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# EuroFM Journal

## International Journal of Facilities Management

CRACKING THE PRODUCTIVITY NUT

Proceedings of the 10TH EuroFM Research Symposium, Vienna, Austria

24-25 May 2011

www.eurofm.org ISBN/EAN 978-94-90694-05-0

# Innovative approach to budget maintenance costs using the example of sacral buildings

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## ABSTRACT

The adequate maintenance of the tremendous number of existing sacral buildings worldwide is one of the major contemporary challenges faced by church facility managers today. In times of declining tax revenues and decreasing numbers of church members, the maintenance experts in charge are constantly forced to crack the productivity nut namely to reduce the arising costs yet to assure the best performance and quality of the building at the same time in order to offer pleasant churches to clergymen and churchgoers. Nevertheless, the large diversity in terms of construction, building age and artistic value combined with a lack of church-specific maintenance know-how usually leave facility managers unable to plan a reasonable budget for the upcoming year. With the help of a data base system the historic maintenance costs of 30 church buildings of the Protestant Church in Baden were therefore recorded, structured and analyzed.

Based on the newly gained results, a new PABI Budgeting Tool (Praxisorientierte, Adaptive Budgetierung von Instandhaltungsmaßnahmen / practical adaptive budgeting of maintenance measures) for sacral buildings was developed. The tool enables the user for the first time to calculate the required maintenance expenditures for a large portfolio of church buildings in a transparent and simple way by using a characteristic figure and the building volume as calculation base combined with different influencing factors specific for the maintenance of sacral buildings.

## Keywords

Budgeting method, maintenance of church buildings

## 1 INTRODUCTION

The Protestant Church in Baden is responsible for the maintenance of a huge number of congregational, rectory and church buildings. The associated costs for maintaining this portfolio are tremendous (Rapp, E. 2010). In case of the Protestant Church in Baden, the expenses add up to more than 40 million Euros estimated for the year 2010 (Protestant Church in Baden, 2010). The church authorities therefore initialized a project to analyze the processes, dependencies and influences on building maintenance especially for sacral buildings, with the goal of adapting the existing PABI – tool for postwar buildings, developed at the KIT in 2008 (Bahr, C. 2008), to church-specific needs in order to enable church associates to determine a correct and optimized maintenance budget by simple calculation. The main challenge here is to guarantee the timely allocation of an exact budget that avoids underfunding (causing a maintenance backlog) and overpayment (spending more financial resources than necessary) to effectively ensure a long-term policy of maintenance reserves (Bossmann, J. 2010). The timely allocation of the money needed for maintenance measures is furthermore very important so that minor damages can be repaired before they turn big. Keeping a building in good condition by carrying out timely maintenance measures therefore reduces the risk of secondary damages and consequentially minimizes the overall cost of maintenance measures (Leschnik, W. 1998).

| **Planned Budget 2010 (rounded)** | | |
|---|---|---|
| Congregational work | 131,763,000 € | 39.2% |
| Building maintenance | 40,513,000 € | 12.1% |
| Organization, church board and | | |
| Property administration | 28,322,000 € | 8.4% |
| Religious education | 26,204,000 € | 7.8% |
| Welfare and social work | 23,640,000 € | 7.0% |
| General church functions | 23,254,000 € | 6.9% |
| Programs for children and young people | 20,456,000 € | 6.1% |
| Education and training | 19,410,000 € | 5.8% |
| Reserves | 8,746,000 € | 2.6% |
| Expenses for church tax collection | 5,964,000 € | 1.8% |
| Pastoral care, counseling and supervision | 5,704,000 € | 1.7% |
| Public relation | 1,786,000 € | 0.5% |
| | **325,762,000€** | **100%** |

Table 1 Planned budgeting for the year 2010 (Protestant Church in Baden)

## 2 METHODOLOGY

On behalf of the Protestant Church in Baden, the Department for Facility Management (FM) at the Karlsruhe Institute of Technology (KIT) analyzed the history of 30 church buildings with special regard to the maintenance measures conducted in the past.

