



Horizon 2020



Nano-Cathedral

D6.3 – Report on Social and Economic impact for audience analysis

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1 Introduction

The activities related to WP6, dedicated to the analysis of socio-economic and cultural impact, began at M12 and were dedicated to the analysis of economic (Task 6.1), social (Task 6.2), and cultural impact (Task 6.3) of the newly developed consolidants and protectives for stone treatment on built heritage. The major innovation of the newly developed products consists of the use of nanomaterials and in their custom tailored design.

In all participating countries a representative sample of the population was surveyed in order to assess the audience's knowledge about nanotechnology, the weighting of the risks and benefits of nano-products, and the general attitudes toward heritage protection and the expectation of the public towards the appearance of historic monuments. These surveys provide a broad data base for answering a number of relevant questions in the economic, social and cultural impact areas.

A number of workshops were organised during the second part of the project. These workshops served as an opportunity for learning and training of participants and for clarifying open questions and discussion of issues among project members. All project workshops were evaluated by paper and pencil questionnaires. The participants were generally highly satisfied with the workshops on the whole, the presented papers, the demonstrations of application methods, and techniques of analysis .

Finally two focus groups were performed with masons and sculptors at the Cologne cathedral. This qualitative inquiry provides an in-depth insight in the work of practitioners, who might eventually apply the new nano-products.

The introduction of new tailor-made nano-products on historic monuments has the potential to alter the existing perceptions on the way historic monuments will be preserved in the future. The data base for the analysis of cultural impact consists of literature, reports from the projects sites and an online survey among visitors of the monuments.



2 Fieldwork

The social impact was analysed by measuring and assessing the perceptions and attitudes of different stakeholders: public, participants of workshops and group discussions. Since the novel Nano-Cathedral products are not introduced to the market yet, it is not possible to evaluate their definite effects. However, valuable in-depth insights on the potential of the novel products were gathered and allowed to draw predictions for their social impact. Questionnaires and interview guidelines were designed and tailored to fit the surveys, in-depth interviews and group discussions for these stakeholders. Key topics were adapted to the research interest in order to evaluate the social impact.

2.1 Audience survey on the general public

The general public of the European countries was identified as an important audience. The public opinion on nanotechnology and heritage protection forms the basis for how the novel Nano-Cathedral products will be accepted. Thus large-scale standardized online surveys were conducted in all participating countries. In preparation for the surveys questionnaires were designed and adapted to the circumstances in the respective countries. With the support of the project partners the questionnaires were translated into the language of the country. All in all N=5.599 persons (representing different socio-economic groups, e.g. by gender, age, educational level) shared their perceptions and attitudes. Due to the sample size in each country comparable and generalizable conclusions can be drawn about the acceptance of nanotechnology and the willingness to use nano-products in general and on build heritage.

Country	Field Time	N
Germany (1)	10.02.2017-15.02.2017	1.111
Austria	16.02.2017-27.02.2017	1.075
Spain	27.10.2017-13.11.2017	551
Norway	03.11.2017-20.11.2017	528
Italy	07.11.2017-16.11.2017	556
Belgium	17.11.2017-28.11.2018	547
Germany (2)	19.10.2017-27.10.2017	1.231
Σ		5.599

**Key Topics:**

- Attitudes towards new technologies
- Attitudes towards nanotechnology in relation to other new technologies
 - Knowledge about nanotechnology
 - Perceptions of risks and benefits of nanotechnology
- Evaluation of the purpose and expectations towards heritage protection
- Expectations from built heritage when visiting as a tourists
- Perceptions and expectations towards the visual appearance of the built heritage

Whenever general statements are made for all the six participating countries, the mean of the means for the countries is used. Then all countries are treated as equal even though the population differs significantly.

2.2 Survey among practitioners and end-users:

The workshops offered valuable learning and training opportunities for the expert audience but also for the interested public on the current state of the Nano-Cathedral project, present new research findings, exchange views and assessments with the audience and increased knowledge about the novel nano-products by answering questions. In addition on site demonstration and presentation of the application and performance of the newly developed nano-products were offered. The focus of these demonstrations was on the application modes and different approaches and principles in heritage preservation.

