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Rationalised Economic Appraisal of Cultural Heritage

Case study of the Nidaros Cathedral in Trondheim

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Summary

The REACH project, ENV4-CT98-0708, aims to bring together the relevant information on physical and economic factors, which provide necessary data to managers, concerned with care of the built cultural heritage. This will be used to develop an integrated cost-benefit model incorporating the relevant factors "The REACH management tool". The Nidaros Cathedral in Trondheim was selected as one of the case studies in the REACH project. The main reasons for selecting the Nidaros Cathedral were:

- The Cathedral is one of the few historical buildings where a willingness to pay study has been performed.
- The Cathedral has its own workshop for maintenance and repair with its own budget. It should therefore be possible to obtain fairly good estimates for the amount of repair needed and the cost involved.
- Some very important studies about the environment impact and the building condition have been carried out during the 1990s.

The Nidaros Cathedral is probably the best known cultural and historic building in Norway, and the building, as it stands today, is better documented than most other historic buildings in Norway.

Through the environmental and deterioration studies in the 1990s it was shown that the faulty constructions and materials as well as the harsh climatic conditions around the building was a much larger threat to the lifetime of the building than the man-made pollution situation in Trondheim. However there are indications that the local air pollution situation could have plaid a more important role in earlier years.

Since the Nidaros Cathedral has its own state-owned workshop (The Restoration Workshop of Nidaros Cathedral), information about the yearly budgets and how the money was spent is available. From the information given in Table 1, the approximated mean annual costs for the last 10 years show that cost for a historic building is high. One important factor is that a large building like this Cathedral needs their own management team and also to carry out specific investigations to fulfil their obligations. This part covers for 24% of the total budget. It is also important to know that the work is extremely labour demanding and that 88.7% of the cost is labour costs. The main cost during the period has been for maintenance and repair of the stone façade. If we subtract the work on the roof and stained glass windows and leave the management as a part of the stonework, the total cost will be 6750000 NOK/year or 843750 Euro/year. With an exterior façade area of 7000 m^2 the average cost for stonework will be 965 NOK/m^2 or 120 Euro/m^2. A main part of this price is allocated to dressing and carving of decorative details. The annual cost is expected to increase in the future as a consequence of more weight put on labour-demanding direct conservation measures and higher demands on documentation of e.g. accomplished measures.

The results for the social costs and benefits study show that this type of studies may give an important contribution to the understanding of the importance of

cultural and historic monuments. For the Nidaros Cathedral it is very interesting to observe that the willingness to pay values obtained in the 1991 study is much higher than the cost allocated to the budget for The Restoration Workshop of Nidaros Cathedral. Even with a conservative extrapolation of the results from the study, the willingness to pay values was 5 times higher than the average annual budget.

Case study of the Nidaros Cathedral in Trondheim

1 Introduction

The REACH project, ENV4-CT98-0708, aims to bring together the relevant information on physical and economic factors which provide necessary data to managers concerned with the care of the built cultural heritage. This will be used to develop an intergrated cost-benefit model incorparating the relevant factors. It will seek to provide a basis for the model by:

- collating available information on pollution and dispersion modelling,
- devising a cost model for material degradation,
- devising data collation and a cost model for direct costs,
- devising data collation and a cost model for indirect costs,
- devising data collation and a cost model for environmental policy issues.

Inside the project specific case studies were selected. Some of the case studies were selected to obtain parts of the necessary background information needed for the cost-benefit model while some are selected for demonstrating the use of the model.

The Nidaros Cathedral was selected as a case study for following reasons:

- The Cathedral is one of the few historic buildings where a willingness to pay study has been performed.
- The Cathedral has its own workshop for maintenance and repair with its own budget. It should therefore be possible to obtain fairly good estimates for the amount of repair needed and the cost involved.
- Some very important studies about the environment impact and the building condition have been carried out during the 1990ies.

2 Description of the Nidaros Cathedral

2.1 The building history of the Nidaros Cathedral

The Nidaros Cathedral was well known throughout Europe in the medieval period and visited by many pilgrims because it hosted the corpse of St. Olav, the previous King Olav Haraldson, who became a martyr after his death in 1030. The Cathedral formed together with the Archbishops palace the ecclesiastical centre in Norway from 1152 to1537.

The Nidaros Cathedral was built on top of the foundations of an earlier church, built by King Olav the Peaceful around 1070. In the period from 1140 –1160 the lower part of the present transept, including the eastern chapels and the north porch were built in Norman style. The triforia and the clerestories of the transept were finished during the period 1160-1180 in the Transitional style. The

Archbishop Eystein Erlendson introduced the Gothic style to the Cathedral, and he built the eastern part of the Cathedral, including the famous Octagon during the period 1183-1235. The western part of the Cathedral including the nave and the west front was constructed from 1235 –1300. Due to the later fall of the Cathedral we do not know how the west front really looked like, because it was only the two lower stories that were preserved in the last century when the documentation of the church started. But it is very likely that the west front was constructed in the same way as the English Cathedrals from the same period.