The research carried out is based on quantitative research methods, especially the analysis of empirical data. The information needed was taken from 64 building files provided by the Protestant Church. The hereby gathered data served as a basis for the setup of an access database. First, 2.804 data sets were allocated and structured with the help of the database, including all documented value-maintaining and value-increasing measures of the past 100 years. Each data set covers information concerning the character (continuous or extraordinary measure), the activator (for example legal regulation, complain, site inspection), the date, the costs, the cause (for example war damage, vandalism, general damage) and the description of the maintenance action.

Based on the newly generated data, the second step included extensive statistical data analysis in order to identify the relevant influences and dependencies in the maintenance process of church buildings. To this end, different linear regressions models were used. As a result it became

possible to identify four significant influencing variables, namely the building age, the building geometry, the architectural complexity and conservation costs in case of a listed building.
In a third step, all of the four significant influencing variables and the referring costs were statistically evaluated and consecutively defined using weighting factors.

In a last step, the well-known PABI calculation tool for postwar buildings (Bahr, C. 2008) was adapted to be applied especially on a large portfolio of church buildings, by using the building volume (calculation base) and a characteristic figure (calculation parameter) as starting figures combined with specific maintenance factors for sacral buildings to calculate the budget more precisely.

## 3 RESULTS

As mentioned above, the PABI – tool for sacral buildings was developed on the basis of the existing PABI – tool, developed at the KIT in 2010 (Bahr, C. 2010) for postwar buildings. Nevertheless, due to the uniqueness of church buildings per se, the original budgeting method had to be adapted in many respects. The following chapter describes the new approach and the changes needed to develop the new PABI – tool for sacral buildings.

### 3.1 The PABI – Tool for Sacral Buildings

Correct maintenance budgets can be determined by simple calculation. As the following formula shows, a budget is mainly calculated by adding the costs of the continuous and extraordinary measures. The measures themselves are described by the product of the calculation base, the calculation parameter and the particular correcting factor.

*PABI - Tool for sacral buildings – principle formula:*

$$B_M = \sum_{i=1}^{n} \underbrace{CB \cdot CP_{c,i} \cdot CF_{S,I,CM,i}}_{\text{continuous measures}} + \sum_{i=1}^{n} \underbrace{CB \cdot CP_{e,i} \cdot CF_{O,i}}_{\text{extraordinary measures}}$$

| | |
|---|---|
| *$B_M$* | *Annual Maintenance Budget in €* |
| *CB* | *Calculation Base in gross volume* |
| *CP* | *Calculation parameter in € (indexed 2009)/m³ gross volume* |
| *CF* | *Correcting factor to consider influencing factors* |
| *i* | *Cross building index* |
| *n* | *Number of buildings* |
| *c* | *Continuous maintenance measures* |
| *e* | *Extraordinary maintenance measures* |
| *S,I,CM* | *Continuous maintenance measures like service, inspection, and corrective maintenance according to DIN 31051(DIN, 2003)* |
| *O* | *Extraordinary maintenance measures, e.g. improvement according to DIN 31051(DIN, 2003)* |

The correcting factor ($CF_{S,I,CM}$) for continuous maintenance measures, service, inspection and corrective maintenance according to DIN 31051 (DIN, 2003) is calculated by the multiplication of the weighting factors for the building age and the architectural complexity:

$$CF_{S,I,CM} = W_{BAc} \times W_{ACc}$$

| | |
|---|---|
| *CF* | *Correcting factor* |
| *S,I,CM* | *Continuous building maintenance like service, inspection and corrective maintenance according to DIN 31051(DIN, 2003)* |
| $W_{BAc}$ | *Weighting factor building age* |
| $W_{ACc}$ | *Weighting factor architectural complexity* |

The correcting factor ($CF_O$) for the extraordinary maintenance measures with a project character like an improvement according to DIN 31051 *(DIN, 2006)* is defined by the multiplication of the weighting factors for the building age, the building geometry, the architectural complexity and the conservation costs (preservation order):

$$CF_O = W_{BAe} \times W_{BS} \times W_{ACe} \times W_{PO}$$

| | |
|---|---|
| *CF* | *Correcting factor* |
| *O* | *Extraordinary building maintenance with project character like an improvement according to the DIN 31051(DIN, 2003)* |
| $W_{BAe}$ | *Weighting factor building age* |
| $W_{BG}$ | *Weighting factor building geometry* |
| $W_{ACe}$ | *Weighting factor architectural complexity* |
| $W_{PO}$ | *Weighting factor preservation order* |