The participants consisted of a broad variety of people – including restorers/practitioners, architects, engineers, scientific researchers, members of different public administrations and organizations, students and the general public. In order to document the perceptions and attitudes of the about N=500 participants of the Nano-Cathedral workshops in Rome, Vienna, Ghent, Vitoria and Cologne and at an additional workshop in Pisa written questionnaire were handed out. In total N=175 questionnaires were returned

Location	Country	Date	N
Rome	Italy	03/03/2017	18
Vienna	Austria	21/09/2017	6
Ghent	Belgium	24/10/2017	29
Pisa	Italy	01/12/2017	53
Vitoria	Spain	26/01/2018	44
Cologne	Germany	15/03/2018	25
Σ			175

**Key topics:**

- Evaluation of the purpose and expectations towards heritage protection
- Attitudes towards new technologies; technology affinity
- Attitudes towards nanotechnology in general
 - Knowledge about nanotechnology
 - Perceptions of risks and benefits of nanotechnology
 - Acceptance of nanotechnology and willingness to use nano-products
- Attitudes towards the use of (chemical) stone treatment products (consolidants and protectives)
- Attitudes towards conventional consolidants and protectives (satisfaction, expected improvements in application and effectiveness, price development)
- Expectations towards quality, performance, safety, price and applicability of nano-products for stone consolidation and protection in comparison to conventional products
- Willingness to use the novel Nano-Cathedral products
- Satisfaction with the workshop

2.3 Group discussion with stone masons/sculptors:

Two guide-line based group discussions took place at the cathedral workshop (*Dombauhütte*) in Cologne with ten stone masons/sculptors and additional 13 practitioners were questioned in Vienna and Pisa. The participants of the group discussions had different levels of work experience (from still in training to over 40 years), different work focus (e.g. production of workpieces, restoration works, stone replacement works) and different educational and working backgrounds. While some learned the job within the cathedral workshops, others collected their first experiences in the private sector. Thus, it was not only possible to gain insights into the perceptions of people experienced in working on built heritage but also of stone masons who worked in the private sector before. Therefore the results allow also some tentative conclusions about the potential of novel nano-products outside the built heritage in the free market/for the private companies.

Location	Country	Date	N
Cologne (1)	Germany	14/03/2018	6
Cologne (2)	Germany	14/03/2018	4
Vienna	Austria	24/04/2018	10
Pisa	Italy	-	3
Σ			23

The two group discussions were moderated by Dr. Zoltan Juhasz, while two others kept the minutes. The statements were anonymized, interpreted, and summarized in the deliverable with respect to the following aspects:

- Principles in heritage protection and different approaches (preservation vs. exchange)



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- Working processes in monument preservation
- Openness towards new technologies, methods and products
- Conflict line between traditional hand craftwork and modern/innovative methods and products
- Perception of nanotechnology: knowledge, openness towards nanotechnology, estimation of risks and benefits
- Chance and potential use of nanotechnology in heritage protection

During the course of the project and after the first public surveys in Austria and Germany were already conducted, the discussion and suggestion to test people's visual perception of built heritage and the interlinked impact on tourism arose. Thus, copy tests were realized in the second wave of public surveys (in Belgium, Italy, Norway and Spain) and within the large scale audience/visitor survey in Austria (see also contribution by DBHWIEN in Task 6.3). In order to include the perception of all participating countries, the additional survey in Germany was conducted. All objectives and activities listed in the grant agreement for Work Package 6 were completed. Additionally, activities exceeding the Grant Agreement were performed: a supplementary survey was conducted in Germany (N=1.231) in order to analyze the visual perception of built monuments.



3 Results

3.1 Audience survey on the general public

In order to understand the potential impact of the introduction of novel nano-products it is necessary to look at the attitudes of the different stakeholders. Of course, it is a precondition for the successful introduction of nano stone-treatment products that the political framework allows the free development and use of the novel technology and the resulting products. National governments, the national ministry of cultural affairs, and individual politicians might have a plan for the preservation of cultural goods and therefore a direct influence on the maintenance of the most relevant and prestigious national monuments. Therefore, politics have a great impact in the form of regulations on the framework of how nanotechnology can be used.

It is in the government's interest to keep the people and the environment safe and the monuments intact. Thus, safety certificates and long-term studies that show that there are no major risks in using nano-products are important requirements for governments to authorize and support the free use of nano-products. Therefore it is important that universities and other scientific institutions research and educate on nanotechnology. Also, public financial support for research will broaden the knowledge on nanotechnology as well as the opportunities of it.

Depending on how strong the relevant regulation in the specific country is, the government can significantly influence which products will be allowed under which circumstances. If the use of nano-technological products is strongly restricted for environmental or health reasons, it is impossible to unfold the full economic potential of these novel products. Therefore support from politics and preservationists is a precondition for a successful introduction of specific nano-products for stone treatment into the market.

The decision for specific regulations is based on scientific findings but it is also influenced by the public opinion on nanotechnology and heritage protection, which shapes the context in which products such as the ones developed within the NANO-CATHEDRAL project will unfold. It is advantageous for the success of such nano-products in the market if the public is open-minded towards new technologies and, particularly towards nanotechnology. Only if in the eye of the public the benefits outweigh the risks, will there be a willingness to accept and potentially even apply nano-products on a greater scale. If, however, people are afraid of the potential risks of the new technology they change the public discussion about nano-technology influence politics and hinder the economic potential.