From the 14th century until the middle of the 19th century the Cathedral was quite destroyed by several fires. After the Reformation in 1537 the Cathedral became a parish church where only the central and eastern part of the church was maintained and the nave including the west front remained in ruins.

In the Constitution of 1814 the church was appointed as the coronation church in Norway and the maintenance of the church became a national responsibility. Therefore in 1841 the National Assembly decided to finance an investigation of the condition of the church. A plan for restoration was accepted in 1854 and finally in 1869 the restoration work started under the leadership of architect Schirmer. In 1877 the restoration of the chapter house and the octagon was finished and in 1890 the interior of the choir was finalised. Not until 1930 was the nave restored. Before they could rebuild the west front they had to get suggestions for the design of the west front and two architectural competitions were announced, the first in 1908 and the second in 1928. The result turned out to be a screen facade in the English tradition like the one in Lincoln Cathedral. The reconstruction of the west front with all its sculptures was not finalised totally before 1983.

2.2 Location of the Nidaros Cathedral.

The Nidaros Cathedral is situated in the Centre of Trondheim. Trondheim which was founded about 1000 years ago, has today about 140 000 inhabitants, and the city is situated on the southern shore of the Trondheim fjord about 50 km east of the Atlantic Ocean. The city is situated in a valley on the delta of the Nidelva river, forming a flat peninsula on which the city centre has been developed. The Nidaros Cathedral is located on the highest point of the peninsula surrounded by a park.

2.3 Use of the Object

The Nidaros Cathedral today used as a parish church for the people of Trondheim. The Cathedral is still the Cathedral for blessing of the new king and keeps today the coronation jewelleries, which are being exposed to the public some hours per day. The Cathedral is registered as a national treasure and the maintenance is still a national responsibility financed by the government. The Cathedral is one of the most visited tourist attractions in Norway and guided tours are organised in several languages for the tourists. There are also a lot of concerts and other activities connected to the church.

3 The local pollution situation

Trondheim has been influenced by the local industries and heating plants from the first half of the 19th century. SO_2 has been monitored in the city since 1973, the average values in the winter season was more than 30 $\mu g/m^3$ in the 1970s, but this fell down to less than 10 $\mu g/m^3$ in 1987. Compared to Central Europe and UK, these concentrations are very low. At present the average concentration of SO_2 is about 5 $\mu g/m^3$. It is interesting to observe that the daily values exceeded 90 $\mu g/m^3$ several times during the 1970s. Since there was no monitoring before 1973, we do not know about the exact values of SO_2 in Trondheim from before 1973, but from an overview of historical SO_2 emission in Norway we can assume that the general SO_2 concentrations in the city had their highest values from the end the 19th century to the middle of the 1960s.

Local sources may have contributed to the local higher concentration than the general trend for the concentration through the years. A heating plant for the Cathedral was constructed for the first time in 1860 with a low chimney close to the north wall and has been replaced and enlarged several times up to 1979. The plant was coal-fired until 1931 and with heavy oil up to 1979. Since then a combination of light fuel oil and electricity has been used. To estimate the effect from this source has not been done, but the yearly emission of SO_2 has been estimated to 5 tonnes for the period 1933-1979, but then it was drastically decreased to less than 0,13 tonnes after 1979 (Jacobsen, 1990).

The automobile traffic has been increasing in Trondheim during the last years. At the main road passing west of the Cathedral about 35.000 vehicles are passing by every day. NO_2 from traffic has been monitored and values between 50-80 $\mu g/m^3$ have been observed during the winter season. In addition a great amount of asphalt dust from the use of studded tires shows that the total air pollution in Trondheim has only been slightly decreased during the last 20 years, but the type of pollutants have changed.

4 Environmental parameters

The earlier air pollution situation has probably contributed to the situation of today since the stones and mortar used in the cathedral has been exposed to the environment for a long period. However other important environmental parameters with local effect have been climatic parameters like driving rain and sea salt deposition. These parameters have been a part of the deterioration processes during the whole lifetime of the Cathedral and will still be even if the man made air pollutant concentrations is reduced to a background value. Interestingly, very little chloride is found at the cathedral - salts come from cement and stones mostly.

So far no one has come up with a dose response equation for soapstone that is the main stone type used in the Cathedral. For the copper roofing equations exist taking into account SO_2, O_3, chloride and acid rain.

To day an air quality management system has been tested for use in Trondheim. Based on this system, scenarios for the impact of air pollutants on materials where dose-response equations exist can be calculated for the Cathedral as well as for the rest of the city.