## 3.2 Calculation Base

All PABI – tools developed in the past generally used the replacement value of a building as the calculation base to determine the maintenance budget. The reason for this is quite obvious: The term replacement value is clearly defined, widely understood in the real estate business and automatically takes the rising construction prices in account. Furthermore, the replacement value can be used well as a shared basis for the calculation of a large and very heterogeneous portfolio (Bahr, C. 2008).

Nevertheless, in the course of the development of the PABI – tool for sacral buildings it became apparent that the determination of the replacement value of extremely old historic buildings is very difficult. The missing information about the building costs of the buildings connected with the change of currencies in Germany throughout the centuries lead to the assumption that the replacement value cannot be determined and indexed correctly for the majority of all sacral buildings. This causes a considerable risk of miscalculation. Yet, because of the major relevance of the calculation base in the PABI – tool, the potential miscalculation of the replacement value has a direct impact on the evaluation result and therefore might lead to a considerable falsification of the maintenance budget.

It was therefore decided to change the calculation base for sacral buildings from the replacement value to a general geometric building figure measured in gross volume. At this stage, it is important to point out that this procedure has only been possible because of the fact that the new PABI – tool for sacral buildings will only be applied on one single type of building, namely church buildings. Only the limitation to one building type ensures the comparability of the applied initial value and therefore allows the substitution of the replacement value with the building volume.

### 3.3 Calculation Parameter

The substitution of the calculation base in the principle PABI – formula consequentially requires an adjustment of the calculation parameter. Since the new calculation base is rendered as a geometric building figure without any cost relation, it is now necessary that the new calculation parameter includes the cost-related dependencies to describe the correlation of the calculation base and the estimated maintenance budget. The calculation parameter from the formerly used percentage rate (Bahr, C. 2010) had to be changed into a church-specific statistical figure measured in €/m³ gross volume. The multiplication of the calculation base and the calculation parameter therefore allows a first prediction of the maintenance expenditures of the portfolio.

The determination of the calculation parameter measured in €/m³ is based on the average maintenance costs per year for all church buildings analyzed. Because of the differentiation of the PABI – tool in continuous and extraordinary measures, it was necessary to identify two separate parameters (continuous = 0.41 €/m³ and extraordinary = 4.77 €/m³).

In this context, it is important to keep in mind that both parameters (costs / volume) listed before refer to the year 2009. To ensure a correct application in future times, the calculation parameters have to be indexed (according to the base year) using the building price index given by the German Federal Statistical office (Statistisches Bundesamt). Contrary to other existing PABI – tools, the new tool for sacral buildings takes account of the prize development by indexing the calculation parameter.

As mentioned before, the multiplication of the calculation base and the calculation parameter facilitates a first prediction of the maintenance expenditures of the portfolio but does not include any building-specific characteristics. The following chapter lists different influencing factors that have been proven to have a significant impact on the maintenance costs of church buildings. To ensure a more exact budget, the influencing factors are included in the budgeting procedure in the form of weighting factors.

### 3.4 Influencing Factors

The analysis of 30 church buildings lead to the identification of four relevant factors influencing the level of the necessary maintenance costs, namely the building age, the building geometry as well as the architectural complexity or preservation order in case of a listed building.

#### 3.4.1 Building Age

Research publications point out the building age as one of the most important influencing factors regarding maintenance expenditures (Hampe, K.-H. 1986) (König, H. 1988). According to Bahr, this fact was confirmed for the entire group of the analyzed postwar buildings in terms of the continuous as well as the extraordinary maintenance measures (Bahr, C. 2010). As a result, the building age was integrated in all existing PABI – tools and consequently needed to be analyzed for sacral buildings also.