Although the average citizen in European countries has probably little or no contact to nano-protectives and nano-consolidants, their awareness of nanotechnology remains of major importance. The public's views on nanotechnology influence how this technology is perceived in and how the topic is framed in the public and political discussion. To gain a better picture of the population's stance, a representative sample in all participating countries was interviewed.

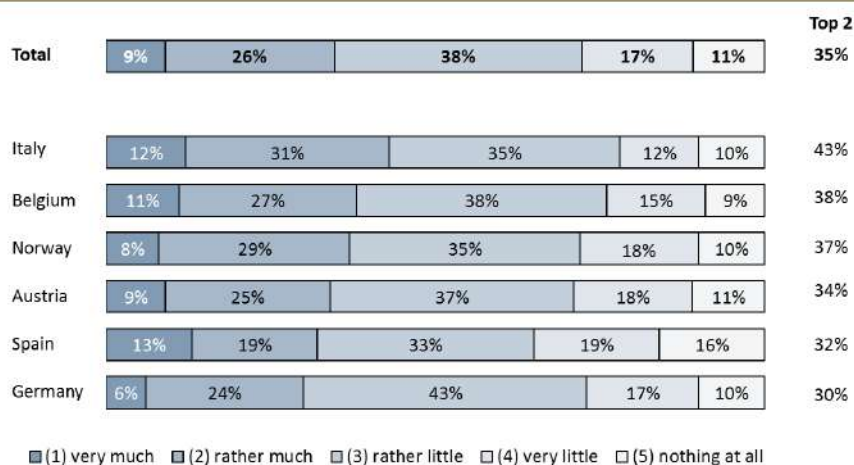


3.1.1 Awareness of and interest in nanotechnology and the willingness to use Nano-Products

Presently the awareness of nanotechnology in the participating countries is not widespread. Only 35 percent had heard or read “much” or “rather much” about this technology. An almost equal part had heard “little” and 28 percent had heard “very little” or “nothing” about nanotechnology. This means that two thirds of the respondents were not really aware of nanotechnology. There were smaller differences between the awareness in the participating countries. The range for greater awareness was between 43 percent (Italy) and 30 percent (Germany).

Since nanotechnology is not widely known, the public opinion on nanotechnology will be shaped in many cases by new research results and novel products. This is a chance for the future economic development of nano-products: if nano-products are marketed well and people start hearing more about the benefits of nanotechnology, a positive connotation with the term “nano” will be built up. Therefore risks and potentially negative effects of nano-products should be analyzed and eliminated before its introduction into the market.

How much did you hear or read about nanotechnology?



Public Survey in Six European Countries

Source: based on data gathered in Germany by BACES within the NANO-CATHEDRAL project

When asked whether the respondents would agree to the statement “nanotechnology interests me a lot” most respondents did neither agree nor disagree to this statement (40%). They might be somewhat interested in nanotechnology but would not claim to have a strong interest. On average respondents in Italy and Spain were more interested in nanotechnology than respondents in Austria, Belgium, Germany and Norway. Between 56 percent and 68 percent of the Spanish and Italian respondents, respectively, were interested in nanotechnology whereas only 35 to 45 percent of the other countries “completely” and “rather” agreed. While there seems to be some interest in nanotechnology and its development among citizens, the majority is presently not highly involved with it.



45 percent of the respondents stated that they would use products with nano-materials while around the same number indicated to still be indecisive (“neither agree nor disagree”) with the statement. This shows that a lot of people had not made up their mind about nanotechnology yet. Only a minority (3%) would outright refuse to use nano-products. When it came to being very open to using nano-products Italy prevailed over all other countries: while in the other countries’ respective numbers were between ten to twelve percent, 20 percent of the Italians stated that they completely agreed with the statement “I would use nano- products”.

3.1.2 Attitudes towards Nanotechnology and Other New Technologies

One central concept that was measured was the public’s outlook on nanotechnology in comparison to other new technologies. Respondents were asked how positive or negative they thought the effects of selected new technology would be for their life in the future. These attitudes were measured on an 11-point scale ranging from 1 “very positive effect” over 6 “neutral” to “very negative effect”. The detailed scale allows to gain a differentiated views on the evaluations all countries. In comparison to nanotechnology the respondents perceived the future effects of solar and wind energy as well as IT and computer technology more positive. On the others side the effects of robot technology, genetic engineering, and nuclear energy were on average seen as more negative than nanotechnology.

Around a fifth of the respondents stated that nanotechnology has a very positive effect, while a great number chose the middle categories (5-7) on the scale. Especially people from Austria, Belgium and Germany seemed to be indecisive. Germany, Belgium and Norway were also the countries with the lowest rate of respondents expecting nanotechnology to have a very positive effect in the future, while Spain had the highest proportion of optimistic views (37%).