5 Materials

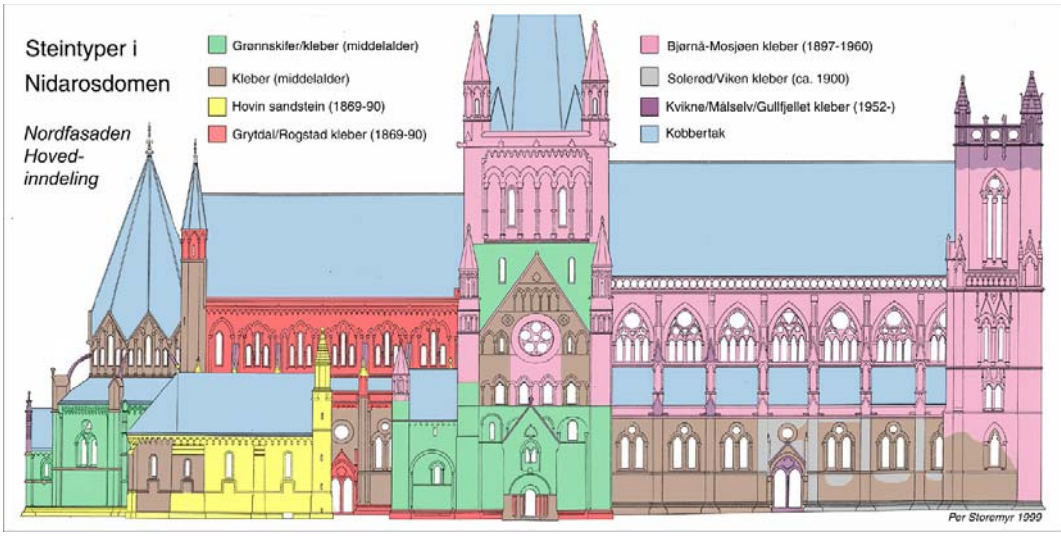

Figure 1: An overview of stone materials used on the North facade of the Nidaros Cathedral (Drawing: Per Storemyr, 1999).

Nidaros Cathedral is built of stone from more than 60 different quarries, as well as of brick, lime mortars, and cement mortars and concrete (Storemyr 1997).

Exterior facades are mainly built of various kinds of greenschist, soapstone and meta-sandstone. *Very roughly*, and not including features like buttresses, recessions, windows, decoration etc; the *exterior* facade area is some 7000 m^2, divided between

- 20% greenschist
- 75% soapstone
- 5% meta-sandstone

Less durable stone introduced during the last large restoration (1869-1969), and used at places where they weather intensively. These stone types cover some 5-10% of the total area.

Roofs are made by cast iron constructions and wooden constructions and are covered mainly by copper. The total copper-sheeted area is some 3870 m^2.

Most of the Cathedral is equipped with stained glass windows from the first half of the 1900s. Roughly, there are some 240 stained glass *complexes*. About four complexes are restored annually.

6 Deterioration and maintenance

In this contest there will be a survey of the condition of the main group of materials, stone, masonry and copper that has been used at the Nidaros Cathedral. The deterioration of the Cathedral is caused by different factors like structural problems, weathering of the materials (caused by physical, chemical and biological agents) and lack of maintenance.

The weathering of stone can be a very complex process and for the Cathedral it has a long history going back to the medieval period.

The stone used in the Cathedral are provided from more than 60 domestic and a few foreign quarries. Soapstone and greenschist are the most important stone types used on the facades. In the Middle Ages local greenschist and soapstone that tend to delaminate along foliation planes and lose pieces along dissolving carbonate veins were used. During the restoration period soapstone from about 20 different quarries throughout Norway were used and especially two types; the Grytdal and the Bjørnå type had very poor durability. The Grytdal stone contained very high amount of iron sulphide, which resulted in severe salt weathering, and the Bjørnå stone tended to flake and get large-scale delamination. Most of the weathering problems connected to the soapstone are either related to the natural composition of the stone or a result of the local condition on the Cathedral such as air pollutants, water leakage with a lot of soluble salt, and freeze/taw cycles.

There is little knowledge about the original medieval lime mortar used on the Cathedral. Several projects aimed at understanding the mortars are presently undertaken. When the restoration began in 1869 they also started to produce lime mortar, but the use of it seemed to be limited since they also imported Portland cement from England. The lime mortar was probably mixed with Portland cement in the beginning and then after 1930 it was mainly used Portland cement.

The inflexible high-alkaline Portland cement mortars, which were used in the joints, resulted in water leaks and gave rise to salt weathering and formation of white calcite crusts.

Prior to the restoration most of the roofs were covered with tiles including eaves that protected the sculptured corbels below. During the restoration, the roofs were covered with copper or lead and the eaves were replaced by gutters, which resulted in weathering of the sculptured corbels because they became more exposed to precipitation and frost than before.

The octagon and the aisles of the choir got lead roofs during the restoration and these areas had problems with water infiltration, but since 1960s these areas has been changed to copper plates.

There are to day no problems with the copper plates themselves, but because of the change of the design of the roof during the restoration including exterior gangways and parapets, problems concerning water leakage have occurred. Water leaks are definitely the main factor that governing the weathering at most parts of the cathedral today.

7 Maintenance costs

The Nidaros Cathedral has its own state-owned workshop (The Restoration Workshop of Nidaros Cathedral, RWNC) with about 40 employees, of which about 25 persons work as restoration technicians (all traditional crafts needed to maintain a Cathedral). In addition there are managers, architects, researchers, archivists, financial consultants and others.

