Buildings deemed worthy of statutory protection in Scotland are considered in respect of their age; designer; social and economic history; technology; regional variation; association with persons or events; or "group value". Stone cleaning of Listed Buildings in Scotland requires statutory consent, clearly recognising that cleaning has the potential to reduce or remove heritage value. Reasons for the conservation of buildings may fall under the headings of historical, aesthetic or social (Snickars 1997), and their assessment will often involve a complex consideration of more than one aspect. A range of assessment methods from the literature and practice were identified, and an approach developed through which the known physical effects of cleaning were clearly capable of influencing the assessment. In addition, the assessment method takes clear account of national and international approaches to heritage protection, and avoids historical problems involving inappropriate scales of measurement.

This chapter presents the assessment method developed from the literature, and represents a conceptually sound approach to the generation of value judgements. Operation of the assessment method is explained, with a rationale for the selection of examples.

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[2] Even where demolition has occurred, the protection afforded to derelict ancient ruins suggests that a preservation of historical value or information is possible even in the most extreme circumstances.
[3] The patina formed as the result of natural weathering processes, and is thus part of the fabric of the material.

7.2 Assessment procedure

7.2.1 Operation of assessment

The assessment method to be used operates through the consideration of a range of five elements, taking account of the likely effects of stone cleaning. Although the assessment itself is largely subjective, a reliable value judgement is assured through the structured and logical approach to be taken in every case.

The elements to be considered with each example are architecture, history, environment, usability and integrity. These areas were identified in chapter four as having precedent for use in practice, being relevant to the subject of stone cleaning, and reflecting the range of issues in national and international conservation guidelines and legislation. Definitions of the elements are as follows[4]. These definitions should be used in the heritage assessment of stone cleaning.

Architecture: style, construction, age, Architect, design, interior.

History: **context**: associated with, and effectively illustrative of, broad patterns of cultural, social, political, military, economic or industrial history.

Environment: **continuity**: contributes to the continuity or character of the street, neighbourhood or area; setting: **setting** and/or landscaping contributes to the continuity or character of the street, neighbourhood or area; **landmark**: A particularly important visual landmark.

Usability: cost of preservation, restoration, maintenance, and/or interpretation.

Integrity: **alterations**: has suffered little alteration, and retains most of its original materials and design features; **condition**: building is in good structural condition.

The assessor should consider the elements from these perspectives, in order that the range of possible effects of cleaning are reflected in the assessment mechanism.

An example of the assessment table is shown in figure 7.1, hypothetically completed to assist this discussion. This example is provided to identify the manner in which a range of probable heritage variations can be reflected through the table as used in the later case

[4] Please refer to section 4.4.5.2 for a rationale, discussion and further definition of these areas.

studies. Immediately following figure 7.1, reference should be made to the explanatory text included to clarify the meaning of the symbols and changes noted.

Figure 7.1 - heritage assessment table (pro- forma)

	greatly reduced	reduced	unchanged	increased	greatly increased
Architecture			x		
History			x		
Environment	←		→		
Usability			x		
Integrity		←		→	

The consideration of each area begins from the pre-cleaning condition for the building under consideration. Three different assessments are possible for each element, these being no change; a clear value shift in one direction; and the possibility of both gains and losses in value.

Firstly, where an "x" indicates that an area will be "unchanged" by cleaning, it should be understood that the judgement relates to the **building under consideration** only, and does not judge that building in relation to others. For example, were two buildings considered in isolation, where one was recognised as being of greater architectural importance than the other pre-cleaning, and the judgement was that neither building's "architectural" worth would be greatly altered by cleaning, then both studies would record an "unchanged" against "architecture". Likewise, it is indicated against "history" and "usability" that cleaning will not increase or reduce heritage value with respect to either of those elements.

The second possibility with regards to the assessment is that cleaning would be anticipated as leading to a likely increase or decrease in heritage value. Again, the assessment begins by considering the pre-cleaning state of the building in relation to each element, and indicates the likely direction and magnitude of change that might result. Reference should be made to the known physical effects of cleaning and the rationale for ascribing value to that element in the first instance. Figure 7.1 illustrates against "environment" a situation where it is anticipated that cleaning will greatly reduce heritage value in relation to that area.

The third possibility is that a complex situation may arise with regard to one or more of the variables, in that the physical and social effects of cleaning may potentially produce both negative and positive results. For example, an increase in the aesthetic continuity of a facade may be possible where cleaning is sensitive to surrounding buildings as well as the case study facade itself. It is also possible, as identified earlier, that a number of cleaning methods on one facade can produce a non-uniform and aesthetically detrimental effect. Figure 7.1 illustrates against "integrity" a situation where it is anticipated that cleaning has the potential to both increase and decrease that aspect of heritage value, depending on the method used and results.

The relative importance of each element must be considered through the final discussion, but should not enter into completion of the assessment table itself.

As noted in chapter four, the assessment attached to each criterion is largely subjective, but should be related in all cases to the likely physical change. The assessor is forced to consider a range of areas through which heritage value can be ascribed to buildings, and in so doing the movement towards a value judgement is rooted in a conceptually sound range of criteria.

Once the assessment of all five areas has been completed, with a rationale for the outcomes noted, the decision-maker must consider the results together. Although this process will by necessity involve a degree of subjectivity - most obviously in relation to the importance given to each area - where that subjectivity is rooted in a strong knowledge of the subject area it must be regarded as a feature and a potential strength, as opposed to a weakness.

7.2.2 Selection of examples

Two examples are presented in this chapter, and have been selected to reflect the influence which variables including location, stone type, Listing category, size, use, design and environment can have on the assessment, and the interpretation of results.

The examples used were selected after consideration of the attributes to be tested by the model itself. The buildings are located in cities of greatly different size, and have different local environments. Variation between the examples with regard to the original (local) source of building stone, the level of traffic present (pedestrian, vehicular), overall size of facade, use, surrounding and adjoining buildings and history were of importance to the study. Indeed, although this assessment should be completed for all properties, it was interesting to consider buildings which may have already been identified as having heritage value through Listing (one of the examples is Listed Grade "B" - "*buildings of regional or more than local importance*").

Due to variation between the examples with regard to the above, the elements to be tested - architecture, history, environment, usability and integrity, are likely to be of relevance and require a diverse approach in their consideration.

7.3 Example applications

Examples of how the model can be applied in practice are presented. For the purpose of these assessments, it is assumed that a low pressure dry grit blasting cleaning technique is to be used. That method has a lower potential for damaging the stone itself, and gives a more accurate picture of "best practice".

7.3.1 Example 1

Building to be assessed

Location:	George Street, Edinburgh
Stone type:	Buff sandstone (medium levels of soiling)
Description of facade:	The building is in use as retail premises on the ground floor, with offices above ground level (four stories in total above street level). Low level of stone carving on facade (some carving between stories). The building is illustrated in figure 7.2, with views of the streetscape in figures 7.3 and 7.4.
Surrounding area:	A wide urban street setting, with many buildings with similar size of facade nearby. Although some non-sandstone building work has taken place in the past, the overall impression is of a unified use of materials, with variation in design. The building is situated on the periphery of a Conservation Area, within which the majority of buildings have been cleaned.
Listing category:	The building is not Listed, but is surrounded on both sides by buildings listed at grade B and C(S).

Illustrations

Figure 7.2 - Building selected for example 1

George Street, Edinburgh: The building to be considered is in use as retail premises at ground level, with offices above. The original stone detailing can be seen to be common with the property to the immediate right.

Figure 7.3 - Streetscape (1) for example 1

George Street, Edinburgh: This view of the streetscape, looking to the west, illustrates that differences in stone colour on the terrace have been highlighted (or possibly caused) by past cleaning. An architecture continuity of sorts exists through the preservation of horizontal lines, and original window designs.

Figure 7.4 - Streetscape (2) for example 1

George Street, Edinburgh: This illustrates a view of the streetscape to the east. A graduation in colour due to different cleaning methods being used can be seen towards the end of the terrace, above "Waterstons".

Assessment of each criteria grouping

History: The facade for this building is in keeping with the design style used for many other buildings in George Street, defined visually by the material and neo-classical style used for many properties. Events surrounding the building are of no great historical significance. No connections with persons, events or patterns of importance.

Environment: The building is of no particular significance from the perspective of it being a landmark property, although it forms a part of the overall streetscape. A number of buildings in George Street have been cleaned previously, creating a patchwork effect in places. It is clear also that a number of different cleaning methods have been used, leading to a range of post-cleaning facade colours. A further loss of aesthetic or structural continuity would therefore be to the detriment of the street as a whole, should cleaning lead to a worsening of the patchwork effect. If, however, cleaning aided in improving continuity, benefits to the heritage value of the area as a whole might be apparent.

Usability: The building is currently used for both retail and commercial purposes, so might expect an enhancement of market value following cleaning. Due to its location on a busy street, however, re-soiling must be regarded as a likely in the long term. The building's usability would not be altered significantly as a result of cleaning.

Integrity: The present stone condition is acceptable, with little evidence of decay. Algal growth is apparent in places. Cleaning should always be regarded as an alteration, however, and if cleaning was to result in short or long term damage to the stone, the condition would be adversely affected.

Predicted effect of cleaning

The preceding section discussed how the criteria groups applied to the current case study. That discussion informs the following prediction, as does consideration of the cleaning methods available for use. "Architecture" is included as a variable to illustrate that the cleaning process will not in itself alter an important area of heritage value, i.e. the original design.

	greatly reduced	reduced	unchanged	increased	greatly increased
Architecture			x		
History			x		
Environment		←	—	→	
Usability			x		
Integrity		←	→		

Decision - example 1

The rationale for the indicated potential changes in two criteria areas varies between those criteria. Regarding "environment", the continuity of a facade within the streetscape would be at risk were the cleaning to lead to the building appearing out of place in the terrace. However, were the cleaning to result in an improved unification of the visual appearance of the terrace as a whole, an enhancement of heritage value might be possible. The "integrity" indicator shows an overall loss of value as being possible, as the physical condition of sandstone will be at best undamaged by the process. Therefore, cleaning seems incongruous with any attempt to preserve the original.

Using a straight amalgamation of the five variables, a marginal loss of heritage value can be seen to be likely, although this may not be the most appropriate approach in all circumstances. The importance of each aspect of heritage value will not be equal for every case, and this must be considered when considering results. For this particular case, none of the variables dealing with non-temporal value (i.e. architecture, history, environment, integrity) are particularly at risk by cleaning, so it must be concluded that **heritage value would in this case not be placed at undue risk[5] by cleaning[6].**

[5] By this, the author means that the current heritage value of the building lies in its being part of a larger whole. That larger whole will not be greatly damaged by the cleaning of this property, although were a large number of such properties to be cleaned, the environment and integrity variables could be significantly affected.

[6] It must be borne in mind that the heritage assessment module forms only part of a larger value system. Were the output of the financial and environmental assessments, or the completion of on site test panels, to indicate that cleaning should not progress, the heritage indicator should not over ride that decision. Indeed, where the financial/ environmental assessment returns a negative result, it is advised that a heritage assessment is excluded entirely.

7.3.2 Example 2

Building to be assessed

Location:	High Street, Elgin.
Stone type:	Buff sandstone (medium soiling levels)
Description of facade:	The building is in use as retail premises at street level, with office accommodation on the upper floors. The facade itself features ornate carving work, with carved balustrading at eaves level. The building forms part of the historic town centre of Elgin, within which a number of facades have been cleaned in the past. The building is illustrated in figure 7.5, with views of the streetscape in figures 7.6 and 7.7. A detail showing spalling and algal growth on a nearby cleaned facade is shown in figure 7.8. McKean (1997) notes that there is "*less of the earlier period...* [from Elgin's architectural design] ... *on the South side*" of the High Street. The property considered here, built in 1857, features "*sculpted shell hoods*", "*ornate carvings*" with the "*whole topped by a balustrade*".
Surrounding area:	As shown in figures 7.6 and 7.7, a number of buildings in the area have been cleaned in the past, with mixed results. The stone carving work is, if anything, highlighted by the soiling at present, which due to recent pedestrianisation of the High Street will be unlikely to darken significantly in years to come. Previous stone cleaning in Elgin using abrasive physical methods has been observed causing both immediate and longer-term damage to the stone surface.
Listing category:	Listed grade B.

Figure 7.5 - Building selected for example 2

High Street, Elgin: The building to be considered is shown centrally in the figure. Stone carving work, as referred to by McKean (1997) is clearly visible, with what soiling is present possibly increasing visual interest.

Figure 7.6 - Streetscape (1) for example 2

High Street, Elgin: The figure shows a view of the streetscape to the east. Great variation in both the design and age of surrounding building on the south side of the High Street can be noted. Towards the left of the photograph, an unacceptable loss of continuity due to selective cleaning can be observed, where a carved balustrade has been left soiled, with the remaining facade cleaning.

Figure 7.7 - Streetscape (2) for example 2

High Street, Elgin: The figure shows a view of the streetscape to the west. It should be noted that this portion of the High Street was recently pedestrianised, meaning that existing soiling levels will be unlikely to further darken either significantly or rapidly due to airborne pollutants.

Figure 7.8 - Spalling and algal growth on neighbouring property

High Street, Elgin: This photograph, showing a detail from a nearby cleaned property on the same side of the High Street shows both stone decay and algal growth. Although the decay may not be due to cleaning, it has certainly been made more apparent as a result. The algal growth appears to be localised around the rainwater downpipe, suggesting a problem with runoff. Although the root cause should be correctable, therefore, the existing growth is much more apparent due to the cleaning, and further cleaning may not be possible due to the building being Listed.

Assessment of each criteria grouping

History: This building is an essential part of the historic town centre of Elgin, and looks on to the city's marketplace. The building, originally constructed as a bank, has operated as retail premises at ground floor level with commercial offices above for many years. Elgin High Street has been altered significantly in recent years, with the construction of a large (for the location) shopping centre opposite the case study building. Although that development has led to the demolition of a large area, the existing facade was retained, preserving to some extent the continuity of the streetscape. The building's historical importance has been recognised through its Listing at Category (B), due to its location, age and ornamental stonework. As noted, the ornamentation is at present highlighted to some extent by the (light to medium) soiling layer, and a danger of either stone damage or aesthetic loss through prominent algal growth (refer to figure 7.8) would be a very great loss. Therefore, the **historical aspect could potentially be greatly reduced through cleaning.**

Environment: The building forms an important part of the streetscape, and loss of detail on the stone would significantly reduce both the current condition and the likely remaining lifespan of the stone itself. Although buildings that have been cleaned surround the building on all sides, it is unlikely that a harmonisation of colour through cleaning would significantly improve the appearance of the streetscape, which benefits to some extent from the building's present appearance. Cleaning would therefore be unlikely to disrupt continuity, but would similarly be unlikely to significantly improve the environmental aspect. Therefore, the **environmental aspect would be unlikely to change as a result of cleaning.**

Usability: At present, the condition of the stone is good, with little need to undertake repair works. Were cleaning to result in damage to the stone, costs might be incurred which would not otherwise arise. Therefore, the **usability aspect could potentially be greatly reduced through cleaning.**

Integrity: The present stone condition is very good, with very little alteration since construction. Indeed, that integrity is a major reason for the Listing category. Therefore, the **integrity aspect could potentially be greatly reduced through cleaning.**

Predicted effect of cleaning

	greatly reduced	**reduced**	**unchanged**	**increased**	**greatly increased**
Architecture			x		
History	←	—	→		
Environment			x		
Usability	←	—	→		
Integrity	←	—	→		

Decision - example 2

Regarding "integrity", a significant loss of value is noted as being possible, with little potential for gain. The current level of soiling is medium to light, pedestrianisation meaning that a significant darkening of the existing soiling due to airborne pollution is unlikely. Therefore, historical information (in the form of carvings or tooling) is not obscured at present, and could in fact be destroyed by the cleaning process.

Using a straight amalgamation of the five variables, a loss of heritage value is likely, although this may not be realised were a sensitive cleaning method employed. Due to the levels of soiling present, a low-pressure water wash might be sufficient to remove the existing layers without damage to the stone, although low-pressure methods have been largely ineffective with sandstone in the past.

The dangers to heritage of cleaning this building are clear. That the building is currently Listed (and would therefore require planning consent prior to cleaning), confirms that **cleaning of this building should not go ahead**, and would be likely to produce heritage loss in any case.

7.4 Discussion

It has become apparent from the literature, methodology and application that although "architecture" as considered here is vital in the forming of heritage value, it may be difficult for a wide range of alterations to affect that aspect. This raises an important issue, namely that results from the assessment must consider all elements together, and take account of the fact that where a building is Listed, that designation may be due to one or more of the elements considered.

The "historical" aspect of the assessment has been shown to be most closely related with listing category in the examples shown, in that where Listing is due to historical importance or age, that designation should be taken account of in the assessment.