In a first step, the accumulated maintenance costs (indexed Euro per year) were graphically illustrated for the entire lifecycle of each church building as shown in the following figure:

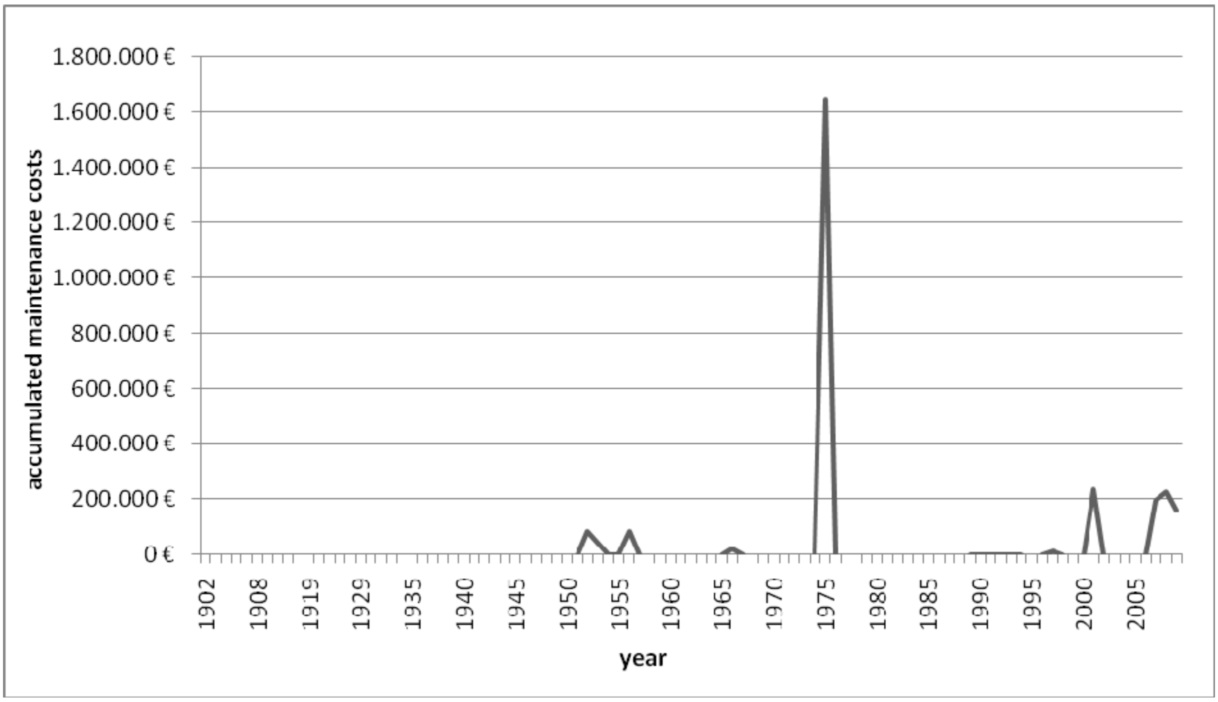


Figure 1: Progression of extraordinary costs using the example of the “Ludwigskirche in Langenstein-bach”

The analysis of the charts showed that the graphs for the majority of all sacral buildings periodically reach striking peaks (representing extraordinary maintenance measures). Previous research results had proven that such extraordinary maintenance measures normally take place in the period in-between the 30th and 40th year after construction (Bahr, C. 2008). This fact also applied to the results of the postwar church buildings and therefore could easily be confirmed.

In case of those sacral buildings erected before 1945, this comparison was more complicated, since the maintenance data available often did not reach back to the time of construction: For a sacral building constructed 100 years ago, the data on maintenance expenditures may only reach back 60 years. Nevertheless, the chart analysis of prewar church buildings lead to the assumption that the time period of 30 to 40 years is also suitable to describe the presumable period in-between two extraordinary maintenance peaks including all age groups of sacral buildings. The majority of the analyzed prewar buildings actually show the 30 to 40 year cycle. The weighting factor for the building age was therefore calculated based on a 40 year maintenance cycle for extraordinary measures.