The workshop is not only responsible for the maintenance, but in co-operation with the congregation also with the daily running of the Cathedral, the nearby Archbishop's Palace and various other listed buildings in Trondheim. In addition, the workshop is a national centre of competence for the conservation of historic masonry buildings.

The fact that the workshop is a rather complex organisation, dealing with a complex set of buildings, makes it somewhat hard to break down maintenance costs for the Cathedral itself. As a start we can state that the annual contribution from the Norwegian government is some 23 mill. NOK (1998), while the workshop's income is in the range of 10 mill. NOK (1998)

Another thing that makes it hard to break down relevant costs for the Reach project is that there has been limited large-scale work on the Cathedral over the last 10 years. This is because a large-scale restoration has been planned and because the workshop awaits the final go from the parliament. Currently, the workshop is undertaking detailed research and planning for the restoration within the framework of EU Raphael projects. Moreover, as the workshop has moved its locations and entered the modern world of computer networks, a lot of time has been allocated for these things the lasts years.

With regard to the actual maintenance, material and other costs, and the following values has been given by the Restoration Workshop of Nidaros Cathedral. The prices are the approximate *mean annual costs* over the last 10 years:

Table 1: Approximated mean annual costs for Nidaros Cathedral for the last 10 years.

Group	Man-labour year (1=300.000 NOK)	Direct costs (NOK)	Total (NOK)
Production of stone from own quarry	2,5	200 000	950 000
Plaster casts	2	50 000	650 000
Dressing and carving	8	100 000	2 500 000
Maintenance of roofs	0,3		100 000
Conservation of stained glass windows	2	100 000	700 000
Scaffolding work	0,5		150 000
Daily maintenance	2	100 000	700 000
Management and investigation/research	5	300 000	1 800 000
Total mean annual costs	22.3	850 000	7 550 000

The labour costs will, according to these estimates, cover for 88.7 % of the yearly costs at The Restoration Workshop of Nidaros Cathedral.

8 Plans for the future restoration of the Cathedral

A restoration plan for the next 20 years has been worked out (Storemyr & Lunde 1998), and the work will start within the next 12-18 months. Important work to be done includes:

- Restoration/conservation of about one fourth of all facades
- Change of water discharge systems
- Renovation of indoor heating system
- Improvement of fire-security and electrical systems

All these measures are currently being planned and several themes, like for instance the Cathedral's stability, are investigated carefully. The workshop is also working on a measured survey system based on 3D photogrammetry/AutoCAD. This system will be most helpful also as a maintenance tool. The cost for the planning project is 10 mill NOK from 1998 to 2001 (50% EU, 50% RWNC)

The annual cost is expected to increase in the future as a consequence more weight put on labour-demanding direct conservation measures and higher demands on documentation of e.g. accomplished measures.

9 Use of the Cathedral

The main use of the Cathedral to day is:

- Church for the local inhabitants
- Public/tourists (about 400.000 visitors annually)
- Museum (in connection with the nearby Archbishop's Palace)
- Concerts and theatres
- Important national events (coronations or blessings of the king)

Income from visitors in 1998: Tickets 4,15 mill NOK, sale 2 mill NOK

The importance of the Cathedral is reflected on the following three levels:

- As a congregation church
- As a regional church
- As a national shrine

With regard to the use of the Cathedral, RWNC is responsible for security and for minimising wear and tear on the building.

10 The indirect cost study for Nidaros Cathedral

One of the main benefits for having the Nidaros Cathedral as a case study was that one of the few indirect cost studies linked to a specific historic and cultural monuments were carried out at the Cathedral in 1991. The study "Social Costs And Benefits Of Preserving And Restoring The Nidaros Cathedral" by Ståle

Navrud and Jon Strand is now published in English (Navrud and Ready 2001). In Chapter 10 in this report a description of the method used and the results obtained is given.

10.1 Introduction

The main purpose of this cost study was to elicit the value of protecting and restoring the Nidaros Cathedral in Trondheim, Norway, which is the oldest medieval building in Scandinavia. Thus, a contingent valuation (CV) survey of visitors to the Cathedral was carried out in the summer of 1991. This is one of the very first applications of environmental valuation techniques to cultural heritage.

This valuation exercise is of interest for several reasons. First, the Nidaros Cathedral is a major, and perhaps even the most important, cultural monument in Norway. A value of this monument may serve as a benchmark against which other Norwegian and international monuments can be valued, especially at the time of the study since this was one of the very first applications of CV to cultural heritage. Secondly, by its design, the study provides information about the relative value of retaining the Cathedral in its present state, versus restoring it in the future. Almost certainly, the value of the latter alternative will provide a lower bound for the value of the former. Restoring the Cathedral is in principle always an actual future option (given that it is not completely deteriorated), while retaining it in the present state is not, whenever further future damage will be inflicted.