The "environment" element is conceptually simple but complex in operation. Although isolated cleaning can potentially reduce environmental continuity, it is not true that progressively cleaning a streetscape over time will produce aesthetic harmony (due to variation in cleaning method, operative, stone type or weathering characteristics). The environmental element, where possible, could be informed by the environmental valuation exercise, and therefore take greater account of local opinion. Cleaning clearly has the potential to greatly influence the aesthetic perception of buildings or areas, and this must be considered here. Heritage value, although ascribed by society and not generally short-term in nature, could well be reduced or lost where that value had emerged from a specific local environment, subsequently altered through cleaning.

Usability, as considered here, should be most closely concerned with the potential cost of maintaining a building. It has been shown conclusively that cleaning has the potential to damage stone, and would carry a repair cost in many cases. Where uncleaned stone is in an acceptable condition, this variable would be likely therefore to indicate a potential reduction in value. Where stone was in a poor condition pre-cleaning, the likelihood is that cleaning would be ill-advised in any case.

Regarding the "integrity" of a building, damage to stone detailing or a need for the replacement of damaged stonework would both reduce the "original" condition. Whilst it is recognised that many buildings are altered for reasons of changing use or expansion, the major objective of stone cleaning is to improve the aesthetic appearance. Where that is realised only at the expense of long-conserved stone materials, the justification of cleaning is difficult. Operation of the assessment model requires that the assessor is familiar both with the known effects of cleaning, and the definitions of each criterion (as identified in chapter four). Although largely subjective assessments are required, those assessments are based upon a logical approach to the subject and established practice.

The final interpretation of results requires that the five elements be considered together, again requiring that the assessor make subjective judgements as to the relative importance of each. The model's strength in this respect is that prior to reaching this stage, a knowledge of the history, environment, Listing position, design and current environment must be established, thus ensuring that the judgement reached is **transparent, logical and based on established data**. Although further work is required to establish applicable methodologies for the practitioner, the conceptual basis established here can stand firm.

7.5 Conclusions

The heritage assessment mechanism presented in this chapter is successful in a number of respects. The mechanism itself draws upon previously reported attempts at assessment, but from the outset takes a subjective approach.

This work has in a number of respects developed a more broadly based and integrated method of assessment than those represented in the literature. Firstly, the understanding of heritage as recognised at both national (Town and Country Planning (Scotland) Act 1972) and international (ICOMOS 1966, UNESCO 1972) levels has been clearly linked with known potential physical changes. What was previously a wide and rather imprecise definition of heritage has been re-conceptualised through the assessment model allowing for the effect of physical alterations to be assessed in a clear and reproducible manner.

Problems of inappropriate objective measurement methods experienced in the past (Crompton and Lichfield 1962, Kalman 1980, Lichfield 1987, Melhorn and Kellor 1973) have been identified and removed from the assessment model. Past confusion concerning what can be regarded as "precise" has been clarified by concentrating on a clear understanding of "value judgements". In agreement with Lamont (1955), the assessment method follows a scientific path in that links between the likely effects of cleaning and an identified heritage value system form the basis of the analysis, producing results as reliable, if not more so, as those from a wholly objective approach.

Finally, although it could be argued that "heritage" is considered already through the Listing process, that process is largely hidden from the public, with decisions far from transparent. The assessment mechanism presented here allows the non-planner to better understand the heritage worth of a property, and should thus have a far wider applicability than the field of stone cleaning. In addition, all buildings must be recognised as having the potential to contribute to "heritage", and consideration of that fact should be central to all design and procurement decisions.

By placing the assessment mechanism at the critical stage in the overall assessment, the importance of heritage essentially becomes the key criterion by which cleaning should be judged.

1. The built heritage has been assessed in the past through legislative controls, where the ideology and aims are stated, but the process hidden. It has been shown how that ideology can be reflected in the five elements of assessment used in this study, through which an assessment of value can be structured, thus ensuring all factors influencing heritage value are considered (including Listed Building legislation, design, history, age, environment, cost and condition).
2. It has been shown that stone cleaning is capable of influencing heritage value, through the direct linking of heritage indicators with the known physical effects of cleaning. However, where the heritage value of a building relates to aspects unconcerned with the exterior facade (e.g. internal design), heritage value will not be affected by cleaning.
3. Where a building is Listed, planning consent is required prior to the application of any cleaning method. Where this is the case, the assessment mechanism may prove useful in determining whether a planning application would be worthwhile. Where it cannot be shown that cleaning would be likely to result in heritage benefits (and certainly not in heritage loss), planning consent would be likely to be refused.
4. All buildings, regardless of Listed status, should be considered under a heritage assessment. Heritage relates not to individual buildings, but to the built environment as a whole (not all of which by any means is formally protected).

The method presented in this chapter has been designed to provide a logical and robust structure for the assessment of links between stone cleaning and heritage, and offers a basis from which the generation of sound value judgements can be built.

The approach taken has followed a clear developmental path focusing on identification of the meaning of heritage; identification of existing legislation controlling aspects of the built heritage; identification of previously reported assessment methodologies, and linking of the selected/ developed method with known physical effects of cleaning.

7.6 References

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8. *An overall value assessment*

8.1 Introduction

This thesis has focused on an overall value assessment, within which discrete value sub-systems have been considered. The preceding chapters have investigated financial, environmental and heritage value, and presented methodologies for the assessment of each. Chapter two set out a path to be followed by the research, and introduced the desire to move towards a holistic understanding of value.

The results from chapters five to seven make it clear that the outcome of any value assessment can be open to influence from the prejudice, objectives or knowledge of the valuer. Such personal influences mean that the presentation of a definitive scaled value measurement will be unlikely to adequately represent the richness and complexity of real life situations. What has been shown, however, is that the objective[1] assessment of both financial and environmental value, and a logical and subjective assessment of heritage value, is possible. This chapter is concerned therefore with the development of a conceptual model for an holistic assessment, with consideration given to the practical implications.

8.2 Derivation of a conceptual model

The major aim of an overall value assessment is to incorporate the entire value system and avoid unrealistic influence from any part or parts of that system. An over-emphasis on part of the system "*jeopardises the consideration of others*"[2] (Ilozor *et al.* 1997). Figure 2.1, presented in chapter two, illustrated how a range of criteria must be considered, and that the groupings used to divide that system are flexible.

The divisions used for this thesis were determined in a systematic and logical manner, and wherever possible evaluated using available assessment methods. The important objective was to ensure that the divisions chosen did not exclude any single part of the system from detailed consideration.

[1] Both financial and environmental value assessment require a degree of estimation on the part of the assessor. Where such estimation is based on expert opinion and observation of past performance, the objectivity of the overall exercise will not be undermined.
[2] Meaning that concentrating on, for example, financial value, to the exclusion of environmental and heritage value, would result in unrealistic, and non- holistic, results.

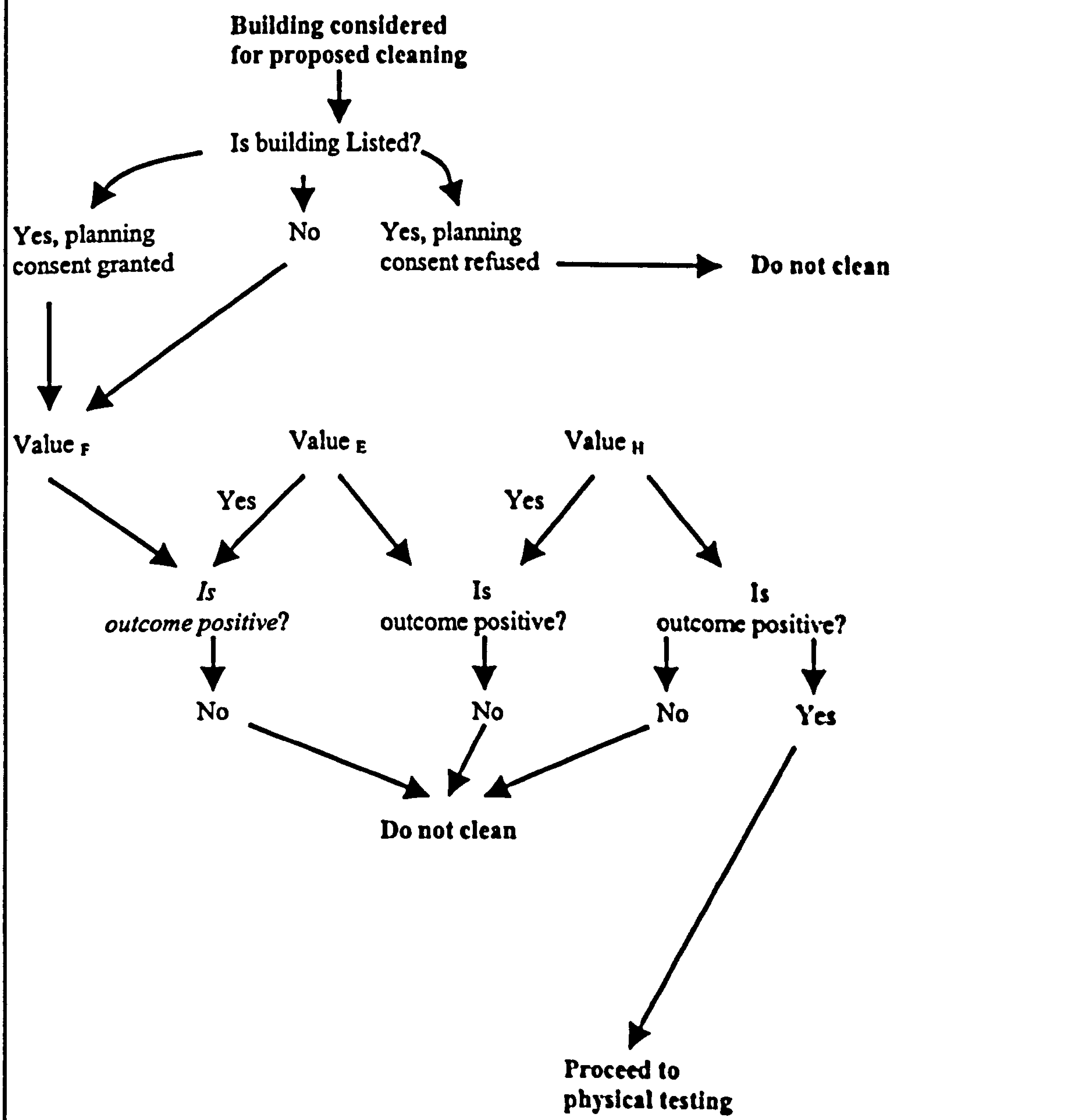
The conceptual model presented here develops the tentative system, outlined in Figure 2.1, to include methods and criteria of assessment. Ilozor *et al.* (1997) suggest that current building project selection techniques, based largely around whole life costing techniques, should not be considered in isolation, and suggest that assessments of "aesthetic value" should be considered also. The author would argue that for the majority of new build projects such a situation already exists, due to the design team consisting of experts in design, cost and structure. Ilozor *et al.* (1997) develop this situation through the use of methods to assess "aesthetics", which might be termed elsewhere "environmental" valuation techniques.

The importance of the built environment in terms of heritage must not however be overlooked, necessitating a fundamental adjustment to the model presented by Ilozor. The consideration of heritage and conservation is vital where buildings under consideration meet the criteria identified for the assessment of heritage (including most properties considered for potential stone cleaning). Therefore, whilst largely objective methods of assessment to examine both financial and environmental value may be used as part of a larger model, less well defined issues relating to heritage value must also be considered.

Chapters five to seven showed how discrete areas of value can be assessed in a robust and systematic manner. These aspects of value were selected as they encompassed assessments and values ranging from objective to the subjective. Taken together, the methodological approaches can be seen to embrace the overall value system. Whilst in agreement with findings from both this project and previous studies, the approach taken is practically useful, innovative and will lead toward the formulation of better value judgements.

The approach proposed for a practical overall assessment is shown in figure 8.1.

Figure 8.1 - Modelling of overall value assessment



Key

Value $_F$ represents an assessment of changes in financial value
Value $_E$ represents an assessment of changes in environmental value
Value $_H$ represents an assessment of changes in heritage value

Proceed to physical testing refers to on-site testing of alternative cleaning methods.

The process shown in figure 8.1 indicates how an assessment of use and non-use values presents a preliminary assessment[3]. A negative result regarding use and non-use value would indicate, from a value perspective, that cleaning would be unwise. Should the model indicate however that a net gain in use and non-use value is likely, heritage value should be considered.

The decision methodology first outlined in chapter three suggested a two-stage assessment. The first stage considers financial and environmental value together, followed by the second stage, the assessment of heritage value. A CATWOE analysis, with a root definition and monitoring and control system, was suggested, and is restated here.

C- customers:	owner/occupier/public
A- actors:	stone cleaners/ specifiers
T- transformation:	soiled building ———————— less soiled building
W- worldview:	optimisation of value from stone cleaning
O- owners:	decision-makers
E- environmental constraints:	a positive amalgamation of Financial and Environmental value, possibly vetoed by an unacceptable risk to heritage

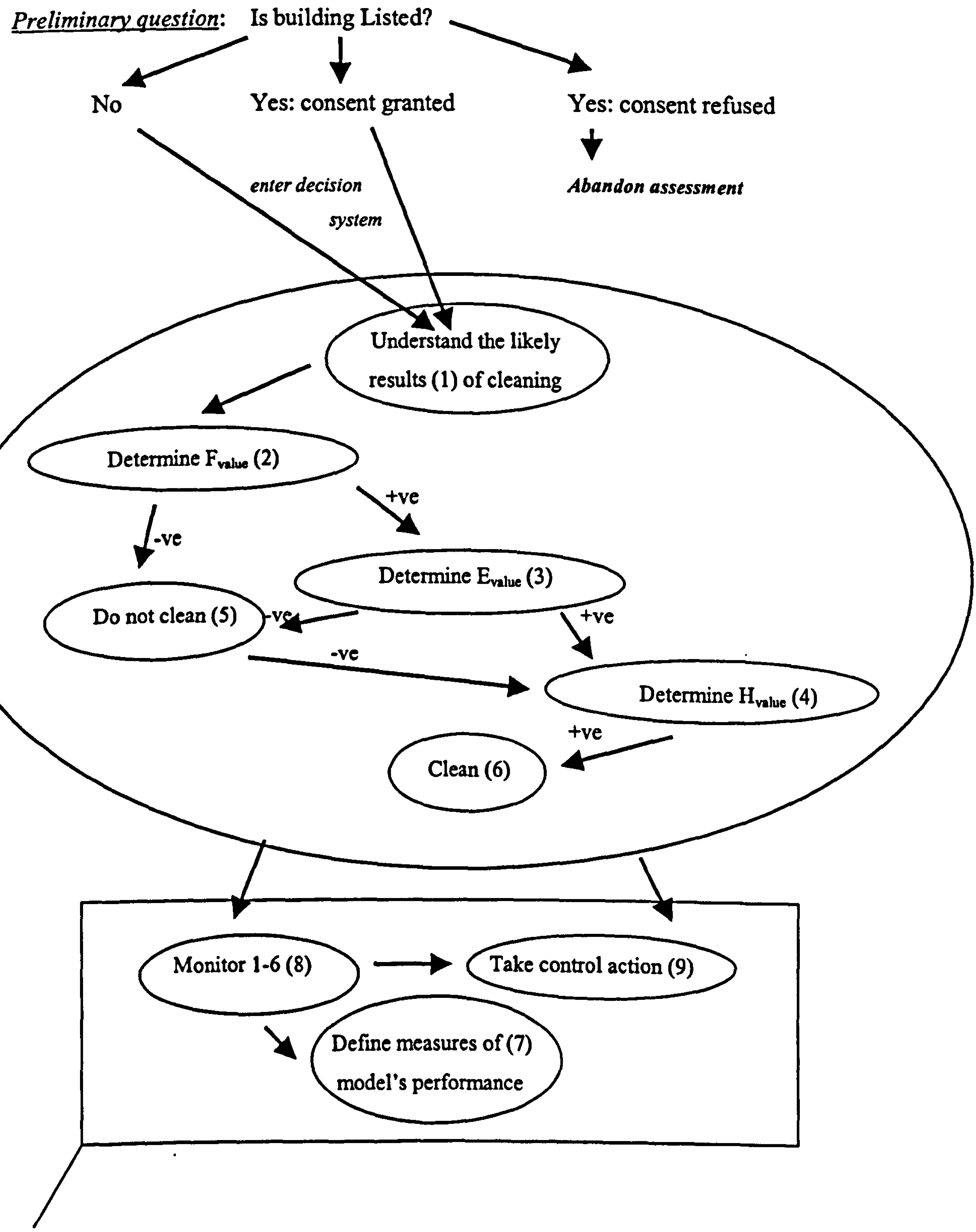
A root definition of the overall value assessment associated with that analysis and this project reads thus:

> "An overall value assessment mechanism, where soiling may be removed from the stone facade of a building, in order to realise a number of associated benefits, providing that those benefits are not unacceptably compromised by value loss."

The model for this root definition as shown in chapter three indicated a basic structure for the assessment, prior to modelling of the assessment stage themselves. That definition of the assessment is developed in figure 8.2, taking account of the work presented in the intervening chapters.