All charts were harmonized. For postwar buildings, the year of construction was defined as building age 0. Then, the documented maintenance costs were recorded for a 40 year cycle accordingly to the year of their occurrence. For prewar buildings, the striking peaks representing an extraordinary maintenance measure were defined as fictitious building age 0. As for the postwar buildings, all documented maintenance costs were recorded for a 40 year cycle according to the year of their occurrence compared to the striking peak. If a building showed more than one striking peak in the course of its graph, the procedure was simply repeated. This approach is based on the assumption that the condition of a completely improved building is similar to the condition of a newly constructed building.

In order to guarantee the comparability in terms of expenditures, the documented maintenance costs of each church building were indexed on the year 2009 and correlated to the corresponding building volume. The successive evaluation of the average maintenance expenditures was done in ten-year sections, according to the method used when the PABI – tool for postwar buildings was developed.

The result shows a characteristic cost allocation: The annual maintenance expenditures per extraordinary maintenance measure for the first 30 years after construction respectively the extraordinary maintenance measure vary in-between 2.19 and 2.66 €/m³ (gross volume). However, the calculated costs in the period from the 31st to the 40th year total at 8.85 €/m³.

The expenditures in between two extraordinary measures add up to an average of 2.45 €/m³ for the first 30 years before they bounce up to become almost four times as high for the last decade of the 40 year cycle.

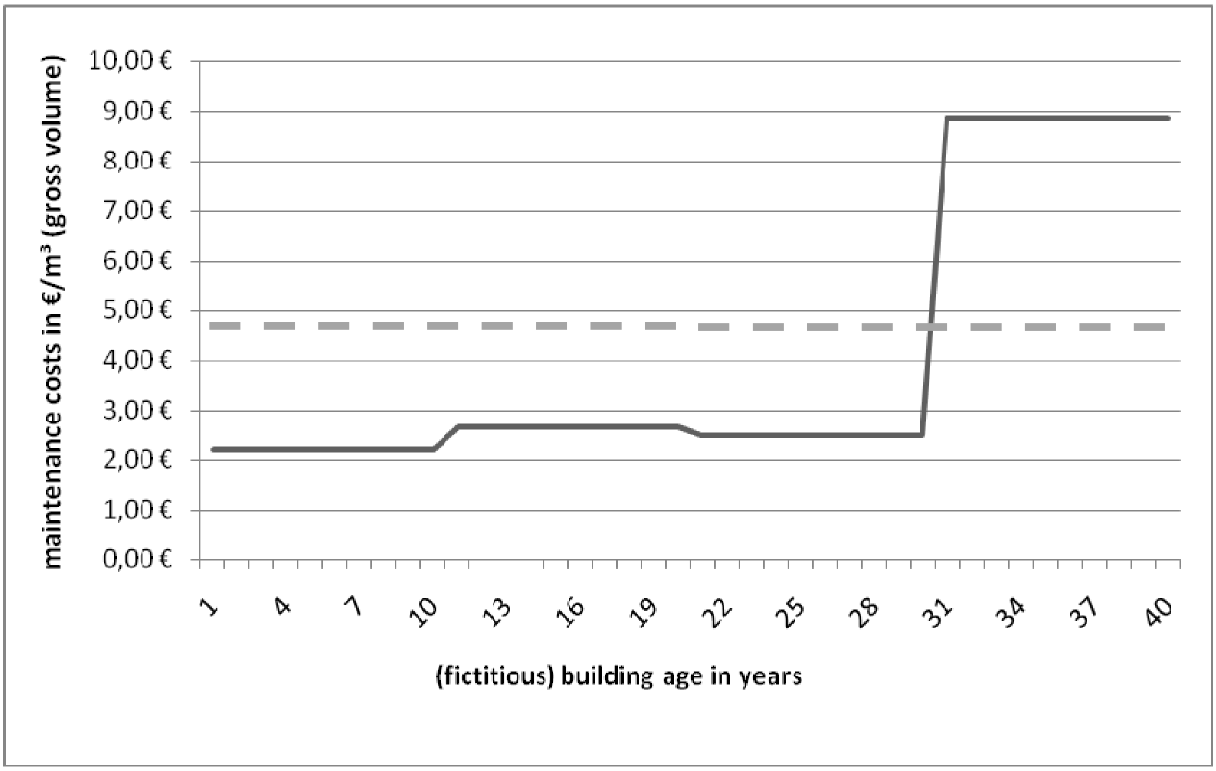


Figure 2: Progression of the average extraordinary maintenance costs according to the building age