Thirdly, the study provides information on methodological aspects of the CV method in an area of application where few studies had been conducted at the time. This in particular concerns embedding and scope, which deal with the question of whether respondents are able to identify their value of one particular cultural monument, versus the values of all cultural monuments, or an even more encompassing category of public goods. Another methodological issue dealt with in the study is whether it matters if the proposed payment is to be made in the form of a tax or in the form of a voluntary payment into a fund designed to protect and restore the Cathedral. Theoretically, the former should be the more incentive compatible payment mechanism and yield a lower mean value than the latter case, where individuals might act strategically and state a high WTP just to get the fund set up, and then free-ride when actual donations are collected. On the other hand, it is generally recognised that utilising a tax payment mechanism may yield values that are biased downward since many individuals are sceptical toward increased taxes in general and therefore protest the payment mechanism by answering zero even when they have a positive willingness-to-pay (WTP).

In the study we distinguish between two different types of protective measures:

1) Through reduced air pollution it is presumed that the present degree of originality of the Nidaros Cathedral can be retained.
2) If air pollution is not reduced, it is conceded that the Cathedral will deteriorate gradually over time, and thus lose more of its original structure. In such a case we propose that the Cathedral can be protected through increased maintenance and restoration.

In both cases we preserve the Nidaros Cathedral, but in the latter case it looses more of its originality, which is an irreversible effect. All respondents were asked about their WTP for each of these two types of protective measures.

10.2 The Survey

The CV survey was conducted outside the Nidaros Cathedral during the summer (June-August) of 1991. 237 persons were contacted, of which 163 were willing to be interviewed in person. The main reasons for not wanting to be interviewed was a simple refusal (52 %) and problems with the language (29 %) by mastering neither a Scandinavian language nor English. Open-ended WTP questions (without a payment card) were used. The survey sample was split into four sub-samples, in order to test for effects of different payment vehicles, and sequence and scope.

The first three questions posed to sub-samples 1 and 2 were designed to make respondents aware of negative consequences of air pollution other than the corrosion and soiling of cultural monuments. They were also reminded that air pollution is just one problem among several potentially serious environmental concerns facing our society. By giving this information we wanted to put this issue in a broader context to avoid embedding effects, i.e. respondents stating their WTP for a more comprehensive good than the one they are asked for.

In the first WTP question, respondents in sub-sample 1 were asked for a voluntary donation to a fund, while sub-sample 2 was asked for increased taxes:

> *"What is the most you are willing to pay per year, into a fund (in increased taxes), in order to protect the remaining originality of all cultural buildings and monuments in Norway?"*

The second valuation question to these two sub-samples was then:

> *"How much of the total amount you stated you were willing to pay in order to protect the remaining originality of all cultural buildings and monuments in Norway, do you wish to allocate to the protection of the Nidaros Cathedral?"*

This sequence of valuation questions implies a "top-down" approach starting with valuing the more inclusive category of public goods before valuing a single object. The main purpose of such sequencing of questions is to reduce embedding effects, by making respondents aware that the particular good valued is just one item among a larger class of goods, all of which may be valued positively. This can also be viewed as a scope test, to test whether respondents are stating a higher WTP for more than for less of a public good.

Sub-samples 3 and 4 were not given any initial information about other environmental problems, nor were they subjected to the first question above. Instead their first question was as follows:

"What is the most you are willing to pay per year into a voluntary fund, in order for the entire remaining originality of the Nidaros Cathedral to be protected?"

Sub-samples 3 and 4 faced identical questions (where for both a voluntary contribution was used as the payment vehicle). The only difference between the two was that sub-sample 3 consisted of Norwegians, and sub-sample 4 were foreigners (whereas sub-samples 1 and 2 consisted entirely of Norwegians). Thus, the only differences between sub-samples 1 and 3 were the amount of information provided and the initial valuation question posed to sub-sample 1, both of which were designed to reduce embedding effects. Comparing the WTP from these two groups should thus potentially provide information on the impacts from embedding problem in our survey. Sub-samples 1 and 2 differ only in terms of the payment vehicle, and comparing these provides information on the effect of the payment vehicle on WTP. Correspondingly, a comparison of sub-samples 3 and 4 would show potential difference in WTP between Norwegians and foreign visitors to the Cathedral.

The next question, posed to all was:

"You have now expressed the maximum amount you are willing to pay. How would you distribute the amount you stated to be willing to pay in order to protect the remaining originality of the Nidaros Cathedral, among the following alternative motives:
i) The experience of visiting the Nidaros Cathedral,
ii) The value of protecting the Nidaros Cathedral, for others to visit it and in order to leave it intact for future generations,
iii) Other motives; please specify"

This question gives an informal measure of the relative sizes of the use and non-use components of value.

The next question concerned the other specified way in which to preserve the Nidaros Cathedral, namely restoring it. The question posed was whether the value attached to restoring was greater than, less than or the same as the value of preserving the present degree of originality. If the valuation was stated to be either greater or less, we asked a question about the most they would be willing to pay into a fund for restoration of damage inflicted on the Cathedral from air pollution.