[3] The methods presented in this thesis to allow the measurement of financial and environmental value only assess user and option values, and do not assess heritage value. Although greater magnitudes of value may be reflected within the environmental value assessment, this cannot be assumed. Using the contingent valuation process as presented in Chapter 6, the respondent is not given the option to measure negative value (other than by registering a protest bid).Therefore, the model would be incomplete without the adoption of a process of heritage assessment, as a key section in the main assessment.

Figure 8.2 - Model of overall value assessment root definition



Note: elements (7), (8) and (9) are concerned with monitoring and refinement of the **model.** In practical terms, this requires ongoing field testing of the main value assessment, in particular elements (2), (3) and (4). It should be understood that elements (7), (8) and (9) **do not** refer to a monitoring and control of stone cleaning.

Figure 8.2 develops the decision model suggested in chapter three (Figure 3.3), in that previously broad objective/subjective value bandings now reflect the value assessment methodologies developed subsequently. Referring to the numbered elements of the figure, the manner in which the model has been developed becomes clear.

Preliminary question: **Is the building Listed?**. As identified in the course of reviewing literature for this project, the Listed status of a building in Scotland has a significant bearing on whether stone cleaning may proceed. The requirement for Listed Building Consent to be given before any listed building may be cleaned will add not just time but resources, in terms of the preparation of a planning application, and the planning process itself. At this, pre-value assessment stage, the party considering stone cleaning must consider what benefits or costs are likely to accrue, both if consent granted or refused. Without going through a full assessment programme, the implications for value will inevitably influence the decision as to whether consent is sought, or the process abandoned.

Element (1): **Understand the likely effects of cleaning.** Through a literature review of previous work in the field, the current state of knowledge was established. The literature review, in addition to covering the results of cleaning and the various available cleaning methods, also covered the modelling of the major constituent parts of the value system (with examples of application in relation to stone cleaning where possible). In particular, approaches to the modelling of longer-term financial costs have been established previously, and were subsequently adapted and developed for use here. Literature concerning the assessment of environmental values suggested that the assessment would, if implemented correctly, produce an economic model (with significant variables identified). Regarding heritage value, it was found from the literature that much of the work completed previously, whilst citing examples of applications in the past, appeared less than rigorous regarding the selection and measurement of criteria. This was addressed in chapters four and seven. The literature review established that, whilst general approaches to value assessment have been developed, these are constantly being refined. Therefore, the assessment methods used within the model should be regularly reviewed and refined as necessary.

Element (2): **Financial value assessment.** The financial model as illustrated in chapter five should be applied to the case in hand, the results of that application indicating if the likely financial outcome will be positive or negative. If the result is positive, progress to element (3). If the results are negative, do not clean (5).

Element (3): **Environmental value assessment.** Consideration should be made of the environmental value changes that would be likely to result from stone cleaning. Where works were proposed in the city centres of Aberdeen, Edinburgh or Glasgow, results from the contingent valuation survey in chapter six should be referenced. Where no such study has been reported for the area considered, a contingent valuation should be completed. Factors including the stone type, likely aesthetic effect, scale of the project, sources of funding, building ownership and use and prominence of the building should all be examined. The results from chapter six indicate that, whilst the overall perception was positive, public knowledge of the process and outcomes is vital. In addition, the environmental value for cleaning of granite buildings was significantly less than for sandstone. If the overall result of this assessment is positive, progress to element (4). If the results are negative, do not clean (5).

Element (4): **Heritage value assessment.** The heritage assessment model as illustrated in chapter seven should be applied to the case in hand. As stated in chapter seven, heritage value is essentially non-transient, meaning that short terms financial gains cannot justify a permanent heritage loss. Where an acceptably low risk to heritage is anticipated, cleaning may progress (element 6). If the results are negative, do not clean (5).

Elements (7-9): **Monitoring and control action.** The model should be applied in as wide a selection of pre-cleaned buildings as possible. By monitoring the results of the model, and comparing these with actual results, refinements can be made as required[4]. As stated in figure 8.2, elements (7), (8) and (9) are concerned with monitoring and refinement of the **model**. It should be understood that elements (7), (8) and (9) **do not** refer to a monitoring and control of stone cleaning. Rather than presenting a set of dogmatic rules, the assessment methods developed in this thesis conceptualise and structure value judgements so as to

[4] See also chapter nine, future work.

ensure a rigour and logic to decision-making. Elements (7), (8) and (9) would seek to preserve that conceptual strength, whilst developing and improving practical issues as required.

The methodological issues identified earlier in relation to the assessment of financial, environmental and heritage value must be addressed in the holistic assessment, if the model's output is to be relied upon. The aim of the model is to structure the assessment process, so as to ensure that major considerations with regard to value to adequately addressed in all cases. Thus, a repeatable methodology is derived. The process described in figure 8.2 has be sub-divided into an assessment of financial, environmental and heritage value, due to the split between objective and subjective approaches.

The method is valid on a theoretical level, but should also be applicable at a practical level. Where cleaning is proposed, this model facilitates the application of research findings, making it possible that the widest range of cleaning effects are at least considered. Even where uncertainty prevails as to the magnitude of the longer-term effects, the inclusion of these inevitably deepens the analysis.

8.3 Consideration of townscapes or individual buildings

It should be noted that the methodologies developed for the assessment of financial and environmental value relate to dissimilar circumstances. Whilst the assessment framework for financial value as presented applies to individual cases of stone cleaning, the environmental evaluation is based on a larger-scale cleaning programme. In addition, results of the environmental study indicate that the value estimated by respondents to accrue from stone cleaning is the total use and non-use value attached to cleaning over a townscape, rather than to the discrete area specified in the questionnaire form itself. Therefore, although it is in theory possible to relate the assessments of financial and environmental value, in practice the basis of each must be adjusted to form similar scenarios.

Single Building	Townscape
Financial model applies Environmental model applies, but must consider payment mechanism	Financial model applicable, Environmental model applies

Therefore, the assessment models developed in chapters five and six relate to different scales of stone cleaning programme. The users of an overall assessment model may likewise require to focus on either individual buildings or the value implications of city wide cleaning.

8.4 Application of overall assessment model

8.4.1 Introduction

As indicated in section 8.2, the aim in developing a model of overall assessment was to ensure both robustness and fairness in the appraisal of value change. Where the cleaning of a stone facade is proposed, the application of this model would allow the user to be content that the financial, environmental, social and heritage implications have been considered, quite apart from any physical decisions relating to the cleaning method. This section presents the application of an overall value assessment in two differing sets of circumstance.

The aim of the holistic valuation is to provide a decision structure, within which both known information and the personal judgement of the user can be combined to produce a reliable set of conclusions. Predicting the future is intrinsically uncertain, but that uncertainty can be limited through the use of a defined information structure. The aim, it must be clear, is not to measure value, as such. An attempt to do so would contradict the understanding that value, whilst objective to the individual, will vary in magnitude between individual due to differences of experience, knowledge and personal response.

Bias in the decision process due to professional judgement or experience can be overcome, through the requirement that each aspect of the assessment is but one stage in an iterative process, thus ensuring the needs of the many are satisfied where possible. The examples given follow examples presented previously in chapters concerning financial, environmental and heritage value, and illustrate how the generic approach can remain constant, whilst the particular requirements of the case in hand may change.

8.4.2 Selection of examples

The examples used here to illustrate use of the overall value assessment were selected after consideration of the attributes to be tested by the model itself. It was necessary to ensure that the examples reflected the range of assessment techniques to be used in the model, in both scope and magnitude. Regarding building use, the examples include residential, commercial and retail properties, with the latter types included as parts of mixed use buildings. Stone type also varies between the examples, with sandstone from the north and south of Scotland, and granite for the example in Aberdeen. The location and local environment of the examples was thought important, and a range of traffic loadings, road widths, cities, surrounding buildings and the potential for future soiling are all reflected in the examples.

The importance of Listing to stone cleaning has been established, and one of the examples, discussed earlier in chapter seven, is now assessed for all aspects of the value system. The purpose of selecting that example in particular was to illustrate that the building owner can complete a value assessment prior to application for planning consent, thereby coming to a deeper and more realistic understanding of the building's values, and the likelihood of success of the application.

The extent to which stone carvings appear on the building facades also varies between properties, as do the buildings situated nearby. Two new examples are to be used in this chapter, located in Edinburgh and Aberdeen. The example from Edinburgh is a residential tenement building, with ten flats in all. The building is located close to the city centre, but is not Listed, and is not in a conservation area. A granite example from Aberdeen, in use as retail premises at street level with residential properties above, is located on the major dual-carriageway route from the city to the west. The potential for re-soiling is clear, and few buildings nearby have been cleaned.

Both examples are illustrated with photographs to assist the reader.

8.4.3 Example 1

This example refers to a residential building situated in Edinburgh. The building facade is illustrated in figures 8.3 and 8.4.

size of facade:	15 metres x 25 metres (approx.)
windows/doors:	20m2
location:	city centre
ownership:	private ownership
occupation:	owner occupied
stone type:	buff sandstone
current market price:	10 flats @ £ 45,000

The building is not Listed, and is not situated in a Conservation Area. Therefore, the value assessment may proceed to the first stage.

Financial Assessment

The financial model (run using the Monte Carlo approach), indicated that were stone cleaning to result in upwards of 2.69% of the facade requiring stone indenting (replacement) in the long term, that any financial gain is lost. Where scaffolding (cleaning) costs are ignored, that figure rises to approximately 30%. In reality, and in accordance with results from the market price study, stone cleaning would be likely to be completed alongside refurbishment works, so the cost of scaffolding should be at least apportioned to cleaning. The effect of this is to suggest that were between 9 and 15% of the facade to require repair as a result of cleaning, that a financial loss would be realised[5]. It is *essential* that cleaning be regarded as a long term alteration, so this outcome to the model should be considered as carrying greater weight than any short term financial gain.

[5] The % indicators resulting from the model are based on a 25 year delay between cleaning and repair. Where the areas failing were of architectural importance (e.g. in controlling areas of water distribution such as sills, or from an aesthetic perspective, such as areas of carved stonework), the delay may well be considerably less than 25 years, reducing the % further. In any case, the labour and material resources required will remain constant.

Figure 8.3 - Building selected for example 1

East London Street, Edinburgh: The portion of the facade to be considered is shown centrally in the figure. The terrace is on the north-facing side of the street, and consequently received limited direct sunlight. Accommodation in the building extends to the basement level. The facade has limited stone carving work, but the stone is generally in an acceptable condition.

Figure 8.4 - Streetscape for example 1

East London Street, Edinburgh: The photograph illustrates a view to the east. It can be observed that no buildings in the immediate vicinity have been cleaned.

In practice, the relatively slight financial gain initially, coupled with the realisation that the benefit would only be acquired were the building sold, might in itself be sufficient to warrant a decision to not clean. Were grant assistance available to support cleaning, however, this situation might change. With the building being in private ownership, concerns of any wider environmental gain or benefit may be of limited concern (although this should not be the case). For the purposes of the assessment exercise here, progress will be made to stage 2, the environmental assessment.

Environmental assessment

Reference to the environmental valuation completed for Edinburgh identifies that a positive result was recorded, although resistance to the use of public funds to aid stone cleaning of private buildings was noted. This has implications for grant assistance in the future, although the overall response that cleaning produced a positive environmental change might in itself justify public interest in this area. It must be borne in mind that the bids received were greatly influenced by the respondents' knowledge of the effects of cleaning. To restate the issues concerned with longer-term effects of cleaning, were repair needs identified in the financial model to be realised on a wide scale, environmental values may well reduce, and produce an overall perceived loss. The environmental valuation here would support earlier progress from the financial assessment.

Heritage assessment

The impact of stone cleaning on the heritage value of the property must now be established, against the indicators of architecture, history, environment, usability and integrity. As with the heritage value assessments completed in chapter seven, the low pressure dry grit blasting technique has been assumed[6].

[6] It is appreciated that the initial financial costs of cleaning could potentially increase due to the application of this method, making the outcome of the financial model seem rather optimistic. Against this must be balanced the likelihood that longer term damage to the stone surface would most likely be reduced, thus re- balancing the financial outcome.

An analysis/ appraisal of the building produced the following:

	greatly reduced	reduced	unchanged	increased	greatly increased
Architecture			x		
History			x		
Environment		←	—	→	
Usability			x		
Integrity		←	→		

For this particular case (and as reflected in chapter seven) none of the variables dealing with non-temporal value (i.e. architecture, history, environment, integrity) are particularly at risk by cleaning, so it must be concluded that heritage value would in this case not be placed at undue risk[7] by cleaning.

With this example, a **marginal financial benefit,** combined with a **positive environmental valuation** for Edinburgh, led to a heritage analysis. The outcome of that analysis indicated that the **heritage value would not be placed at risk** through cleaning. Therefore, the assessment indicates that cleaning would be likely to produce an acceptable value outcome. Progression to pre-cleaning tests would follow this stage.

Where testing indicated that cleaning would be likely to cause unacceptable damage to the stone surface, cleaning should not progress.

The resource implications of this outcome cannot be ignored. Where cleaning might lead to a need for stone repair in the medium to long term, the resource implications must be considered and planned for. A whole life approach to cleaning will ensure that a predicted benefit at the point of cleaning might be realised. Where repair is required after a number of years, the percentage of facade area beyond which financial losses will occur will reduce if the repair work is not planned for in terms of both cost and stone source.

[7] By this, the author means that the current heritage value of the building lies in its being part of a larger whole. That larger whole will not be greatly damaged by the cleaning of this property, although were a large number of such properties to be cleaned, the environment and integrity variables could be significantly affected.

This run of the holistic assessment indicates that value gains are possible, although these gains are attached and specific to the building being considered. A wider assessment of value, from the perspective of the entire built environment, might judge the wider implications of cleaning for stone, labour, quarrying and the essentially short term nature of benefits (due to re-soiling) unacceptable.

8.4.4 Example 2

This example refers to a mixed use (retail/ residential) premises situated in Aberdeen. The building is illustrated in figures 8.5 to 8.7.

size of facade:	20 metres x 7 metres (approx.)
windows/doors:	16m2
location:	outskirts
ownership:	private ownership
occupation:	owner occupied
stone type:	tooled granite
current market price:	£ 290 000 (retail accounts for £130 000)

The building is not Listed, and is not situated in a Conservation Area. Therefore, the value assessment may proceed directly to the first stage.

Financial assessment

The financial model (run using the Monte Carlo approach), indicated that were stone cleaning completed, and required to carry the burden of scaffolding costs, that a financial loss would result where upwards of 2.34% of the facade required repair due cleaning after 25 years. Where scaffolding costs are ignored, were upwards of approximately 32% (on average) of the facade to require stone indenting (replacement) in the long term as a result of stone cleaning, any financial gain would be lost. In reality, and in accordance with results from the market price study, stone cleaning would be likely to be completed alongside refurbishment works, so the cost of scaffolding should be at least apportioned to cleaning. The effect of this is to suggest that were approximately 17% of the facade to require repair as a result of cleaning, that a financial loss would be realised[8].

[8] As first holistic example 1, the % indicators resulting from the model are based on a 25 year delay between cleaning and repair.

Figure 8.5 - Building selected for example 2

Auchmill Road, Aberdeen: The building to be considered extends across the photograph. Only that flat on the first floor has a stone facade, with the second floor an alteration to the roof space. For the purposes of the financial assessment, both first and second floor properties are assumed to benefit from cleaning, due to a general "uplifting" of the aesthetics.

Figure 8.6 - Streetscape (1) of example 2

Auchmill Road, Aberdeen: The photograph illustrates a view of the facade to the west. It can be observed that the building is located on a dual carriageway, which carries a heavy traffic load throughout the day. Nearby buildings are greatly varied in terms of design, size and materials.

Figure 8.7 - Streetscape (2) of example 2

Auchmill Road, Aberdeen: The photograph illustrates a view of the facade to the east. Due perhaps to the proximity of the carriageway, it can be observed that there is little evidence of previous stone cleaning on the road.

In practice, the slight initial financial gain, coupled with the realisation that the benefit would only be acquired were the building sold, might in itself be sufficient to warrant a decision to **not** clean. Were grant assistance available to support cleaning, however, this situation might change. With the building being in private ownership, concerns of any wider environmental gain or benefit may be of limited concern (although this should not be the case). The implications for a potential positive benefit to the retail business (due to a possible improvement in marketability), must be considered, however, unlike with residential property where the perception of the general public may be of lesser concern to the owner/ occupant.

Reference to the **environmental valuation** completed for Aberdeen identifies that although a positive result was recorded, that result (referring to predominantly granite-faced buildings) was much less conclusive than studies completed in Edinburgh and Glasgow (mainly sandstone). A deeper analysis of that result suggested that the aesthetic benefits of cleaning granite are less marked than with sandstone, so the implications of cleaning for marketing and presentation purposes may be similarly reduced. In addition to carrying implication for grant assistance and public policy, this also signals a strong indicator that the financial aspect of the assessment must show a strongly positive prediction (which was not the case here), or risk being balanced by a weak environmental response. In practice, it would be advised that cleaning not progress in this case, as the short-term financial costs might not be recouped, let alone justified through an environmental or social gain. It is also likely that rapid re-soiling would take place due to the buildings location on a busy dual carriageway.