Derived from the average expenditures (pictured in the diagram above) and the extraordinary figure of 4.77 €/m³, it would have been possible to determine the building age weighting factors for all four decades of the 40 year cycle. However, since the results of the first three decades differ only marginally (2.19 – 2.66 €/m³) for no clear reason, it was decided to use the arithmetic mean to define the weighting factor for the period from year 1 - 30.

$$W_{BA,e\ 01\text{-}30} = \frac{(2.19+2.66+2.49)\ \text{€/m}^3\ \text{(gross volume)} / 3}{4.77\ \text{€/m}^3\ \text{(gross volume)}} = 0.51$$

$$W_{BA,e\ 31\text{-}40} = \frac{8.85\ \text{€/m}^3\ \text{(gross volume)}}{4.77\ \text{€/m}^3\ \text{(gross volume)}} = 1.86$$

W = Weighting factor / BA = Building Age / e =extraordinary measure

The calculation of the financial burden, based on the extraordinary maintenance measures, determines a weighting factor of 0.51 for the years 0 – 30 and 1.86 for the years 31 – 40 referring to the calculation parameter of 4.77 €/m³ (gross volume).

### 3.4.2. Building Geometry

Numerous publications define the geometry of a building as another important factor regarding maintenance measures (BMI, 2005). Research has shown that buildings with a high ratio concerning the relation of the building surface and the building volume cause higher expenditures than buildings with a lower ratio (Kalusche, W. 1988). The surface/volume relation therefore is a good indicator for the expected intensity of the maintenance measures. Unfortunately, no data on the surface of the church buildings could be obtained from the Protestant Church in Baden. This is not surprising, facing the numerous church constructions with a very complex design of the building surface.

Since the building geometry certainly needed to be taken into account as an important influence on the maintenance measures, it was necessary to find another way to rate the analyzed churches. Because of the lack of data concerning the building surface, it was decided to substitute the surface/volume relation with a new gross floor space/gross volume relation. This approach is based on the assumption that the majority of church buildings have only one floor. Consequently, church buildings with lower ratios (m²/m³) should have smaller building surfaces than buildings with higher ratios.

The calculated results vary from 0.0652 - 0.2911 m²/m³. The arithmetic mean for all churches is 0.1273, while the statistical meridian turns out to be 0.1124. Similar to the procedure chosen by Bahr when developing the PABI – tool for postwar buildings in 2008, the analyzed portfolio was separated into two groups: Group one containing the buildings with a ratio higher than the statistical meridian and group two containing the churches with a ratio lower that the statistical meridian. Once the two groups were formed, the average costs per cubic meter and year were determined and then related to the extraordinary figure of 4.77 €/m³ in order to finally achieve the weighting factors.

$$W_{BS,e\,(<0,1124)} = \frac{3.97\ \text{€/m}^3\ \text{(gross volume)}}{4.77\ \text{€/m}^3\ \text{(gross volume)}} = 0.83$$

$$W_{BS,e\,(>0,1124)} = \frac{4.96\ \text{€/m}^3\ \text{(gross volume)}}{4.77\ \text{€/m}^3\ \text{(gross volume)}} = 1.06$$

W = Weighting factor / BG = Building Geometry / e =extraordinary measure

The calculation of the financial burden, based on the extraordinary maintenance measures, leads to a weighting factor of 0.83 for buildings with a ratio smaller than 0.1124 and 1.06 for buildings with a ratio higher than 0.1124 referring to the calculation parameter of 4.77 €/m³ (gross volume).