After these WTP questions, a number of other questions were posed concerning the purpose of their visit to the Nidaros Cathedral, the number of visits to the Cathedral in recent years and planned future visits, the nature of the trip and travel costs related to the visit, and the beliefs of respondents concerning what fraction of the Cathedral's facade is original.

10.3 Results

We attempt to value two different qualities of the same good; the Nidaros Cathedral preserved for the future in its current condition, and the Cathedral restored to its current external (but less original) state after some future deterioration due to air pollution. These values are in the study represented by

estimated WTP to prevent the Cathedral from deteriorating, and for restoring it, respectively. In welfare economic terms these values represent equivalent variation measures of consumer surplus, EV. For a particular respondent this is defined as:

$$(1) \qquad U^{*}(Y, Q_1) = U^{*}(Y\text{-}EV, Q_0)$$

where U^{*} is a particular utility level for the respondent, Y is his or her income, and the quality of the good deteriorates from quality level Q_0 to Q_1 if nothing is done to reduce air pollution. Q_0 must here be identified with the two alternative qualities, namely the preservation and the restoration quality respectively, and with EV in principle taking different values in these two cases.

Table 2: Willingness-to-pay (WTP) for preserving or restoring the Nidaros Cathedral (NC) and all cultural monuments in Norway. WTP per respondent per year; in Norwegian Kroner (NOK); 1991-values. 1 NOK = 0.12 EURO = 0.11 USD.

WTP for:	Mean WTP	Standard Ev.	Min WTP	Max WTP	No. of obis (N)
Preservation of all cultural monuments in Norway (WTPALL)	1,160	1,749	0	12,000	86
Preservation of NC (WTPP)	318	475	0	3,000	161
Restoration of NC (WTPR)	278	440	0	3,000	157
WTPP divided into: I) WTPP-USE Own experience visiting NC	44	133	0	1,000	160
ii) WTPP-NONUSE Protect NC for others and future generations	252	406	0	3,000	160

Note: 1 A third category includes motives like the historic importance and the religious value of the Nidaros Cathedral as a place of worship. These "other motives" accounted for the remaining mean WTPP of 22 NOK.

Table 2 shows that mean WTP for protecting all cultural monuments in Norway was 1160 NOK per year (in 1991-NOK), and mean WTP for preserving (WTPP) and restoring (WTPR), the Nidaros Cathedral comprises 27 and 24 % of this amount, respectively. This is of course a considerable fraction, and it may appear unreasonable that one particular building absorb one fourth of the value allocated to all Norwegian cultural buildings and monuments. On the other hand, the Nidaros Cathedral may well be the most important cultural object in Norway. In addition, the individuals surveyed have shown a particular current interest in the Cathedral by actually visiting it during the time of the survey. We therefore feel there is no obvious reason to suspect serious embedding effects in our survey, although the possibility cannot be completed ruled out.

Interestingly, we note that only 44 NOK out of the mean WTP of 318 NOK to preserve the Nidaros Cathedral (WTPP), or about 14 %, is on average motivated by use value. When comparing mean WTPP and WTPR, we see as expected that the former is greater, but only slightly so; 318 versus 278 NOK. The difference is not significant at the 5 % level. Concerning respondents' beliefs about the originality of the present Cathedral, the fractions that believed 100, 75, 50 and 25 % of the current facade is original was 3 %, 24 %, 22 % and 45 %, respectively.

Roughly 35-50 % of the facade is actually in its original state. We also found that stated WTP amounts are greater for those who believe that the current facade is more original; a doubling of this share (e.g. from 25 to 50 % or from 50 % to 100 %) raises WTPR by 47 %, and WTPP increases by 31 %.

On the question about the relative value of preservation versus restoring, 65 % of respondents stated that preservation in the current state was more valuable, while 35 % stated that the two values were the same (As expected, none stated that restoring is more valuable than preserving). Although a large majority thus prefer preservation, the mean WTP for these two alternative protective measures were not statistically different (at the 5 % level). Since a preservation question was posed to all respondents before the restoring question, there may be some anchoring from the first to the second, which may bias the stated WTPR value in the direction of stated WTPP. Another possible issue is lack of realism of the preservation alternative. This alternative requires the immediate elimination of all effects of air pollution on the facade of the Cathedral, which probably is impossible to carry out in practice.

Concerning other variables, we found no significant effect on stated WTP from an increase in the number of visits to the Cathedral during the year in question (1991), nor were there a significant difference between men and women.