An assessment of heritage impact is not required in this case, and the building should not be cleaned.

8.4.5 Example 3

This example refers to a mixed use (retail/commercial) premises situated in Elgin. The building is that considered in example 2 of chapter seven (illustrated in figures 7.4 to 7.7).

size of facade:	12 metres x 15 metres (approx.)
windows/doors:	30m2
location:	city centre
ownership:	private ownership
occupation:	owner occupied
stone type:	sandstone
current market price:	£ 250 000 (equally divided between retail and commercial)

The building is Listed grade (B). In practice, the building would require planning permission prior to cleaning, and the following overall assessment could be used on behalf of the Client to determine the likelihood of success.

Financial assessment

The financial model (run using the Monte Carlo approach) indicated that were stone cleaning completed, and required to carry the burden of scaffolding costs, that a financial loss would result. Where scaffolding costs are ignored, were upwards of approximately 22% (on average) of the facade to require stone indenting (replacement) in the long term as a result of stone cleaning, any financial gain would be lost. In reality, and in accordance with results from the market price study, stone cleaning would be likely to be completed alongside refurbishment works, so the cost of scaffolding should be at least apportioned to cleaning. The effect of this is to suggest that were approximately 11% of the facade to require repair as a result of cleaning, that a financial loss would be realised[9].

In practice, the extremely slight initial financial gain, coupled with the realisation that the benefit would only be acquired were the building sold, might in itself be sufficient to warrant a decision to **not clean**. Were grant assistance available to support cleaning, however, this situation might change. With the building being in private ownership,

[9] As first holistic example 1, the % indicators resulting from the model are based on a 25 year delay between cleaning and repair.

concerns of any wider environmental gain or benefit may be of limited concern (although this should not be the case). The implications for a potential positive benefit to the retail business (due to a possible improvement in marketability), must be considered, however, unlike with residential property where the perception of the general public may be of lesser concern to the owner/ occupant.

Reference to results from the environmental analyses completed in Edinburgh and Glasgow, concerning predominantly sandstone buildings, reflects a generally positive response to the results of cleaning in those cities. It could be argued, therefore, that this building would be likely to benefit environmentally from cleaning. As discussed where this example was presented for a heritage assessment in chapter seven, however, the building at present does not appear to be having a detrimental effect on the aesthetics of the streetscape, it's ornate carvings highlighted rather than hidden by the medium soiling levels. It is suggested, therefore, that the environmental effects of cleaning might be positive with regard to light reflectivity, but that the carvings losing definition would balance this. In addition, it should be noted that buildings cleaned nearby are exhibiting signs of decay or algal colonisation, which should clearly be avoided.

Should the assessment be progressed to the heritage element, however, it becomes clear that the building should not be cleaned. Significant dangers to the heritage value were indicated by that assessment (refer to section 7.3.2), and Listed Building consent would be unlikely as a result.

8.4.6 Discussion of examples

These examples show that the assessment methods developed help to ensure that a holistic view is taken within the context of a modelled value system. This thesis has from the earliest sections established that value as ascribed to buildings could conceptually be assessed through the forming of logical value judgements. Those judgements rely not on the objectivity or subjectivity of the assessment method, or even the value sub-groupings selected for assessment.

Instead, the reliability and validity is based on whether a structured, conceptually sound and causal-based approach is adopted. The assessment method here is clearly structured, moving from the objective assessment of transient values toward the subjective assessment of non-transient and non-renewable values. This approach is conceptually sound as it reflects the manner in values are attached to the built environment, and in that it seeks to protect those values which are important at society-level, and which once lost cannot be replaced.

Throughout, assessments have been based not on models taken from the literature, but on the understanding that the known or likely effects of cleaning must be linked with value. In a sense, the work has moved beyond the subject of stone cleaning towards a much deeper understanding of value. The examples show that each constituent area of the assessment will take on a different level of importance depending upon the situation.

Where the financial assessment produces a likely significant benefit, it could be argued that a positive environmental assessment would be likely. After all, the financial assessment depends to a great extent upon the results of cleaning being warmly received. If, however, the financial assessment were to suggest a loss, or only marginal gain, immediately following cleaning, it would be unlikely that this could be balanced by the environmental assessment.

The environmental assessment is so placed as to force consideration of the financial results at a community level. Results from chapter six indicate that the knowledge of cleaning will have a great impact upon the perceived value, and that any environmental gains would be more apparent with sandstone, rather than granite, buildings. Future work should consider the potential for gathering information of the "heritage" criteria through an environmental assessment, thus helping to refine the heritage model further.

The heritage model, although using criteria similar to those appearing in some past work (for example, Kalman 1980, Nijkamp 1987, Fusco Girard 1987), has taken an original and innovative approach towards the assessment mechanism itself. In addition, criteria, far from being arbitrary, have been shown to relate closely with legislation, guidelines, and have been applied successfully in the examples given. Whilst further work would provide a useful practical testing of the model, the current model has been shown to be theoretically sound, and based in current practice.

By approaching the subject of stone cleaning from a value perspective, the assessor is forced to take a holistic view of the subject. Preserving social, heritage and non-renewable values can avoid dangers of stone cleaning leading to unacceptable future damage to the built environment. Most importantly, by approaching the subject from the perspective of the structured value judgement, it can be stated that decisions will be more acceptable and that those decisions can be regarded as truly accountable to society as a whole.

8.5 Viability of the model

For reasons rooted in the historical demarcation of disciplines and responsibility, overall value assessment has in the past tended to be overlooked by both practice and academia alike. Whilst all construction and conservation work must consider the value system, this has tended to take place in discrete stages, with the result that a truly holistic assessment will often not take place.

The key contribution to knowledge emanating from this project lies in the overall value assessment. The validity of that model lies in both the overall structure, and its constituent parts. As established at the outset, value must be regarded not as object in itself, but as being ascribed to objects or areas. The model is unique in the sense that this is apparent from the methods of assessment, and the assessment path. The conservation of values that cannot be renewed if lost and the use of assessment methods appropriate to recognised areas of the value system both contribute towards the emergence of a conceptually robust approach to the subject.

No one part of the value system can be said to be unaffected by others, or exist in isolation. Heritage status, appearance, location and opinion all influence financial value. Environmental value is influenced by the funds available to care for properties and the heritage values associated with an area, both by individuals and society alike. Heritage value is similarly influenced by finances available to care for buildings, and rather than being defined by the form, is created and sustained through the attitudes and needs of society. In isolation, no one part of the value system could be said to reflect overall value, yet together the demarcations used in this project make coverage of the overall value system possible.

From a practical perspective, the assessment mechanisms provide a route through which a complex decision-making procedure can be structured. The overall "soft" decision system structures the methodologies developed so as to allow the value system to be considered in manageable stages. Within the overall "soft" system, the "hard" financial model structures the financial costs and benefits affected or caused by cleaning, and produces an output against which financial resources or aspirations can be judged. The environmental assessments completed here established that the contingent valuation approach was appropriate for use in this context, and identified important variables to be considered by the decision-maker. Finally, the heritage assessment mechanism takes account of existing approaches to the considered of heritage, and allows for the likely heritage implications of cleaning any building to be identified. Results from the holistic model provide a clear indication of whether cleaning would result in a value benefit or loss, with an emphasis on the preservation of non-renewable value. Thus, **value is preserved through the completion of well-structured value judgements.**

The model form presented is based on the logical manipulation of known data. Indeed, wherever arbitrary decisions as to the magnitude of an effect were required by methodologies from the literature, those aspects have been identified and excluded from the models developed. Where the value assessment was to be applied in practice, the data used must be reliable and applicable to that situation. **The model allows for the structuring of information and data, but cannot attest to the reliability of that information.** As stated, the major contribution with regard to reliability stems from the decision structure, with a coherent use of established concepts of value.

With regard to the workable applicability of the model, a practical development of the assessment methods contained within requires further refinement, and further work involving field-testing and refinement of the model would lead to greatly improved decisions in the future, and the establishment of value benchmarks. Whilst the financial and environmental aspects of the assessment utilised widely established methods of data gathering and analysis, the approach taken with heritage value has emerged largely from the (often theoretical and philosophical) literature, and requires development. Indeed, it became clear through operation of the overall assessment that some commonality exists between concerns of the environmental and heritage assessment models, suggesting that this would prove a fruitful area for investigation.

Lessons learned and conclusions emerging from this research could be applied in a wide range of fields, thus making a **positive contribution to the integration of a design team.** The overall value assessment presented here provides a mechanism and model through which **holistic decisions** can be reached.

8.6 References

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9. *Conclusions and further research*

9.1 Introduction

The hypothesis tested in this thesis was as follows:

> "By applying value assessment methodologies prior to the application of stone cleaning, more robust decisions can be made".

This work has investigated and established attitudes towards value, value assessment and value judgements from the literature, and progressed towards the development of a systematically structured and conceptually sound overall value assessment method. It became clear from an early stage that value, rather than being a tangible object in itself was ascribed to the built environment by individual, communities and society. By reflecting that ascription process in the assessment method, and reflecting areas within the value system that might otherwise be considered in isolation, the production of more reliable and rational decisions is possible.

The overall goal of the research reported in this thesis was to investigate whether the application of value assessment methodologies could lead to more robust decision making prior to the application of stone cleaning. The aims of the thesis, as described in chapter one, were:

1. To investigate the potential effects of stone cleaning on aspects of overall value.
2. To model those effects to facilitate robust value assessments.
3. To establish an approach to overall value assessment, incorporating the developed models and ensuring that the whole value system is considered.

9.2 Investigation of the potential effects of stone cleaning on aspects of overall value

From the outset of the investigation, it became clear that both objective and subjective aspects of value related to the effects of stone cleaning.

It was found that stone cleaning has the potential to influence financial value in a number of respects, greatly expanding upon previous work in the field (Mansfield 1988, Newby *et* *al.* 1991). In the short term, stone cleaning carries a financial cost which may be balanced by increases in property market selling price. That increase would in reality only be realised if, of course, a building were sold following cleaning. It has been shown that stone cleaning has the potential to damage the stone itself, with implications for a subsequent repair need. The resources that are required for such work (both financial and material) should be considered alongside the short term financial costs of stone cleaning.

Stone cleaning has previously been found to have an effect on the perceived aesthetic value of sandstone buildings (Webster *et al.* 1991). The wider environmental effects were investigated here, improving upon previous use of environmental valuation techniques in the built environment (Hanley 1991) whilst taking due account of established guidelines of best practice (Arrow *et al.* 1993). It was found that the public response to stone cleaning had been favourable in Edinburgh and Glasgow, and less so in Aberdeen. A significant relationship was found to exist between knowledge of stone cleaning, educational background, and the level of valuation. The lower valuation in Aberdeen was investigated, and the perceived visual effects of cleaning granite found to be less clear than with sandstone.

The meaning of heritage in the built environment was investigated, and it was found that heritage value, depending on the circumstances, had cultural, economic and environmental aspects, all of which could be affected by the consequences of stone cleaning.

A determination of overall value changes resulting from stone cleaning required that all aspects of value identified be considered.

9.3 Modelling the potential effects of stone cleaning on aspects of overall value to facilitate robust value assessments investigate

The form of model selected and developed for the financial value assessment attempts to ensure that uncertainties in the data need not lead to unreliable results. Where data was unavailable, this has been recognised, as variables were included in the financial model. The model allows for the financial effects of cleaning to be predicted for buildings with sandstone or granite facades. Initial costs and benefits have been modelled, incorporating indicators derived from the property market study undertaken as part of this project. The extent of intervention work during the life cycle that would balance short-term benefits is calculated, allowing the model's user to appreciate fully the long-term considerations. At present, reliable indicators of the actual long term requirements of cleaning are not available, meaning that the results of the financial model must be related to the known physical effects of the various cleaning methods available. Should indicators become available, these can be evaluated easily against results from the financial assessment and incorporated into the overall model.

Results from the environmental valuation indicate that the public perceives the effects of cleaning positively, and do not currently regard possible damage resulting from cleaning as over-riding the potential benefits. Where cleaning is contemplated in areas constructed from sandstone, results from that survey suggest that the environmental impact would be positive. The modelling of environmental value was possible to the extent that a bid level was determined, and significant indicators identified. **That model (as shown by the bid curve) can be taken as an indication that cleaning in the future may have a positively perceived environmental impact.** The lower environmental bid level received in Aberdeen, when compared with Edinburgh and Glasgow, indicates that the stone type must be considered as part of an environmental assessment, and that care should be taken when operating in circumstances outside those tested (i.e. in city centres with sandstone/granite).

The identified indicators for **heritage value assessments** were grouped under the headings of architecture, history, environment, usability and integrity, and links with **recognised conceptual approaches acknowledged** (Historic Scotland 1993, ICOMOS 1966, UNESCO 1972 and 1976). Each area can be assessed for a given case, and the likely effects of cleaning predicted (from *greatly reduced* to *greatly increased*). The criteria selected for use have been linked with both the physical effects of cleaning, and established heritage assessment practice (including legislation). Problems inherent in many previous approaches to heritage assessment (Fusco Girard 1987, Kalman 1980, Nijkamp 1987), including the apparently arbitrary nature of weighting and scoring methods have here been avoided.

9.4 Establishment of an approach to overall value assessment, incorporating the developed models and ensuring that the whole value system is considered

A model for overall assessment was developed through the analysis of its constituent parts (i.e. objective and subjective, financial, environmental and heritage). The entire value system has been satisfied in that a logical approach to overall assessment has been developed, incorporating legislative implications, and models for the assessment of constituent parts of that system. The approach ensures that an irretrievable or overall loss of value will not result through the inappropriate application of stone cleaning. This approach to overall value assessment is unique, and guides the model user to consider a wider range of value effects than was previously practical.

An assessment of heritage (i.e. non-renewable) value changes was positioned in the overall assessment framework to follow those for financial and environmental value. This ensures that, even where an overall benefit appeared likely following initial assessment, the model recognises that heritage should be regarded as non-transient, and cannot be replaced once lost. As stated, where short term losses in value could be regained in the long term (e.g. financial or visual value), that loss can be reasonably balanced by gains elsewhere. Where losses in value cannot be regained, and currently form important parts of the overall value system, a balancing of loss is not possible.

The model as presented could be reasonably applied in a wide range of situations. The monitoring and control aspects of the overall value assessment are essential, however, and the model would be likely to require refinement in the longer term. Within the three value "modules", a reappraisal of the variables and interaction between variables should be completed following application in the field.

9.5 Limitations of the model

A number of limitations in the assessment methods used and developed in this thesis need to be acknowledged. Although all data gathered was adequately tested, the limited sample sizes must be recognised as compromising the reliability of the model. Respondents in both the property valuation survey and contingent valuation were, however, from representative groups, which would actually influence or be influenced by the value changes investigated.

The heritage assessment, whilst conceptually sound, based strongly in current practice, and embracing a suitable range of factors, must be regarded as an untried tool. Further work, as identified in the section 9.7, is required to validate and refine the model, thus ensuring that concerns over reliability and practical applicability are addressed.

The model relates only to building facades of sandstone or granite. The potential benefits or dangers of stone cleaning in relation to other building materials have not been considered, making the model as it stands inapplicable in a wide range of circumstances. Investigation of other materials would not require a re-structuring of the overall assessment, but rather a revision of how variables are to be defined and applied.

This research considered only urban situations, and use of the model in a rural context would be inappropriate without further development and testing. Is such a case, a re-investigation of the financial and in particular environmental implications for value would be required.

The only financial benefit considered within the model was concerned with (building specific) property market selling price. Other potential benefits from cleaning in relation to an effects on property prices where an urban area is cleaned, or the potential benefits for retail (including tourism) performance have not been investigated. Although the latter area in particular was felt to be open to influence from a wide range of factors, and that the effects of cleaning would be difficult to isolate, it should not be ignored. Further work, as described in the next chapter, should study these areas further.

The absence of reliable or accurate predictors of the long-term effects of stone cleaning at present makes application of the financial and heritage models partially reliant on the knowledge and judgement of the model's user, to an extent that would not otherwise be the case. Judgements as to the likelihood of long term intervention being required and thus balancing short-term financial gains are therefore less reliable than would be desired. As stated, work ongoing at the Robert Gordon University will rectify this situation, and findings from that study should be incorporated into the model when available.

9.6 Summary of contributions

The work in this thesis describes the contribution to knowledge derived from studies undertaken in the field of value assessment, with particular reference to masonry conservation. The main contributions can be summarised as follows:

1. **The development of a unique, innovative and robust approach towards value assessment.** The separation of objective and subjective assessments at the practical level, whilst ensuring a holistic approach at the conceptual level, allows an all-embracing value assessment to be completed. In addition, the recognition of value as being ascribed, rather than existing as an object in itself, provides the assessment with a freedom lacking in much of the previous work.

2. **The successful investigation of the environmental effects of stone cleaning.** Applications of the contingent valuation method within the urban built environment have rarely been attempted in the past, and previously with little success. The application as reported here successfully applied the method within a largely untried situation, and took full account of the complex effects of cleaning. Application of the method within the built environment itself solved a number of practical difficulties and better informed the respondent group.