### 3.4.3. Architectural Complexity

The term architectural complexity was introduced for the first time in the context of the development of the PABI – tool for historic buildings (Bahr, C. et al. 2009). Based on an extensive review of architectural history, Bahr was able to point out that there has been a constant change in the architectural complexity according to the main building style of the period. Architectural periods of plain and simple characteristics like the Romanesque, the Renaissance and the Classicism were followed by architectural styles which were characterized by complex and highly pretentious constructions like the Gothic period, the eras of Baroque and Rococo as well as Art Nouveau. Bahr therefore distinguished between two “Architectural Complexity Classes (ACC)”: One for the simple and plain architectural styles and the other one for the complex and pretentious ones. Bahr analyzed the maintenance expenditures of both classes and proved that the maintenance costs for the complex historical buildings (ACC II) were by far higher than the expenses for the class of the plain constructions (ACC I).

Bahr assumed that, as for historic buildings, architectural complexity would probably be significant for sacral buildings, too. The generated data was therefore analyzed and evaluated in terms of architectural complexity and its effects on continuous and extraordinary maintenance measures. The approach to define the weighting factors equals the procedure described in chapter 3.4.2

$$W_{AC,e\ (ACC\ I)} = \frac{4.26\ €/m^3\ (\text{gross volume})}{4.77\ €/m^3\ (\text{gross volume})} = 0.89$$

$$W_{AC,e\ (ACC\ II)} = \frac{5.11\ €/m^3\ (\text{gross volume})}{4.77\ €/m^3\ (\text{gross volume})} = 1.07$$

W = Weighting factor / AC = Architectural Complexity / e =extraordinary measure

While the extraordinary weighting factor for the group ACC I is 0.89, the weighting factor for the complex and pretentious buildings ACC II is a lot higher, namely 1.07. These figures clearly confirm the results of Bahr in 2009.

As mentioned above, architectural complexity is also important with a view to the continuous maintenance measures. This is why the corresponding weighting factor was calculated with the help of the continuous calculation parameter (0.41 €/m³ gross volume).

$$W_{AC,c\ (ACC\ I)} = \frac{0.64\ €/m^3\ (\text{gross volume})}{0.41\ €/m^3\ (\text{gross volume})} = 1.55$$

$$W_{AC,c\ (ACC\ II)} = \frac{0.26\ €/m^3\ (\text{gross volume})}{0.41\ €/m^3\ (\text{gross volume})} = 0.64$$

W = Weighting factor / AC = Architectural Complexity/ c =continuous measure

This result clearly differs from the result of the calculation of the extraordinary weighting factor. Here, the number calculated for the ACC I is higher than the number for the ACC II, in fact the calculated factor of 1.55 for plain constructions is more than twice as high as the factor of 0.64 for complex historical buildings. The financial burden of continuous measures compared to the volume is therefore a lot lower for complex church buildings than for plain buildings. This may seem unusual, but on closer examination it appears quite logical.

The average expenditures for the continuous maintenance measures vary from 1,299 € to 5,239 € per church and year. The arithmetic mean covers 3,223 €. These figures are related to the corresponding building volumes which vary from 1,817 m³ to 16,545 m³ with an arithmetic mean of 7,850 m³. The standard deviation of the average expenditures per church is consequently significantly smaller than the standard deviation in terms of the building volume.

Furthermore, the continuous maintenance costs perform on a comparatively constant level and do not increase proportionally to the growing size of the sacral building. This leads to the fact that the average burden for continuous expenditures for very large church buildings happens to be considerably lower than the one for smaller church buildings.

Per definition, the ACC II group includes buildings with complex and highly pretentious constructions as well as precious interior design. These characteristics can more often be found in large and representative church buildings in bigger communities than on sacral buildings in smaller communities. Since the total volume of the ACC I is therefore a lot smaller than the total volume of the ACC II, it becomes clear that the calculated factor for the ACC I is higher than the factor for the ACC II.

### 3.4.4. Building Conservation/Preservation Order

According to previous studies, the conservation of a building has a definite effect on the level of the maintenance costs (Fuchsbichler, M. 1990). The complex design and the artistic value of listed buildings in addition to the demanding reconstruction procedures involved at improving a listed building generally lead to exceeding expenditures compared to buildings that are not put under preservation order (Martin, D. et al. 2006).