Table 3: Willingness-to-pay (WTP) preserving (WTPP) and restoring (WTPR) the Nidaros Cathedral for the four sub-samples. In sub-samples 1 and 2 the respondents were reminded that air pollution had other negative effects, and that air pollution was just one among several environmental problems. Sub-samples 3 and 4 were not given this information. WTP per respondent per year; in Norwegian Kroner (NOK) 1991-values; 1 NOK = 0.12 Euro = 0.11 USD

Sub-sample no.	**Payment vehicle**	**WTP measure**	**Mean WTP**	**Standard Deviation**	Zero WTP answers **(%)**	**No. of . (n)**
1	Voluntary fund	WTPP WTPR	313 276	495 494	11 9	44 43
2	Increased taxes	WTPP WTPR	324 279	399 370	14 20	42 41
3	Voluntary fund	WTPP WTPR	410 400	623 535	17 15	35 34
4	Voluntary fund	WTPP WTPR	238 174	368 329	38 49	40 39

A comparison of sub-samples 1 and 3 should yield information on possible embedding effects, since the only difference between these sub-samples was that information about additional possible cultural goods to be valued was given only to sample 1, and that one here also tried to "embed" the WTP answers for the Nidaros Cathedral by first requesting WTP for a more inclusive set of cultural goods. The natural prior hypothesis is then that embedding effect should tend to increase WTP answers from sample 3 relative to sample 1 (and relative to sample 2 as well, although the payment vehicle here was different). We correspondingly see that average WTP figures are about 20-25 % higher in sample 3 than in

sample 1, pointing to possible embedding effects. It turns out that when formally tested, these differences are not statistically significant. The results in this respect are thus tentative, but indicate that a certain but perhaps not very large embedding effect is present in the material.

A comparison of samples 1 and 2 makes it possible to measure the impact of different payment vehicles, since the payment vehicle is the only difference between the surveys used for these two groups. We find that the answers here are practically identical, indicating that whatever vehicle bias is present in our survey must be equally strong for both vehicles applied.

The third type of comparison invited by the figures in Table 3 is between WTPP and WTPR. The prior hypothesis is here that WTPP figures should exceed WTPR figures, since the former measures the value of a presumably more valuable good, namely the Nidaros Cathedral in its present state of originality, versus the latter which expresses the value of the Cathedral in a future, restored, state, after being exposed to air pollution damage over a more recent future period. As already commented on above, this hypothesis appears to be proven true in our data. No respondent stated WTPP lower than WTPR, while 65 % of respondents gave a higher WTPP. Looking in more detail at the different samples we find that for all samples the average WTP is greater for preservation than for restoring, but that the difference is relatively small for all. It is relatively greatest for sample 4, foreigners, which may not be unreasonable at least since it is difficult to find good reasons why foreigners should attach a particularly high value to a restored cultural monument in Norway.

A comparison of samples 3 and 4 reveals differences in valuation between Norwegians and foreigners that visited the Cathedral in 1991. We see that the WTP of Norwegians is clearly higher, but this is largely due to the far greater fractions of foreign respondents stating zero WTP.

10.4 Aggregated benefits

To calculate aggregate, annual social benefits we assume that our sample is representative of all visitors to the Cathedral that year. From Table 2 we find that the mean WTP per person per year for the entire sample were 318 and 278 NOK (in 1991 values) for preservation (WTPP) and restoration (WTPR), respectively. The number of visitors to the Nidaros Cathedral in 1991 was approximately 165 000. Using these WTP amounts and visitation numbers the annual benefits to all visitors of preserving and restoring, the Cathedral was 52.5 million and 48.9 million NOK, respectively. These estimates include both use and non-use values for the visitors.

To derive the total social benefits of the Nidaros Cathedral, we have to add the benefits to all those who attach a positive value to the Cathedral but did not visit it in 1991. Note that the aggregate use value among visitors was only about 14 % of their aggregate WTP to restore it (table 3.1), or approximately 7.5 and 7 million NOK, respectively, when the results above are applied. Since we do not have any data on valuation of the Nidaros Cathedral among non-visitors, assigning WTP values to these must be speculative since visitors are a self-selected and not

random sample of the (Norwegian and foreign) populations in this context, and not likely to be representative with respect to such valuations.
Assuming that the non-use values for non-visitors do not exceed the corresponding values for visitors, we can however derive an upper bound on total social benefits of the Nidaros Cathedral among Norwegians. Using the figures above, the annual mean non-use values among Norwegians for preserving respectively restoring the Cathedral in 1991 were approximately 300 NOK, and 275 NOK per person, respectively. With about 3 million adult Norwegians (above the age of 18), the upper bound on the aggregate non-use value among all Norwegians is 900 million NOK for preservation, and 825 million NOK for restoring, respectively.

In fact it may here be appropriate to base the valuation among Norwegians not on the average figures in sub-samples 1-3 as done above, but rather on the most "conservative" of these, namely the figures from sub-sample 1. The difference between values from sub-samples 1 and 3 is likely to be due to greater embedding effects in sub-sample 3, biasing these figures upward (or biasing them more upward than the figures in sub-sample 1). Using sub-sample 1 alone, the mean, annual preservation and restoration values are 270 and 235 NOK per adult, respectively. This corresponds to total social benefits among the Norwegian population of 810 and 710 million NOK, respectively.