3. **By modelling the financial value system** in such a way as to focus on the implications of longer-term stone decay, a clear emphasis has been placed on the longer-term implications of stone cleaning generally. This approach to cost modelling leads the decision-maker towards the adoption a suitably cautious consideration of stone cleaning, in line with previous technical work in the field.
4. **The assessment method developed to consider heritage value** recognised the methodological failure of many previous attempts, documented legislation and those theoretical imperatives pertinent to the subject. Although requiring refinement to allow widespread practical application, the method goes some way to addresses previous failures and sets an agenda for the manner in which heritage should be regarded in the future.

This work presents an approach to value assessment within which holistic value judgements can be formed. The built environment contributes enormously toward the cultural, economic and environmental value systems operating in society, and the potential of stone cleaning to influence that system must be understood and appreciated.

It has been shown conclusively that the formulation of value judgements through the model proposed is a wholly appropriate method of assessing not just the subject of stone cleaning, but any subject largely concerned with value. The built environment is a largely stable, recognisable and central defining feature of the environment in which the great majority of the population lives. This work has presented a view of that environment which allows for rich and accessible assessments of that setting for society. The present day built environment is capable of extensive and rapid alteration, and the effects which change will have on society must be understood and addressed. Robust decision making is made possible through an understanding of the subject area and a rational comprehension of complexity within the overall value system. The assessment method presented addresses both these areas, and presents a conceptually valid and robust decision making tool, thus supporting the hypothesis.

9.7 Further research

A number of questions were raised by this research, suggesting future research paths that should be followed. These research paths have emerged both from the results indicating areas of uncertainty, and from the work itself indicating areas where past work has been limited.

- **The overall assessment includes reference to a monitoring and control function.** This is included to reflect the need for refinement in practice, and the conceptual nature of aspects of this project. As stated in the conclusions, the present model is theoretically robust, but an untried assessment tool. Investigation of the model's performance in practice would allow for validation of the model, and reinforce its applicability for use in practice. Better-constructed value judgements through use of the model are assured, as the value system has been clearly understood, conceptualised and reflected in the assessment methods developed. Further field testing of the overall assessment will allow for the practical reliability to be recorded, analysed and sharpened.

- The effects of stone cleaning on non building-specific finances has not be investigated, either in the past or as part of this project. A study concerning **the effects of stone cleaning on retail performance** (including tourism levels), **and the wider effects on city-wide property markets**, would in itself represent a significant contribution to knowledge. Stone cleaning is only one mechanism through which significant changes can be made to perceptions of the built environment. A deeper understanding of how such changes may be triggered would allow for better informed planning of future development, construction and conservation work.

- This research used a method developed by Webster *et al.* (1991) to assess the perceived effects of stone cleaning on aesthetic value. That method was concerned largely with the consideration of individual properties, often forming part of a larger whole (i.e. terrace, or semi-detached property). **Future work should expand this work to consider the aesthetic effects on the wider townscape.** In addition, answers from a small number of respondents in the environmental valuation indicated that they thought the (heavily soiled) Scott Monument, Princes Street, Edinburgh, had been cleaned, most likely because the monument was hidden by scaffolding for a number of years. This raises questions over the relationship between stone cleaning and other changes that may influence perceived aesthetic value. Further work investigating this area would determine the importance (or otherwise) of stone cleaning as a tool of environmental change.

- **The contingent valuation method** was used in this project as it allowed for any set of circumstances to be considered, and was guaranteed to produce a discrete, objective, measurement of value. The method was applied within only three cities, and a great deal of time was required for implementation of the surveys and subsequent analysis. Should the model be required for use within a city not covered by the surveys already completed, a similar timescale would be required. In addition, a further study investigating the relationship between environmental value at city-wide and building specific levels would enhance the assessment model. Concerns noted in relation to the importance of ownership, public/ private sector, location and use would all be likely to influence the level of bid and number of protest bids received in relation to individual buildings, even where the actual value change was clear. This requires further investigation.

- **The heritage assessment model** presented here integrates current international and national guidelines and legislation relating to heritage, with the known effects of cleaning. The model produced is logically sound, but **requires testing for accuracy and sensitivity** (particularly in relation to individual preferences). The area of heritage assessment has been under-developed in the literature, resulting in a situation where the non-expert has no mechanism for assessing or understanding value, and procedures of legislative protection (however reliable) remains hidden. The model presented here suggests a way forward, which should be developed further.

- As noted in the text, results from the overall assessment made it clear that **a degree of commonality exists between the factors to be considered in the environmental and heritage assessments**. This should be investigated further, as it has been recognised that heritage value, as with other aspects of the value system, is largely ascribed by society. Therefore, were environmental valuation techniques able to provide information regarding the ascription of heritage worth to a building, that would greatly inform future design, planning and development work.

- **Future work should consider the use of indirect environmental assessment techniques in relation to the built environment.** Use of the travel cost method to assess value in geographically isolated situations would be of direct interest to a number of bodies responsible for the care and maintenance of isolated building (e.g. private occupants, Historic Scotland, National Trust for Scotland). Were it possible to apply the hedonic price method, through the identification of both a suitable market and method of measurement for the effects of cleaning, a robust value indicator would be produced. The use of indirect valuation methods to measure discrete aspects of the built environment would serve both as a useful comparison with the contingent valuation results, and represent a significant contribution to the field of value assessment. In addition, **the effects on value of stone cleaning in a rural context** have not been investigated. The results of such a study would both enhance the assessment model presented here, and provide a deeper understanding of the rural built environment generally.

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Appendices

Appendix 1. *Physical effect of stone cleaning methods*

The potential physical effects of cleaning on stone are summarised in table A1.1, below. It is recognised that a number of cleaning methods are available, and that stone type influences the type and extent of effect. As with all cleaning work, testing of the stone surface prior to cleaning will further inform the practitioner as to which of the effects (if any) are likely to be realised. Note that some effects may only be realised in the longer term, however, and that the use of test panels left for only short periods of time would therefore be limited.

Table A1.1 - physical effects of stone cleaning

Sandstone	
Low pressure water washing	• used where particles attached loosely • ineffective with anything more "stubborn" • can be effective at removal of some organic growths • problems associated with saturation: salts penetration and mobilisation (leading to efflorescence and discolouration) • potential damage to loose or decayed pointing • freezing/thaw damage possible if water penetration becomes trapped
High pressure water washing	• design of the outlet lance and skill of the operative of great importance • dangers of erosion to the stone due to pressure of spray • effective at removal of more stubborn soiling than low pressure washing, but will not remove soiling from severely soiled surfaces • can be effective at removal of some organic growths • problems associated with saturation: salts penetration and mobilisation (leading to efflorescence and discolouration) • potential damage to loose or decayed pointing • freezing/thaw damage possible if water penetration becomes trapped • note that high pressure water lance used in removal of wet grit or chemical cleaning agents
Dry grit blasting	• effective removal of heavy levels of soiling not ingrained • loss of stone layers can be difficult to control

	• no risk of staining or damage from water • high level of operative skill required • level of soiling removed depends on porosity of the stone • problems relating to erosion and surface roughening
Wet grit blasting	• much less dust produced than with dry grit blasting • effective removal of heavy levels of soiling not ingrained • high level of operative skill required • problems relating to erosion and surface roughening • freezing/thaw damage possible if water penetration becomes trapped
Low pressure dry grit blasting	• potentially has less impact on the physical condition of the stone than other blasting or washing methods • all soiling may not be removed, as a result of the less aggressive method, particularly ingrained soiling or "thickly encrusted organic growth" • high degree of operative control possible • details on the stone surface can be preserved more easily than with other blasting or washing methods
Chemical cleaning (generally)	• loss of sandstone grains due to dissolving with soiling layers • chemicals retained by the stone after cleaning (amounts depending on porosity, orientation, condition of pointing): mobilisation of salts, bleaching, staining, efflourescences, hydration and dehydration leading to accelerated decay • changes in stone colour • potential for increased rates of algal growth following cleaning (Young 1997) • surface pitting possible where calcite is localised (acid based methods)

Granite	
Water washing	• Even at high pressures, unable of removing substantial soiling from granite. • Can effectively remove organic soiling. • Can be used for pre- wetting prior to chemical cleaning. • Penetration into mortar joints possible.
Dry grit blasting	• No danger of water penetration. • Noise and air (dust) pollution a problem. • Abrasion levels difficult to control, thus dangers of stone erosion. • On softer or weathered granites, surface loss may result. • Roughening of surface possible, with negative implications for aesthetics and re- soiling.
Wet grit blasting	• Less noise and air (dust) pollution than dry grit blasting, but leaves slurry afterwards. • Surface must be carefully washed down after cleaning. • Erosion dangers as dry grit blasting.
Low pressure dry grit blasting	• Less noise and air (dust) pollution than dry grit blasting, but leaves slurry afterwards. • Surface must be carefully washed down after cleaning. • Less danger of erosion, surface loss or roughening than other blasting methods..
Dry brushing	• Removes little soiling, but causes little damage. • Can be effective on rubble or rock faced ashlar facades.
Acid cleaning	• Dilution and dwell times should be minimised, to prevent chemical penetration. • Acids capable of dissolving iron in the stone, leading to surface staining, therefore not suitable for use with weathered or decayed granite.
Poultice alkaline pre- cleaning	• May be applied as degreasers prior to acid cleaning (brush or spray application). • Danger of chemicals remaining in the stone leading to decay. • Alkaline pre-cleaners must be neutralised or thoroughly washed off.

Notes

Information contained in the table is taken from Andrew *et al* 1994 (for sandstone) and Urquhart *et al* (1997) for granite. The table is provided to illustrate the scope of potential effect, and is referred to in the main text.

Appendix 2. *Financial value prediction model*

Examples of financial model application

Example 1

A residential building situated in Edinburgh:

size of facade:	15 metres x 25 metres (approx.)
windows/doors:	20m2
location:	city centre
ownership:	private ownership
occupation:	owner occupied
stone type:	buff sandstone, plain.
current market price:	10 flats @ £ 45,000

The model of the likely financial value change resulting from stone cleaning is presented in Table A2.1

Table A2.1 - initial run of financial value model

Cost factor	Cost	Benefit	Cumulative total
Cleaning (15 x 25) - 20m2 = 355m2 @ £6.00/m2	£ 2130		- 2130
Scaffolding	£ 5000		- 7130
Testing	£ 1000		- 8130
Market price (change) (10 x £45000) @ mean 3.04%		£ 15300	7170
Re- pointing 355m2 @ £15	£ 5325		1845
Initial	£ 13455	£ 15300	1845
Indenting/ stone replacement £350/m2 1845/350 = 5.27m2 = approx. 1.48% of surface			
Plastic repair £50/m2 1845/50 = 36.9m2 = approx. 10.4% of surface			
Tooling surface £50/m2 = approx. 10.4% of surface			

Reference to the table above indicates that the effect of stone cleaning on market price is vital in the short term. An initial cost of £13,455 represents 2.99% of the pre- cleaning market price of the flats. Therefore, if cleaning can provide an enhancement to the market price of greater than 2.99%, in this case an initial financial benefit would be realisable.

Results from the second run, using a Monte Carlo approach, are shown in Table A2.2

Table A2.2 - results of first Monte Carlo run

Variable	Magnitude	Notes
Cost of cleaning	(£ 2130 +/- 15%)	
Scaffolding	(£ 5000 +/- 10%)	
Testing	(£ 700 +/- 15%)	
Market price influenced	£ 15 300 mean	Distribution towards the origin, standard deviation 3.73%)
Re- pointing	(£ 5325 +/- 10%)	
Results:		
Mean	£ 488	
No. of model runs	2000	

Table A2.3 - results of second Monte Carlo run (no scaffold)

Variable	**Magnitude**	**Notes**
Cost of cleaning	(£ 2130 +/- 15%)	
Scaffolding	(£ zero)	
Testing	(£ 700 +/- 15%)	
Market price influenced	£ 15 300 mean	Distribution towards the origin, standard deviation 3.73%)
Re- pointing	(£ 5325 +/- 10%)	
Results:		
Mean	£ 5476	See footnote[1].
No. of model runs	2000	

Table A2.4 - results of third Monte Carlo run (depth profile)

Variable	**Magnitude**	**Notes**
Cost of cleaning	(£ 2130 +/- 15%)	
Scaffolding	(£ 5000 +/- 10%)	
Testing	(£ 950 +/- 15%)	Two reports plus depth profiling.
Market price influenced	£ 15 300 mean	Distribution towards the origin, standard deviation 3.73%)
Re- pointing	(£ 5325 +/- 10%)	
Results:		
Mean	(£ 200)	Loss recorded.
No. of model runs	2000	

Table A2.5 - results of fourth Monte Carlo run (2 reports + depth profile)

[1] The previous mean figure of £488 could have been expected to increase to £5488 following the removal of scaffolding from the calculation. Due to the randomised nature of the Monte Carlo approach, with each variable existing over a distribution, the new mean being £5476 is due to uncertainty in the model. Were the model run for an infinite number of times, the figures would stabilise.

Variable	Magnitude	Notes
Cost of cleaning	(£ 2130 +/- 15%)	
Scaffolding	(£ 5000 +/- 10%)	
Testing	(£ 1150 +/- 15%)	Two reports plus depth profiling and salts identification.
Market price influenced	£ 15 300 mean	Distribution towards the origin, standard deviation 3.73%)
Re- pointing	(£ 5325 +/- 10%)	
Results:		
Mean	(£ 15)	Loss recorded.
No. of model runs	2000	

Longer term costs

The first example of the model in application (prior to Monte Carlo simulation) shows that the possibility of longer term repair and maintenance costs might remove the possibility of any financial gain. It is accepted that longer term costs should not be included at their face value, as interest and the passage of time mean the costs (in terms on their £ value) should be discounted to present day values. The area of stonework which will require intervention due to detrimental effects of cleaning will vary according to the building itself (and will be mapped and costed by the Masonry Conservation Research Group, RGU, in 1999). The areas at which an overall loss is likely are shown in table app2.7 (present values of the costs per m2 of the various interventions are given in table app2.8). The interest rates assumed are shown against each value, and only those scenarios which indicated a gain at the "initial" stage are considered[2].

[2] This is due to the other scenarios resulting in a loss at the initial stage, and thus ruling out an overall long term gain.

Table A2.6 - longer term costs.

Assumed: standard testing		**Initial benefit:**	**£488**	**Area:**	**355m2**
Intervention	**0yrs**	**10yrs**	**15yrs**	**20yrs**	**25yrs**
Indenting (£350/m2)	0.39	*0.58 0.70 0.85	0.71 0.94 1.25	0.86 1.26 1.83	1.05 1.68 2.69
Plastic repair (£50/m2)	2.75	4.07 4.92 5.94	4.95 6.59 8.72	6.02 8.82 12.81	7.33 11.80 18.83
Tooling (£50/m2)	2.75	4.07 4.92 5.94	4.95 6.59 8.72	6.02 8.82 12.81	7.33 11.80 18.83

Assumed: standard testing, no scaffold		**Initial benefit:**	**£5476**	**Area:**	**355m2**
Intervention	**0yrs**	**10yrs**	**15yrs**	**20yrs**	**25yrs**
Indenting (£350/m2)	4.41	6.52 7.89 9.52	7.94 10.57 13.98	9.66 14.14 20.54	11.75 18.92 30.19
Plastic repair (£50/m2)	30.85	45.66 55.25 66.60	55.57 73.95 97.88	67.60 98.94 100	82.22 100 100
Tooling (£50/m2)	30.85	45.66 55.25 66.60	55.57 73.95 97.88	67.60 98.94 100	82.22 100 100

* e.g. Indenting, £350/m2, discount rate 4%, will cost £236.45 at 10 years (see table app2.8). Therefore, the area of the facade requiring work at which point the initial benefit is removed will be £ (488/236.45), which is 2.06m2. Therefore, the **% of decayed building surface area** ***caused by cleaning*** **which would negate any gains is (2.06*100/355)= 0.58%**

** Each box contains figures as follows:

% of area at discount rate 4% % of area at discount rate 6% % of area at discount rate 8%

Table A2.7 - present value of costs per m2 of intervention

	Yrs	Percentage		
		4	6	8
Indenting	0	350.00	350.00	350.00
	10	236.45	195.44	162.12
	15	194.34	146.04	110.33
	20	159.73	109.13	75.09
	25	131.29	81.55	51.10
	Yrs	**Percentage**		
		4	6	8
Plastic repair	0	50.00	50.00	50.00
&	10	33.78	27.92	23.16
Tooling surface	15	27.76	20.86	15.76
	20	22.82	15.59	10.73
	25	18.76	11.65	7.30

Example 2

A commercial building situated in Glasgow:

size of facade:	25 metres x 40 metres (approx.)
windows/doors:	300m2
location:	city centre
ownership:	private ownership
occupation:	owner occupied
stone type:	red sandstone
current market price:	£ 1,000,000 (approx.)