This conclusion is likely to be true for sacral buildings, as well. In fact, the majority of the analyzed churches (21 churches = 70%) are listed buildings, which is why the influence of the preservation order is defined by the following calculation:

$$W_{PO,e\,(yes)} = \frac{5.04\ \text{€/m}^3\ \text{(gross volume)}}{4.77\ \text{€/m}^3\ \text{(gross volume)}} = 1.06$$

$$W_{PO,e\,(no)} = \frac{3.36\ \text{€/m}^3\ \text{(gross volume)}}{4.77\ \text{€/m}^3\ \text{(gross volume)}} = 0.71$$

W = Weighting factor / PO = Preservation Order / e =extraordinary measure

The result confirms the proportion of Martin and displays a definite additional burden for listed church buildings in terms of extraordinary maintenance measures. Obviously, the requirements imposed by the preservation authorities concerning the sophisticated and artistic handcraft skills and precious materials increase financial expenditures. Furthermore, it is often not possible to use modern and well-priced building methods and materials due to the given preservation guidelines issued by the respective authorities.

As a consequence of this additional financial burden, German federal states grant allowances for owners of listed buildings according to the federal preservation law and the predicted maintenance expenditures. Nevertheless, the development of recent years shows that the level of the allowances can vary considerably from state to state. In addition to that, the total amount of given allowances is decreasing. This is why it was absolutely necessary to implement the weighting factor of the preservation order in the new PABI – tool for sacral buildings.

## 4 CONCLUSION

The PABI – tool for sacral buildings enables church facility managers to predict the essential maintenance expenditures for a large portfolio of church buildings in a simple and transparent way. Unlike most existing calculation methods, the new PABI – tool determines continuous as well as extraordinary maintenance costs with the help of building specifications and relevant church specific influencing factors including the *building age*, the *building geometry*, the *architectural complexity* and the *preservation order*.

The building age and the building geometry have been identified to be important influencing factors on maintenance measures in numerous previous studies (Hampe, K.-H. 1986), (König, H. et al. 1988), (Bahr, C. 2008) and also proved to be important for churches. Especially the period in-between the 31st and 40th year after construction or the last extraordinary maintenance measure turned out to be very intensive in terms of financial investments.

The importance of the building geometry was also confirmed by the data analysis at hand. To determine the influence of the building geometry on maintenance measures for church buildings, the standard surface/volume relation used in geometry was substituted. A new gross floor space/gross volume relation was introduced accounting for the lack of information concerning the surface of the church buildings. Nevertheless, the results are almost equal. Churches with a complex building geometry show a significantly higher need for maintenance investments than churches with a simple building geometry.

Finally the factor of the preservation order needed to be included in the new PABI – tool. The majority of the churches in Germany are listed buildings. The complex design and the artistic value in addition to the demanding reconstruction procedures of listed buildings lead to exceeding expenditures compared to buildings that are not put under preservation order.

However other well known influencing factors on maintenance measures like the *technology level* (Kalusche, W. 2004), the *type of use /occupancy* (BMB, 1989) and the *quality of planning and construction* (Bahr, C. 2008) were not included in the new PABI – tool for different reasons: The factors either did not show a significant impact on the maintenance expenditures of church buildings (*technology level, type of use / occupancy*), or it was substituted by another factor. The basic idea of the factor *quality of planning and construction* for example was transferred in the factor named architectural complexity that was developed by Bahr in connection with old historic buildings (Bahr, C. et al. 2009).

The new PABI – tool for sacral buildings is therefore the first calculation method that was developed especially for church buildings. The annual maintenance budget can easily be determined by adding the costs of the continuous and extraordinary measures. The measures themselves are described by the product of the newly developed church specific calculation base, calculation parameter and correcting factors. The correcting factors are made up of the influencing factors described above. For each influencing factor a church specific weighting factor was determined to also take account of the building specifications of each church in the portfolio.

From now on facility managers are able to plan and provide financial resources for church maintenance right on time to carry out necessary maintenance measures before damages arise. As a result, the condition of sacral buildings will be improved providing pleasant churches for churchgoers and clergymen in future times.

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