All these are formidable figures, and they are likely to be too high, for at least two reasons. First, as already noted, non-use values are most likely greater for visitors than for non-visitors on the average. Second, it is possible that the visitors interviewed are not a random sample of all visitors. Remember that approximately 30 % of those approached by the interviewer were unwilling to be interviewed. It is likely that the WTP among these non-respondents is lower than WTP among respondents. This implies that the estimate for overall social benefits is biased upwards, by about 30 % as a maximum.

In addition there are values accruing to foreigners. The number of foreigners visiting the Cathedral in 1991 can be estimated from our sample, where approximately one forth of all persons interviewed were foreigners. Given that also one forth of all visitors were foreigners, this means that approximately 41 000 foreigners visited the Cathedral in 1991. Using the average WTP amounts of 238 and 174 NOK for foreigners from table 2, sample 4, the total valuation of preserving, and restoring, the Nidaros Cathedral, was approximately 10 million NOK, and 7 million NOK, respectively. Use values constituted 18 % of these figures for foreigners, or about 1.8 and 1.3 million NOK respectively, leaving 8.2 and 5.7 million NOK for passive-use values accruing to visiting foreigners under the two alternatives. However, benefits to foreign visitors would not be included in a social cost-benefit analysis (which focus on the welfare effects to the national population).

10.5 Cost-benefit analysis and policy implications

These social benefits of preserving and restoring the Nidaros Cathedral can be compared to the social costs of preservation and restoration. Preserving the Cathedral in its current state requires that air pollution be eliminated such that the facade of the Cathedral is not exposed to pollution in the future. For one thing,

this is practically impossible in the very short run. In the longer run a significant reduction in air pollution is possible, but we do not have any figures to indicate the relevant costs, which can be compared to preservation values.

For restoring, the calculations are simpler. There has for a long time been a restoration program for the Nidaros Cathedral, which aims to retain the outer appearance of the facade of the Cathedral. In 1991 the expenditures related to this program was 9.5 million NOK. Taking this as typical of the annual cost of restoring, it is clear (given that preservation is not undertaken) that restoring the Cathedral is socially beneficial, even if we only count social benefits to visitors to the Cathedral. The benefit-cost ratio seems to be at least 5 (counting only the values of visitors), meaning that for each NOK spent on restoring the Cathedral creates 5 NOK in social benefits, and could be as high as 70 (counting also the estimated values of non-visitors, which are more uncertain). Thus, restoration must be viewed as a very profitable project. The results from this analysis could be used to argue in favour of increasing the restoration budget if that was necessary to achieve a fully restored Cathedral. Before opting for the restoration project, data collection for a complete cost-benefit analysis of the preservation option should also be undertaken, in order to identify the more profitable option of the two.

11 Conclusions

The Nidaros Cathedral is probably the best known cultural and historic building in Norway and the building as it stands to day is better documented than most other historic buildings in Norway.

Through the environmental and deterioration studies in the 1990s it was shown that the faulty constructions and materials as well as the harsh climatic conditions around the building was a much larger threat to the lifetime of the building than the man-made pollution situation in Trondheim. However there are indications that the local air pollution situation could have plaid a more important role in earlier years.

Since the Nidaros Cathedral has its own state-owned workshop (The Restoration Workshop of Nidaros Cathedral), information about the yearly budgets and how the money was spent is available. From the information given in Table 1, the approximated mean annual costs for the last 10 years show that cost for a historic building is high. One important factor is that a large building like this Cathedral needs their own management team and also to carrying out specific investigations to fulfil their obligations. This part covers for 24% of the total budget. It is also important to know that the work is extremely labour demanding and that 88.7% of the cost is labour costs. The main cost during the period has been for maintenance and repair of the stone façade. If we subtract the work on the roof and stained glass windows and leave the management as a part of the stonework, the total cost will be 6750000 NOK/year or 843750 EURO/year. With an exterior façade area of 7000 m^2 the average cost for stonework will be 965 NOK/ m^2 or 120 EURO/ m^2 A main part of this price is allocated to dressing and carving of decorative details. The annual cost is expected to increase in the future as a consequence

more weight put on labour-demanding direct conservation measures and higher demands on documentation of e.g. accomplished measures.

The price for maintenance for the copper roof is low but will increase tremendously when replacement of the copper sheets is needed.
Most of the conclusions for the social costs and benefits study are given in chapter 8.4 and 8.5. However it is very interesting to observe that the willingness to pay values obtained in the 1991 study is much higher than the cost allocated to the budget for The Restoration Workshop of Nidaros Cathedral. Even with a conservative extrapolation of the results from the study, the willingness to pay values was 5 times higher than the average annual budget.

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ABSTRACT
The Nidaros Cathedral has been used as a case study for the "Reach Management System". The two main contributions to the management system has been to obtain direct cost values for maintenance and repair for a historic important building. The second contribution has been on indirect cost, since a willingness to pay study has been performed for the Cathedral. The results from the willingness to pay duly exceeded the average annual budget for the Cathedral with a factor 5.

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A Unclassified (can be ordered from NILU)
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