The model of the likely financial value change resulting from stone cleaning is presented in table A2.8

Table A2.8 - initial run of financial value model

Cost factor	Cost	Benefit	Cumulative total
Cleaning (25 x 40) - 300m2 = 700m2 @ £6.00/m2	£ 4200		- 4200
Scaffolding	£ 15000		- 19200
Testing	£ 1000		- 20200
Market price (change) (£ 1000000) @ mean 3.66%		£ 36600	16400
Re- pointing 700m2 @ £15	£ 10500		26900
Initial	£ 30700	£ 36600	5900
Indenting/ stone replacement £350/m2 5900/350 = 16.86m2 = approx. 2.41% of surface			
Plastic repair £50/m2 5900/50 = 118m2 = approx. 16.86% of surface			
Tooling surface £50/m2 = approx. 16.86% of surface			

Second run of model

cleaning:	cost as indicated +/- 10%
scaffolding:	cost as indicated +/- 10%. Also run with no cost allocated.
testing:	as indicated in "testing" section, above. Separate runs to include depth profiling and salts identification work.
market price:	price % increase indicated over a range.
re- pointing:	cost as indicated +/- 10%

The results are shown in table A2.9

Table A2.9 - results of first Monte Carlo run

Variable	Magnitude	Notes
Cost of cleaning	(£ 4200 +/- 15%)	
Scaffolding	(£ 15000 +/- 10%)	
Testing	(£ 1000 +/- 15%)	
Market price influenced	£ 36 600 mean	Distribution towards the origin, standard deviation 5.65%)
Re- pointing	(£ 10500 +/- 10%)	
Results:		
Mean	£ 1835	
No. of model runs	2000	

We can see that representation of the true shape of the market price gain has reduced the financial benefit. However, the model user must be aware that the balance of variables is critical to the initial result. The Monte Carlo simulation run again, making changes to the "scaffolding" and "testing" variables.

Table A2.10 - results of second Monte Carlo run (no scaffold)

Variable	**Magnitude**	**Notes**
Cost of cleaning	(£ 4200 +/- 15%)	
Scaffolding	(zero)	
Testing	(£ 1000 +/- 15%)	
Market price influenced	£ 36 600 mean	Distribution towards the origin, standard deviation 5.65%)
Re- pointing	(£ 10500 +/- 10%)	
Results:		
Mean	£ 15164	
No. of model runs	2000	

Table A2.11 - results of third Monte Carlo run (depth profile)

Variable	Magnitude	Notes
Cost of cleaning	(£ 4200 +/- 15%)	
Scaffolding	(£ 15000 +/- 10%)	
Testing	(£ 950 +/- 15%)	Two reports plus depth profiling.
Market price influenced	£ 36 600 mean	Distribution towards the origin, standard deviation 5.65%)
Re- pointing	(£ 10500 +/- 10%)	
Results:		
Mean	(£ 1306)	Loss recorded.
No. of model runs	2000	

Table A2.12 - results of fourth Monte Carlo run (2 reports + depth profile)

Variable	Magnitude	Notes
Cost of cleaning	(£ 2130 +/- 15%)	
Scaffolding	(£ 15000 +/- 10%)	
Testing	(£ 1150 +/- 15%)	Two reports plus depth profiling and salts identification.
Market price influenced	£ 15 300 mean	Distribution towards the origin, standard deviation 5.65%)
Re- pointing	(£ 5325 +/- 10%)	
Results:		
Mean	(£ 1290)	Loss recorded.
No. of model runs	2000	

Table A2.13 - longer term costs.

Assumed: standard testing		**Initial benefit:**	**£1835**	**Area:**	**700m2**
Intervention	**0yrs**	**10yrs**	**15yrs**	**20yrs**	**25yrs**
Indenting (£350/m2)	0.75	1.11 1.34 1.62	1.35 1.80 2.38	1.64 2.40 3.49	2.00 3.21 5.13
Plastic repair (£50/m2)	5.25	7.76 9.39 11.32	9.44 12.57 16.63	11.49 16.81 24.43	13.98 22.50 35.91
Tooling (£50/m2)	5.25	7.76 9.39 11.32	9.44 12.57 16.63	11.49 16.81 24.43	13.98 22.50 35.91
Assumed: standard testing, no scaffold		**Initial benefit:**	**£15164**	**Area:**	**700m2**
Intervention	**0yrs**	**10yrs**	**15yrs**	**20yrs**	**25yrs**
Indenting (£350/m2)	6.17	9.16 11.08 13.36	11.15 14.83 19.63	13.56 19.85 28.85	16.50 26.56 42.39
Plastic repair (£50/m2)	43.33	64.13 77.59 93.54	78.04 100 100	94.93 100 100	100 100 100
Tooling (£50/m2)	43.33	64.13 77.59 93.54	78.04 100 100	94.93 100 100	100 100 100

* Each box contains figures as follows:

area at discount rate 4%
area at discount rate 6%
area at discount rate 8%

Example 3

A retail premises situated in Aberdeen:

size of facade:	20 metres x 10 metres (approx.)
windows/doors:	30m2
location:	outskirts
ownership:	private ownership
occupation:	owner occupied
stone type:	tooled granite
current market price:	£ 500 000

The model of the likely financial value change resulting from stone cleaning is presented in table A2.14

Table A2.14 - Initial run of financial value model

Cost factor	Cost	Benefit	Cumulative total
Cleaning (20 x 10) - 30m2 = 170 @ £6.00/m2	£ 1020		- 1020
Scaffolding	£ 5000		- 6020
Testing	£ 700		- 6720
Market price (change) (£ 500000) @ mean 2.02%		£ 10100	3380
Re- pointing 70m2 @ £15	£ 2550		830
Initial	£ 9270	£ 10100	**830**
Indenting/ stone replacement £350/m2 830/350 = 16.7m2 = approx. 1.5% of surface			
Plastic repair £50/m2 830/50 = 16.6m2 = approx. 9.76% of surface			
Tooling surface £50/m2 = approx. 9.76% of surface			

Second run of model

cleaning: cost as indicated +/- 10%

scaffolding: cost as indicated +/- 10%. Also run with no cost allocated.

testing: as indicated in "testing" section, above. Separate runs to include depth profiling and salts identification work.

market price: price % increase indicated over a range.

re- pointing: cost as indicated +/- 10%

The results are shown in table A2.15

Table A2.15 - results of first Monte Carlo run

Variable	**Magnitude**	**Notes**
Cost of cleaning	(£ 1020 +/- 15%)	
Scaffolding	(£ 5000 +/- 10%)	
Testing	(£ 700 +/- 15%)	
Market price influenced	£ 10 100 mean	Distribution towards the origin, standard deviation 5.72%)
Re- pointing	(£ 2550 +/- 10%)	
Results:		
Mean	(£ 1537)	
No. of model runs	2000	

Table A2.16 - results of second Monte Carlo run (no scaffold)

Variable	Magnitude	Notes
Cost of cleaning	(£ 1020 +/- 15%)	
Scaffolding	(£ zero)	
Testing	(£ 700 +/- 15%)	
Market price influenced	£ 10 100 mean	Distribution towards the origin, standard deviation 5.72%)
Re- pointing	(£ 2550 +/- 10%)	
Results:		
Mean	£ 3510	
No. of model runs	2000	

Table A2.17 - longer term costs.

As standard testing with scaffolding produced a likely financial loss at the time of cleaning, longer term costs can only compound this loss.

Table A2.17 - longer term costs

Assumed: standard testing, no scaffold		**Initial benefit:**	**£3510**	**Area:**	**170m2**
Intervention	**0yrs**	**10yrs**	**15yrs**	**20yrs**	**25yrs**
Indenting (£350/m2)	5.90	8.73 10.56 12.74	10.62 14.14 18.71	12.93 18.92 27.50	15.73 25.32 40.41
Plastic repair (£50/m2)	41.29	61.12 73.95 89.14	74.38 98.98 100	90.48 100 100	100 100 100
Tooling (£50/m2)	41.29	61.12 73.95 89.14	74.38 98.98 100	90.48 100 100	100 100 100

* Each box contains figures as follows:

area at discount rate 4%
area at discount rate 6%
area at discount rate 8%

Appendix 3. *Property market study questionnaire*

Masonry Conservation Research Group
The Robert Gordon University

Questionnaire No. [ ]

Stonecleaning and its effect on property valuation.

Firm:	
Address:	

* *Please note that it is not essential you complete your firm's details.*

General Information

Question 1

In which of the following property types do you specialise?
Please give a % indication for each.

Commercial		
Retail		
Residential		
Industrial		
Other (please specify)		

Question 2

Which of the following are you involved in mainly?
Please give a % estimation of workload.

independant valuation advice	
agency	
management	

Question 3

To what extent is your firm involved in the valuation of

Properties for sale		
Properties for rent		(please give % estimation of workload)

Question 4

Have you been involved in the valuation of stonecleaned properties in the last 12 months?

Yes	☐	(please indicate how many cases)
No	☐	

Owner occupier market

Question 5

Please answer the following questions in relation to the property types indicated.

Please indicate, as a percentage (+ve or -ve), your approximate estimation of the adjustment which stonecleaning might make to the open market sale value of a property. If no change to value, indicate as 0.

Please briefly outline the reasons for your assessment.

Commercial

	City centre
	Other areas

Retail

	City centre
	Other areas

Residential

	City centre
	Other areas

Investor Market

Question 6

Please answer the following questions in relation to the property types indicated.

Please indicate, as a percentage (+ve or -ve), your approximate estimation of the adjustment which stonecleaning might make to the rate / m2 and to the yield chosen for a property. If no change, please indicate as 0.

Please briefly outline the reasons for your assessment.

Commercial

City centre
Other areas

Retail

City centre
Other areas

Residential

City centre
Other areas

Question 7

Has your firm been involved in any refurbishment works involving stonecleaning?

Yes	
No	

Question 8

In what way might the following affect your valuation of a property?
Please circle the appropriate number.

Cleaned buildings

	very significant					no significance	
Standard of cleaning achieved	1	2	3	4	5	6	7
Prestige value of the building	1	2	3	4	5	6	7
Aesthetic appeal	1	2	3	4	5	6	7
The surrounding environment	1	2	3	4	5	6	7

Uncleaned buildings

Prestige value of the building	1	2	3	4	5	6	7
Aesthetic appeal	1	2	3	4	5	6	7
The surrounding environment	1	2	3	4	5	6	7

Question 9

Any general comments you may have regarding the importance of stonecleaning, and the methods used, to property valuation would be greatly appreciated.

____

____

____

____

Appendix 4. *Results of property market values exercise*

Data from the property market values questionnaires produced data summarised as follows.

Section 1 - General Information

The overall response rate was 30% (50 forms), with 19 respondents willing to participate in a later interview. 68% of those forms returned were from either Edinburgh or Glasgow, the overall response summaries in table A4.1.

Table A4.1 - Property values study response rates

Location	No. of forms distributed	No. of forms received
Aberdeen	19	5 (26%)
Dundee	6	5 (83%)
Edinburgh	66	18 (27%)
Glasgow	59	16 (27%)
Inverness	5	2 (40%)
Kirkcaldy	4	2 (50%)
Perth	5	1 (20%)
Stirling	6	1 (17%)
Overall	170	50 (30%)

The responses to questions 1 to 4 were useful in that they provided guidance as to the experience and suitability of the respondent group to the study.

The response to question one satisfied the requirement that those respondents providing estimates of effect later in the form in relation to commercial, retail and residential properties, indeed had some experience of valuation with a suitable and wide range of properties. In addition to the categories suggested in the form, isolated respondents had also been involved with ratings work; property management; land development; licensed properties; nursing homes; agricultural buildings; oil installations and properties in the leisure markets.

In response to question two, the respondent group as a whole estimated that the majority of their time concerned independent valuation advice, with most of the remainder dealing with agency work. A significant minority were involved with property management and one respondent indicated they were involved with rent review enquiries.

In response to question three, using mean responses, approximately two thirds (63%) of the group's workload concerned valuation for sale, with the remainder spent dealing with property rental. This was confirmed by the median result. It should be noted that although this infers a "knowledge bias" away from the investor market, the mode response for each sector was 50%.

In response to question four, 63% of respondents had been involved with the valuation of a property that had been cleaned within the last twelve months. In addition, 36% had been involved personally in the execution of a stone cleaning contract at some point in the past.

The responses to section 1 - General Information, satisfied that the respondents were suitable for use as an expert group.

Section 2 - Owner Occupier Market

Results from question 5 are summarised in table A4.2.

Table A4.2 - Estimates of the percentage change in property selling price following stone cleaning

Client type	Property type	Area	Mean %	Median %	Standard Deviation %	No. of responses
Owner- occ.	Commercial	City	3.66	1.5	5.65	35 (70%)
		Outlying	2.73	0	6.70	33 (66%)
	Retail	City	2.25	0	4.60	33 (66%)
		Outlying	2.02	0	5.72	32 (64%)
	Residential	City	3.04	2	3.73	30 (60%)
		Outlying	3.01	2	3.46	29 (58%)

Section 3 - Investor Market

Results from question 6 are summarised in table A4.3.

Table A4.3 - Estimates of the percentage change in property yield following stone cleaning

Client type	Property type	Area	Mean %	Median %	Standard Deviation %	No. of responses
Investor	Commercial	City	2.44	0	5.86	34 (68%)
		Outlying	1.28	0	4.50	33 (66%)
	Retail	City	1.22	0	4.70	32 (64%)
		Outlying	0.97	0	4.43	32 (64%)
	Residential	City	0.56	0	1.95	27 (54%)
		Outlying	0.41	0	1.08	27 (54%)

Section 4 - Associated issues

In response to question seven, 51% of respondents indicated that their firm had been involved in refurbishment works involving stone cleaning. This figure is lower than responses to the similar "valuation" question four, but suggests that the respondent group were well equipped to make the judgements asked in questions five and six. That is, an experience of both stone cleaning valuation and practice is in evidence.

A simple summary of the results from question eight is given in table A4.4.

Table A4.4 - significance of associated variables on valuations

Variable	*1= very significant, 7= no significance*		
Cleaned buildings:	**Mean**	**Median**	**Standard Deviation**
Standard of cleaning	4.46	4	1.48
Prestige value of the building	3.33	3	1.64
Aesthetic appeal	3.61	3	1.48
Surrounding environment	3.05	3	1.64
Uncleaned buildings			
Prestige value of the building	3.53	4	1.75
Aesthetic appeal	3.95	4	1.50
Surrounding environment	3.18	3	1.80

It should be noted that the significance of the data from question eight lies in the possible links with questions five and six. An analysis of those relationships is presented in chapter five.

Appendix 5. *Results of property valuation validation exercise*

London Survey

Introduction

From the literature, no previous study of the effect which stone cleaning might have on property market prices was found. Whilst the longer term effects of cleaning might well have implications in themselves for maintenance (and hence market) costs, there was a concern that the questionnaire format might prove problematic.

50 questionnaire were distributed to general private practice surveying firms in Greater London, primarily to ensure that the questions being asked were understandable and that the format would not in itself be likely to lead answers in one direction or another. The widespread use of limestone and brick as building materials in the London area meant that the statistics produced from this study cannot be readily amalgamated or related to responses from the main study completed in Scotland. The ability of cleaning to uncover stone decay on limestone facades through the removal of outer crusts means also that the rationale for cleaning limestone may well be motivated beyond the aesthetic in some cases.

The questionnaire format was identical to that used in Scotland, save for the removal of a request for a follow up interview.

Analysis and discussion of results

50 questionnaires were distributed, with responses as shown.

returned:	18 (36%)
completed:	10 (55%)
incomplete:	8 (45%)

The response and completion rates were acceptable for the purposes of this study, although the small number of completed survey forms meant that t-test analysis of percentage indicators against responses to question eight would reveal little and be open to great variation.

Predictable effect of stone cleaning on property market selling prices

The adjustments which the respondents felt should be made to value as a result of stone cleaning work being carried out is summarised in table A5.1, below.

Table A5.1 - Respondent groups' estimate of the percentage increase in property selling and letting prices which might be expected following stone cleaning works

Client type	Property type	Area	Mean %	Median %	Standard Deviation %
Owner- occ.	Commercial	City	2.06	zero	4.89
		Outlying	1.44	zero	3.25
	Retail	City	0.72	zero	1.64
		Outlying	0.11	zero	0.33
	Residential	City	2.42	1.25	3.80
		Outlying	0.58	0.50	0.66
Investor	Commercial	City	1.65	zero	4.70
		Outlying	1.10	zero	3.13
	Retail	City	0.60	zero	1.56
		Outlying	0.05	zero	0.16
	Residential	City	1.79	zero	3.70
		Outlying	0.21	zero	0.39

As with the main Scotland study, the mean value for the predicted effect of stone cleaning on property selling price and letting cost tends to increase where the property concerned is in the city centre, although in common with the main study the median effect in the majority of categories is zero. The trimmed mean figures calculated were all less than the mean with only owner occupied commercial properties (1.04%) and residential properties (2.44%) in the city centre producing indicators greater than 1%.

A number of respondents expressed the view that the condition of the stone would be more likely to affect value, rather than the cleanliness. Although the would clearly be influenced by the occupant and use of the building (e.g. the importance of market and image), a clear link between cleaning, aesthetics and repair cost emerged.

Responses to question 8

Question 8 of the survey asked respondents to indicate the extent to which standard of cleaning, prestige value, aesthetic appeal and the surrounding environment would be of importance in their valuation of a property. Of the responses completed, eight respondents completed this section, and no respondents indicated that the questions were either of little relevance or unclear. These questions were important to the main study, in that comments, both hypothesised and received, concerning the importance of marketing, image and condition could be tested through cross analysis of this section with the percentage indicators received.

General comments

Of the forms returned incomplete, the common reason for non- completion was that the firm had no experience of stone- cleaned properties. The relatively high number of respondents in this category stands at odds to the response in the Scottish study where a very high percentage of the overall response had some experience. This may be due to strongly pro-cleaning political and economic pressures existing in Scotland during the 1980s having led to a lerge amount of cleaning taking place.

Summary

As stated, the aim of the London pilot study was to establish the appropriateness and clarity of questions posed. The indicators received, while generally lower than those obtained from the main study, will relate to different predominant building materials and do not in themselves suggest that the survey itself is flawed. The link made between cleaning and stone condition is interesting, though, in that it links directly with the financial value framework set out in chapter five, and would give credence to the claim that cleaning should be regarded as a first stage of a long term maintenance programme, rather than a single stage route to aesthetic and/or financial benefit.

Appendix 6. *Contingent valuation survey questionnaire*

Stonecleaning - Contingent Valuation survey

Introduction

Good morning/afternoon. I am a research student from The Robert Gordon University in Aberdeen, and I was wondering if you could spare a few moments to take part in a questionnaire survey. The survey is being carried out in order to find the extent to which members of the public value stonecleaning being carried in the towns and cities of Scotland, and in particular the cleaning of the buildings in Aberdeen/ Edinburgh/ Glasgow.

Section 1 - background of respondent

1. Are you a resident of Aberdeen/ Edinburgh/ Glasgow?

Yes [ ]
No [ ]

(if *no* answer given, go to question 3).

2. The survey will consider the possible cleaning of Aberdeen/ Edinburgh/ Glasgow. First of all, how many miles do you live from Aberdeen/ Edinburgh/ Glasgow city centre?

miles [ ]

3. How often have you visited Aberdeen/ Edinburgh/ Glasgow city centre in the last month?

Times/ month [ ]

(if question 3>0)
4. Is this figure more or less than usual?

More [ ]
Less [ ]
Same [ ]

comments...
....
....

5. What is the main purpose of your visits to the Aberdeen/ Edinburgh/ Glasgow city centre area?

....

....

....

6. Where do you work, in relation to Aberdeen/ Edinburgh/ Glasgow city centre?

same street	[ ]
same town	[ ]
different town	[ ]
not in employment	[ ]

7. Have you been aware of any stonecleaning work being carried out in the past?

Yes	[ ]
No	[ ]
Unsure	[ ]

8. Can you think of any examples of stonecleaning where you found the results particularly pleasing?...

....

....

9. Can you think of any examples of stonecleaning results which you would regard as being particularly poor?...

....

....

....

10. How strongly do you agree or disagree that public money should be spent on the cleaning of Scotland's historic buildings?

strongly agree strongly disagree

1 2 3 4 5

11. What negative effects of stonecleaning are you aware of?.......................................

....

....

....

12. Are you aware of the following possible results of stonecleaning work?

(i) the removal of a number of layers of the stone itself, leading to a decrease in the buildings resistance to weathering.

Yes [ ]
No [ ]

(ii) salt staining appearing on the face of cleaned stone, as a result of chemical cleaning agents.

Yes [ ]
No [ ]

(iii) algal growths being made more apparent, or even being encouraged, by the cleaning process'

Yes [ ]
No [ ]

(iv) the possibility that a terrace of buildings may take on a patchwork appearance due to a number of different cleaning methods being employed.

Yes [ ]
No [ ]

(v) the possibility that a loss of detail on the stone surface may result from the application of cleaning methods.

Yes [ ]
No [ ]

Section 2 - valuation of stonecleaning process

13. Suppose a trust fund was set up to provide for stonecleaning works to be carried out on buildings which have not yet been cleaned in Aberdeen/ Edinburgh/ Glasgow city centre. The trust fund would be entirely financed by voluntary donations from members of the public.

What would be the maximum that you would be prepared to pay, as a once and for all payment, to help ensure that the project went ahead?

Amount [ ][ ][ ][ ][ ][ ]

(if bid is zero, go to question 17).

14. If you contributed this figure towards the stonecleaning , what items would you spend less on in order to make your contribution?

marginal amount [ ]
don't know/ unsure [ ]
nothing/ income rising [ ]
named item..

15. If the project was extended to include ten buildings, instead of just one, would the amount you were prepared to pay be multiplied by ten?

Yes [ ]
No [ ]

*(IF NO)*Could you please say why that is..
....
....
....

16. Do you feel that the information supplied about stonecleaning has been sufficient to allow you to make realistic decisions about your level of bid?

Yes	[ ]
visuals poor	[ ]
more spoken information required	[ ]

(ask only if bid = £0)
17. Why did you say you were not willing to give a donation?......................................
....
....
....

18. Do you feel that using a trust fund is a suitable way for you consider the subject of stonecleaning?

Yes	[ ]
No	[ ]

(if no) Why is that?...
....
....
....

Section 3 - respondent's personal details

19. Could you also please indicate your age group?

16-24	[ ]	55-64	[ ]
25-34	[ ]	over 65	[ ]
35-44	[ ]		
45-54	[ ]		

20. Could you please indicate which of the following *best describes your educational* background?

Years in secondary school	3	[ ]
	4	[ ]
	5/6	[ ]
	ONC/HNC	[ ]
	Diploma	[ ]
	Degree	[ ]
Professional qualification		[ ]

Higher education...

21. Confidentially, could you please indicate into which of the following categories your pre-tax household income (per annum) falls? (*SHOW CARD*)

£ 0 - £5 000	[ ]
£ 5 001 - 10 000	[ ]
£10 001 - 15 000	[ ]
£15 001 - 20 000	[ ]
£20 001 - 25 000	[ ]
£25 001 - 30 000	[ ]
£30 001 - 35 000	[ ]
£35 001 - 40 000	[ ]
over £40 000	[ ]

Thank you for taking part in the survey.

22. Sex of the respondent.

Male [ ]
Female [ ]

(the interviewer should answer the following question)
23. Did the respondent seem to take the survey seriously, and properly consider his/ her answers?

Yes [ ]
No [ ]
Don't know [ ]

Appendix 7. *Results from contingent valuation survey*

TEXT BOUND INTO

THE SPINE

Location	No.	Resident	Miles	Times	MLS		Work	Aware	Good	Bad	Agg/Dis		Layers	Salts	Algae	Terrace	Detail	Total	Bid
Aberdeen	1	1	4	25		work	1	1		gilcomstone church	2	too clean, bleached	0	0	0	0	0	0	3.00
	2	1	0.5	12		shops	2	1	churches in aberdeen	market cross area	1	scott monument	0	0	0	0	0	0	0.00
	3	1	1.5	25		work	2	1	gilcomstone		3		0	0	0	0	0	0	1.00
	4	1	1	25		shops	2	1			3		1	0	0	1	1	3	1.00
	5	1	1	25		work	2	1	gilcomstone, townhouse	glasgow (from tv)	4		1	1	1	0	1	4	####
	6	1	8	25		work	2	2			4		1	0	0	1	1	3	1.00
	7	1	2	25		shops	4	1			3		0	0	0	0	0	0	2.00
	8	2	0	25		work	1	1	gilcomston		3		0	0	0	0	1	1	2.00
	9	1	1	8		shops	2	2			2		0	0	0	0	0	0	1.00
	10	1	2	25		shops	1	1	gilcomston		3		1	0	0	0	1	2	0.00
	11	1	2	8		bank, shops	2	1	unios st, torry, gilcomston		2		1	0	0	1	0	2	0.00
	12	1	0.5	25		shops	2	1	generally		1		0	0	0	1	0	1	####
	13	1	1.5	10		bank, shops	2	1		generally	5		0	1	1	1	0	3	0.00
	14	1	1	5.5		shops	2	2			2		1	0	0	0	0	1	7.50
	15	1	2	25		work	1	1	gilcompston church		1		1	0	0	0	1	2	1.00
	16	1	0	4.5		shops/clubs	2	1			1		1	0	0	1	1	3	5.00
	17	1	0	1		social	2	1	gilcompston church		1		0	1	0	1	1	3	5.00
	18	1	5	4		shops	4	2			3		0	0	0	1	1	2	0.50
	19	1	0	25		home shops recreation	2	1	ashvale place		2	noise, aerosols, gives old buildings the impression of being new sometimes bad	1	0	0	1	1	3	0.00
	20	1	0	25		home work	1	1			1	degradation of buildings	1	0	1	1	0	3	0.00
	21	1	0	25		home	1	2			2	sand, poor light and tarpaulin	1	0	0	1	0	2	0.00
	22	1	1	25		work	1	1			3	pedestrain congestion	0	0	0	0	0	0	0.00
	23	1	4	25		work	1	3			3		0	0	0	0	0	0	####
	24	2	1	20		work	1	2	gilcompstone church		3		0	0	0	0	0	0	0.00
	25	1	0.5	4		shops	3	1	generally		3		1	0	0	1	1	3	0.00
	26	1	6	20		work shops	1	1	gilcompstone church		3		0	0	0	1	0	1	0.00
	27	2	10	4		student	3	2			3		1	1	1	0	1	4	1.00
	28	1	0	15		work	1	1	salvation army citadel, bos castlegate		4		1	1	1	1	1	5	####
	29	2	32	4		college	3	2	generally	house near home: granite turned white	3		1	1	1	1	1	5	2.00
	30	2	40	1		shops	3	1			1		0	0	0	1	1	2	5.00
	31	2	40	1		shops	4	1	generally		4		1	0	1	1	1	4	####
	32	2	60	1		shops	3	1	house in elgin		2		1	0	0	0	0	1	1.50
	33	1	1	25		work	1	1	Gilcompston		2		1	0	0	0	1	2	2.50
	34	1	1	10		shops/ work	1	3			3		1	0	0	1	1	3	1.50
	35	1	3	10		shops	2	2			2		0	0	0	0	0	0	0.00
	36	1	2	25		work	2	3			1		0	0	0	0	1	1	5.00
	37	1	1	6		shops	4	1	Gilcompston		3		1	1	1	1	1	5	####
	38	1	1	8		shops	2	1			1		1	0	0	1	1	3	5.00
	39	1	2	25		shops	2	3			2		0	0	0	0	0	0	0.00
	40	1	2.5	25		work	1	1			2		1	0	0	1	0	2	0.00
	41	1	0	25		travel to work	2	2			3		1	1	0	0	1	3	0.00

Notes	Spend	Expand	Info	No?	Suitab	Why?	Age	Education	Income	Sex	Serious
1 00	1	2	1		1		2	6	5	2	1
	1		1	oap	1		6	5	3	2	1
	1	2	1		2	better using taxes	2	3	2	2	1
	1	2	1		1		1	6	1	2	1
this bid based on £200/week wage when in work	1	2	1		1		3	4	1	1	1
	1	2	1		1		4	3	8	2	1
	1	2	insufficient interset in cause/subject		1		6	2	2	2	2
	1	2	1		1		1	3	3	1	1
	1	2	1		1		2	5	3	1	3
	1	.	1	Historic Scotland publicity	2	better through indirect taxation e g National Heritage budget	2	6	4	1	1
	1		1	already pay taxes	2	see earlier	2	5	4	1	1
	1	0	1		1		1	2	2	2	1
	1		1	dislikes the results of cleaning	2		4	2	5	2	1
	1	up slightly	1		1		1	7	3	2	1
	1	0	1		1		2	6	5	1	1
	1	0	1		1		2	3	6	2	1
	1	possibly increased	1		2	public money should be used	2	6	6	1	1
	1		1		1	but people might not donate	1	3	3	1	1
	1		1	council or owner of building should pay + more worthy causes	1		1	7	2	1	1
	1		1	unable to afford	1	unsure	2	6	2	2	1
	1		2	historic scotland or national trust or tenants	2	council cleaning dept or lottery	2	6		2	1
	1		1	national and local tax already	1		2	3		1	1
	2	2	1		1		4	3	3	1	1
	1		1	rather donate to local community	1		2	5		2	1
	1		1	once and for all for future? Other charities more important!	1	don't know how they operate	2	6		2	1
	1		1	community charge	2	public building=public funds, private buildings=owners	4	1		2	1
	1		1		1		4	4	3	1	1
	1	2	1		1	Aberdeen bequeeth	3	4	3	2	1
	1	2	1		1	only pay if you want to	1	4	2	1	1
	1	2	1		1		4	7	6	1	1
	1	2	1		1		4	5	6	2	1
	1	2	1		1		4	3	5	2	1
	1	2	1		1		2	6	3	1	1
	1	2	1		1		1	6	2	2	1
	1		1	low priority	1		2	6	5	1	1
	1	2	1		1		1	7	4	1	1
	1	2	1		2	historic scotland/ nat trust, etc	4	5	6	2	1
	1	2	1		2	public/ city council	4	6	6	1	1
	1	2	1	low priority	1	but people might not donate	2	3	5	1	1
	1	2	1	private building then owner, taxes already paid	2		1	5	4	1	1
	1	2	1	taxes already paid	1	if voluntary	2	5	3	1	1

Location	No.	Resident	Miles	Times	MLS		Work	Aware	Good	Bad	Agg/Dis		Layers	Salts	Algae	Terrace	Detail	Total	Bid	Notes	
Edinburgh	1	1	5	8	3	shops	2	1			1		0	0	0	1	0	1	0 00		
	2	1	4	10	3	emp agencies, work	2	1			2		1	0	0	1	0	2	10 00		
	3	1	5	15	3	shops	2	1			3		1	0	0	1	1	3	0 00	The respondant has seen Richard de Marco, among others, and feels that cleaning at all may be a bad thing	
	4	1	1 5	25	3	work	2	1			1		1	1	0	1	1	4	2 00		
	5	1	7	4 5	3	shops	2	1			1 5		1	0	0	1	0	2	0 00		
	6	1	0	25		access	2	1			1		1	0	0	0	1	2	2 00		
	7	1	1 5	2 5	3	access	2	2			1		1	0	0	1	1	3	10 00		
	8	1	6	4	3	shops	4	1			4 5		1	1	0	1	1	4	0 00		
	9	1	5	20	3	work	1	3			2		0	1	0	1	1	3	2 00		
	10	1	1 5	25		work	1	1			1		1	1	1	1	1	5	0 00		
	11	2	4	3	3	bank	2	2			2		1	0	1	1	0	3	0 00		
	12	1	5	10	3	shops	4	1			1		1	1	1	1	1	5	100 00		
	13	1	3 5	4	3	shops	2	1			2		1	1	1	1	1	5	100 00		
	14	1	3	25		shops	2	2			1 5		1	0	0	1	1	3	0 00		
	15	1	5	5 5	3	shops, bank	4	1			1		0	1	0	1	1	3	0 00		
	16	2	5	25	3	work	2	1	gpo, balmoral hotel, george street		1		1	0	1	1	0	3	1 00		
	17	1	1	25		shops	2	1	princes street church		2		1	1	0	1	1	4	0 00		
	18	2	50	1	1	visits, annual	3	1		prefers the buildings to be soiled	3		2	2	2	2	2	10	0 00		
	19	1	2	4		shops	2	1	generally		5		1	1	1	1	0	4	50 00		
	20	1	1	4		shops	2	2			2		1	0	0	1	1	3	1 00	charity	
	21	1	3	25		shops	4	1	charlotte sq, meadowbank area		1		1	1	1	1	1	5	25 00	spare cash	
	22	1	1 5	16		business	2	1	all marchmont		1		1	1	1	1	1	5	1 50		
	23	2	10	4		shops	4	1	bank of scotland		2		1	1	0	1	1	4	0 00		
	24	1	2	1		visit friends	4	1	generally, cowgate, st annes school,dalrye road		2		1	1	1	1	1	5	0 00		
	25	1	2	25		work	1	1	scott monument, caledonian hotel		2		1	1	0	1	0	3	0 00		
	26	1	1	6		shops	2	1			3		1	1	1	1	1	5	0 00		
	27	1	4	4		shops	2	2			3		0	0	1	1	0	2	0 00	charity	
	28	1	3	10		shops	2	1	scott monument		2		1	1	0	1	1	4	1 50		
	29	1	12	25		1	2	2			2		0	0	0	0	0	0	0 00		
	30	1	2 5	25			2	1		stone repair/ replacement	1		1	0	0	1	1	3	15 00		
	31	1	5	25			1	1			3		0	0	0	1	0	1	0 00		
	32	1	5	3		shops	2	1	balmoral		1		1	1	0	1	1	4	0 00		
	33	1	3	25			2	1	northbridge	scott monument	1		1	1	0	1	1	4	100 00	charity	
	34	1	1	25		work	1	1			2		1	0	0	1	0	2	10 00		
	35	2	13	12		transit through	2	1	melville street		2		1	1	0	1	1	4	0 00	she indicated she was not completely in favour of cleaning taking place	
	36	1	2	25			1	1	museum, st andrews square		4		1	0	0	1	0	2	0 00		
	37	1	5	12		shops	1	1	generally		1		1	0	0	0	1	2	50 00		
	38	2	20	2		social	1	2			5		0	0	0	0	0	0	1 00		1 00
	39	1	3	8		shops	4	1	scott monument?????		1		1	0	1	1	1	4	20 00	alternative cleaning methods?	
	40	1	15	8		transit	2	1	scott monument		2		1	0	0	1	1	3	0 50		1 50
	41	2	3	3			1	2			5		1	0	0	0	1	2	5 00		1 00
	42	1	3	3			2	1	mound		2		0	0	0	1	0	1	1 50		
	43	1	7	2		estate agents	1	1	york minster		3		1	0	1	0	1	3	10 00		1 00
	44	1	5	4		shops	1	1	any		3		1	0	0	0	1	2	0 00		
	45	1	1	5	25		2	1	always		1		1	0	1	1	1	4	1 50		
	46	1	2	8	8	shops	2	3			4		1	0	0	1	1	3	5 00		
	47	1	3	8		shops	2	1	balmoral hotel		3		1	2	2	2	1	8	0 00	if in the respondants street, then willing to pay	

Spend	Expand	Info	No?	Suitab	Why?	Age	Education	Income	Sex	Serious
		1	Taxed already	0	Taxed already	2	7	8	2	1
1	0	1		1	taxes	2	5	3	2	1
		1	more important issues	0		4	6	7	2	1
1	2	1		1	definite	1	4	2	1	1
		1		2	taxes	4	7	1	2	3
1	2	1		2	taxes	1	6	1	1	1
1	2	cost info needed, and info on disruption		2	taxes	1	6	4	1	1
		1	Owners should pay	2	Unless buildings are publically owned, the firms should pay	6	3	5	2	1
1	2	1		2	taxes	1	2	1	1	1
		1		2	taxes	3	2	2	2	1
		1	other priorities	2	taxes	3	6	8	2	3
2	2	impossible question		1		4	6	2	1	3
childrens music lessons	2	1		2	taxes	3	7	6	2	1
1		1		1	government should pay	1	2	2	1	1
		1	low income	2	taxes	6	1	2	2	1
1	times 2	1		1	government funded using national funds	4	2	6	2	1
			low income, if in employmeny might be keen	2	ownership? who runs fund? business interets	1	6	1	2	1
			visitor	1		4	3	7	2	1
2		1	more info would be required prior to an actual donation eg. method, etc.	1	+ other sources	4	4	5	2	1
1			more info on re-cleaning	2	owners should pay by compulsory order	2	5	1	2	1
2		1		1		6	2	9	1	1
		1		2	owners/ business liable	3	7	3	1	1
		1	low priority	1		5	2	6	2	1
		1	low income	1		6	2	1	2	1
		1	low income	2	taxes	3	5	7	1	1
		1	low priority	1	only if money available	2	5	2	2	1
			low priority, oter causes more important	1		2	6		2	1
		1		2	public funds	2	7	4	1	1
		1	low priority	2	owners responsible	3	3	4	2	1
		1		1	owners should also be liable	1	3	2	1	1
		1	low priority	1		2	6	7	2	1
			low income, low priority	1		1	6	1	1	1
3		1		1		1	6	3	2	1
		1		1		1	4	3	1	1
		1			depends on donors	4	2	4	2	1
			low income low priority, homeless, etc.	1		4	1	2	2	1
		1		1		4	6	8	2	1
		1		1		1	1	1	2	3
				1		1	4	2	1	1
		1		1		1	6	6	1	1
		1		1	very suitable	2	5	5	2	1
		1		2	depends on collections- enough money?	1	6	1	1	1
		1		1		1	5	4	2	1
			low priority, other charities		possibility, lottery?	3	7	5	2	1
		1		2	taxation, conservation societies	3	6	2	2	1
1	2	1		1		2	6	4	2	1
		1	see notes	2	taxation better	2	8	3	1	1

Location	No.	Resident	Miles	Times	MLS		Work	Aware	Good	Bad	Agg/Dis		Layers	Salts	Algae	Terrace	Detail	Total	Bid
Glasgow	1	1	0.5	25			1	2			1		1	0	0	1	0	2	0.00
	2	1	4	25		job hunting	4	1	battlefield monument and refurb italian centre		1		0	0	0	1	0	1	0.00
	3	1	9	25		work	1	1	generally		2		1	1	0	1	0	3	20.00
	4	1	3	1	3	shops	4	1	maryhill, gw road		2		1	0	0	1	1	3	0.00
	5	1	2	25		work	1	1	housing better		3		1	0	1	1	0	3	0.00
	6	1	7	12		work/ shops	4	1	town cross, city chambers, generally		1		1	1	1	1	1	5	0.00
	7	1	5	4		shops	4	1	generally		1		1	0	0	1	0	2	1.00
	8	1	1	16		social/work	1	2			2		0	0	0	0	0	0	0.00
	9	1	4	25		work	1	1	sauchiehall churches	art school	1		1	1	0	1	1	4	1.00
	10	1	5	25		work	1	1	church, sauchiehall street		1		0	0	1	1	0	2	1.50
	11	1	3	2		shops	2	2	generally	no	1		1	1	0	1	1	4	20.00
	12	1	12	25		college	1	2			1		0	0	0	0	0	0	0.00
	13	2	6	20		regional councillor	2	1	generally	no	1		1	1	1	1	1	5	0.00
	14	1	5	25		work	2	1	stirling library		3		1	1	1	1	1	5	0.00
	15	1	1	12		shops/work	1	1			3		0	0	0	0	0	0	0.50
	16	1	0.5	25		work	1	3	st andrews sq		1		1	0	0	1	1	3	15.00
	17	1	2	25		work	1	1	gt western road- church		3		0	0	0	1	0	1	0.00
	18	1	6	4		shops	1	1	exchange sq		2		1	0	0	1	0	2	1.50
	19	1	2.5	8		shops	1	1	west end, kelvinside, merchant city		2		1	0	0	1	0	2	0.00
	20	1	1.5	25			1	1	mitchell lib-kelvingrove park		1		1	0	0	1	1	3	0.00
	21	1	14	8			1	1	generally		1		0	1	1	1	0	3	100.00
	22	1	1	8		shops	4	1	all		2		1	0	0	1	0	2	200.00
	23	1	1	25			1	1			2		0	0	0	0	0	0	0.00
	24	1	6	1		shops	4	1	tenements big difference, lovely streets		1		1	0	0	1	1	3	0.00
	25	1	5	25		shops, uni	1	1			3		1	1	0	0	0	2	1.50
	26	1	90	1			3	2			3		0	0	0	0	0	0	1.50
	27	1	2	1		shops	4	1	woodlands, charing cross housing		1		0	0	0	1	1	2	0.00
	28	1	15	6			4	1	generally		1		1	0	0	1	0	2	25.00
	29	1	1	25	3		1	2			2		0	0	0	0	0	0	0.00
	30	1	2	25		work	1	1	george square		2		1	0	0	0	0	1	20.00
	31	1	5	25			1	1			1		1	1	1	0	1	4	15.00
	32	1	1	25			1	1	generally, big improvement		1		0	1	1	0	0	2	0.00
	33	1	4	25			1	1	Merchant city, library	Frasers	1		1	0	0	1	0	2	0.00
	34	1	1	25			1	2			1		0	0	0	0	0	0	0.00
	35	0	15	20		work	2	2			3		0	0	0	0	0	0	0.00
	36	1	4	25		work/shops	1	1	mitchell library, city chambers, charing cross	no	2		1	1	1	0	1	4	0.00
	37	2	20	25		work	1	1	west end, tenements, gordon street in 1985	can spoil look (e.g. don't clean university	3		1	1	0	1	1	4	0.00
	38	2	30	0		work	2	2	west george st area	no	2	deterioration of stone durability	1	0	0	1	0	2	20.00
	39	1	4	1		shops	4	2	houses		3		1	0	0	1	1	3	0.00
	40	2	0	20		work	1	1			3		0	0	0	1	0	1	0.00

Notes	Spend	Expand	Info	No?	Suitab	Why?	Age	Education	Income	Sex	Serious
			1	money found elsewhere	2	taxes	1	6	3	1	1
			1		2	council, taxes	2	6	1	2	1
public money should be spent elsewhere	1		1	low priority, charity	?	other sources better if available	2	4	8	2	1
important, everybody should pay			1	owners should fund cleaning	2		4	2	4	2	1
			1	more important issues	1	gives the option to pay, or not	2	6	4	1	1
			1	taxes already paid	2	taxes	4	1	5	2	1
older, historical, builings may be best left alone, and she was mainly thinking of terraces			1		1	also owner/tax	5	2	1	1	1
			1	low income	2	taxes	1	6	1	2	3
low priority			1		1	voluntary for public buildings ONLY	1	6	9	1	1
			1		1		1	3	1	2	1
	3		1		1		2	3	2	2	1
			2	unaware in the past	1		1	4	6	1	3
			1	taxation	2	owners + tax	5	2	3	1	1
			1	trust fund	2	taxes	3	6	6	2	1
believed dampness could result from sc			2		2	owner resp.	3	5	2	2	3
			1		2	lack of interest	2	4	2	2	1
			1	low priority	2	public- govt, private-owner	2	2	1	2	1
			1		1		3	4	3	1	1
			1	low income	1		1	6	2	1	1
			1	recently moved here		if public want OK, taxes better	2	6	5	1	1
			1		1	ongoinng work	6	6	4	2	1
if in employment	3		1		2	taxes ideally	2	6	1	1	1
			1	low income/ low priority		unsure	1	6	1	1	1
			1	taxes already paid	2	taxes	6	5	5	2	1
			1		1		1	6	1	1	1
			1		1	or taxation instead	1	4	1	2	1
			1	pensioner, low income	1		5	2	1	2	1
			1		2	taxes better, as necessary work	- 5	4	4	2	1
			1	many other priorities, felt few would care	2	taxes	1	6	1	1	1
tourism important, image of city			1		2	taxes better	1	6	1	2	1
			1		1		3	2	2	2	1
			1		2	taxes	5	1	4	2	1
public money should be spent elsewhere			1	low priority, charity	1	if not taken from public funds	2	6	1	2	1
important, everybody should pay			1		2	taxes: larger funds, everybody pays	1	6	1	2	1
			1	charity: rather childrens or cancer research	2	shouldn't be financed solely from members of public	2	2		2	1
			1	should be funded through public money	2	see above	2	4		2	1
			1	can think of better causes	1		2	6		1	1
		0	1		2	if public funds could be used, then they should	2	7		1	1
			1		1		3	4		2	1
			1		1		2	2		2	1

Appendix 8. *Sample return sheet for aesthetic value study*

Picture no. X
Respondent no. Y

	1	2	3	4	5	6	7	
Well looked after				X				Shabby
Impressive			X					Unimpressive
Delicate			X					Weighty
Ordinary		X						Distinctive
Inviting			X					Repelling
Orderly			X					Irregular
Gloomy				X				Cheerful
Warm		X						Cold
Attractive		X						Unattractive
Dreadful				X	X			Delightful
Has Character				X				Has no character
Soft				X				Hard
Clean		X						Dirty
Untidy							X	Tidy
Friendly	X							Unfriendly
Dark					X			Light
Pleasing colour				X				Displeasing colour
Elegant		X						Clumsy
Depressing					X			Uplifting
Dignified			X					Undignified
Low status					X			High status
Unique						X		Common

Appendix 9. *Results from aesthetic value study*

This appendix presents data from returns to the survey form in appendix 8.

Each photograph number is listed in the left-hand column, and the abbreviated criteria listed along the top of each grid. For the non-abbreviated criteria, please refer to appendix 8.

The responses from each respondent are listed, according to the scale shown in appendix 8.

Pictures 3 + 4

Photo	Well	Impr	Del	Dist	Inv	Order	Cheer	Warm	Att	Deligh	Has	Soft	Clean	Tidy	Frien	Light	Pleas	Eleg	Uplift	Dignif	High	Unique
3	5	5	5	4	5	6	5	5	4	5	4	5	5	5	5	5	4	5	5	4	5	4
3	5	4	5	5	5	4	5	5	5	4	6	5	6	5	5	5	5	4	5	6	5	4
3	5	5	4	5	5	5	5	5	5	5	5	5	6	6	5	6	5	5	6	4	5	5
3	5	5	4	5	4	5	5	5	5	5	4	5	6	6	5	6	4	5	5	4	5	5
3	5	5	4	4	5	4	5	4	5	4	5	4	5	4	5	6	6	4	5	5	5	5
3	6	5	4	4	5	4	5	4	5	4	5	4	5	5	4	5	4	5	5	4	5	5
3	4	5	4	7	5	1	6	6	6	4	5	4	7	6	6	6	7	6	2	5	6	6
3	6	3	6	2	7	5	7	7	7	7	3	7	7	7	7	7	6	2	7	2	3	4
3	6	5	5	5	3	4	6	7	7	5	3	6	6	6	4	5	6	6	5	4	7	6
3	6	4	6	2	6	4	6	6	5	7	4	5	6	7	6	7	6	3	7	5	6	4
3	5	4	5	5	5	2	5	3	6	5	3	6	6	6	4	5	2	4	5	4	4	4
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3	7	6	5	3	5	2	6	6	5	5	3	5	7	6	6	6	6	3	5	5	5	3
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3	7	7	4	4	7	4	7	4	7	7	4	4	7	6	5	5	7	5	7	7	7	4
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3	6	6	7	6	6	5	7	6	7	5	4	2	7	6	6	6	6	7	7	5	6	6
	5.26	4.97	4.81	4.68	5.00	4.16	5.71	5.16	5.35	5.03	3.94	4.81	5.71	5.26	5.19	5.39	5.16	4.68	5.39	4.68	5.16	5.13
4	2	2	3	4	3	3	4	3	3	4	4	3	3	3	4	3	3	4	4	3	4	3
4	2	2	3	4	3	3	3	3	3	4	2	3	2	3	3	3	3	3	4	3	3	4
4	1	1	2	4	3	4	3	4	3	4	3	3	2	3	4	3	2	4	3	4	3	3
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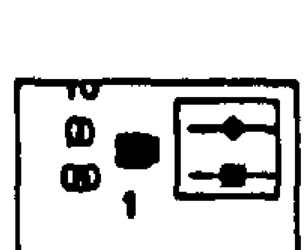
4	2	2	6	3	3	2	4	5	3	4	3	4	2	2	4	3	4	3	4	3	3	3
	1.74	2.35	3.77	3.48	2.77	2.65	3.19	3.32	2.93	3.32	3.06	3.90	1.97	2.32	3.00	2.65	2.48	3.10	3.29	3.23	3.39	3.84



Pictures 9 + 10

Photo	Well	Impr	Del	Dist	Inv	Order	Cheer	Warm	Att	Deligh	Has	Soft	Clean	Tidy	Frien	Light	Pleas	Eleg	Uplift	Dignif	High	Unique
9	5	5	5	4	5	5	5	5	6	4	4	5	5	5	5	5	4	5	5	4	5	4
9	3	3	3	3	3	3	4	2	2	4	3	3	2	4	3	3	4	3	3	4	3	3
9	3	3	3	4	2	4	3	3	3	4	5	3	3	4	3	4	3	4	3	3	4	3
9	2	3	2	4	3	4	3	4	2	4	2	4	2	2	4	3	4	3	4	3	4	3
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9	2	3	3	4	3	3	3	4	3	4	4	3	3	4	3	4	3	4	4	4	3	4
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	2.23	2.93	3.73	4.13	2.77	2.97	3.23	3.00	2.97	3.53	3.67	3.90	2.37	2.90	3.30	3.03	3.17	3.70	3.53	3.43	3.60	4.30
10	3	3	4	4	3	4	5	5	5	4	3	4	4	5	4	4	3	4	4	4	4	3
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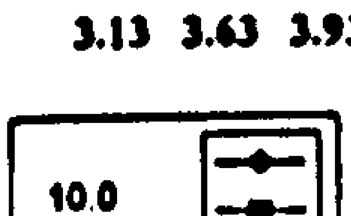

Pictures 11 + 12

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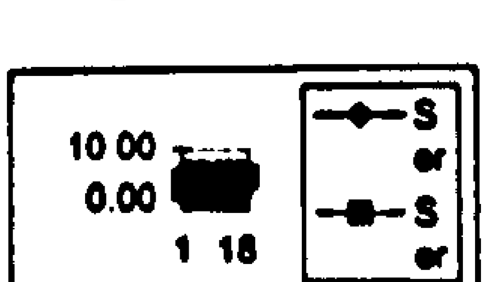

Pictures 13 + 14

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