In the chart below the results for in sub-groups are summarized. A 1 on the scale was put in the “very positive” category. A 2 to 5 still represent a “positive” assessment of the effects of the technology in the future. A 6 was assigned with a “neutral” point of view whereas anything between 7 and 11 was categorized as “negative”.

In general, the respondents were open-minded towards new technologies and had a positive image of the effects of the mentioned new technologies. More than half of the respondents believed that nanotechnology would have positive effects. Some respondents were even very enthusiastic and optimistic about nanotechnology and believed that its effects on our future life would be very positive (22%). Only a minority was very skeptical towards nanotechnology (7%). This is comparable to the assessment of very successful technologies that people use every day. However, when asked in a separate question whether nanotechnology made them feel uneasy, almost a quarter of respondents agreed. It is possible that some people feel a somewhat skeptical towards nanotechnology but at the same time think that its future effects will be positive or at least neutral.

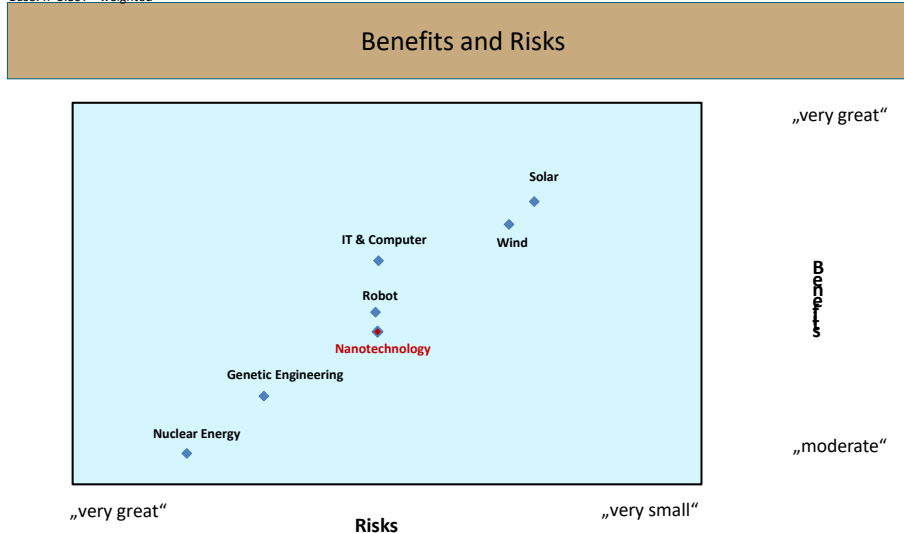
Nevertheless, nanotechnology did not belong to the technologies that were seen as particularly positive. This might stem from the unfamiliarity with nanotechnology, leading to many people not having formed an opinion yet. Some of the people who assigned nanotechnology neutral effects on the future probably have actually been unsure of what to think of nanotechnology. In social sciences this phenomenon is described as the ‘tendency towards the center’. Respondents often claim to have a neutral standpoint when they might actually not have an opinion on the topic at all. They oftentimes tick the middle category instead of the “I don’t know” check box.



The overall public opinion of nanotechnology is however positive enough not to hinder the successful introduction of nano-products into the market. Since nanotechnology is still fairly unknown there is also potential to improve the public's rating of nanotechnology.

3.1.3 Assessment of Benefits and Risks of Nanotechnology

Base: n=5.597 - weighted



Risks: Scale form (1) „very small“ to (5) „very great“ / Benefits: Scale form (3) „moderate“ to (5) „very great“

Public Survey in Six European Countries

The respondents were asked to evaluate the benefits and risks of nanotechnology on a 5-point scale running from 1 “very great” over 3 “moderate” to 5 “very small. The chart above displays the means for the benefits of the respective technology on the y-axis and the mean for the risks on the x-axis. In order to evaluate the economic opportunities of nanotechnology we also measured the evaluation of benefits and risks of reference technologies. Some technologies have not yet developed their full potential (biogenetics) while others have been limited in their use (nuclear energy) due to the public fear of potential risks.

Nanotechnology ranked in the midfield of risk and benefit assessment. The mean of ($\phi=2.94$) indicates that respondents perceive the risks of nanotechnology as moderate. Nanotechnology was perceived as less risky than biotechnology, biogenetics or nuclear energy. This is a good sign for the introduction of nano-products into the market. At the same time, renewable energies (wind and solar) were ranked as clearly less risky. Probably due to the risks of digitalization and data security issues information and computer technology was seen as somewhat more risky than nanotechnology. Due to the similar risk assessment of these technologies one might expect that since many people use computers without great hesitation on an everyday basis, they would also accept nano-products.

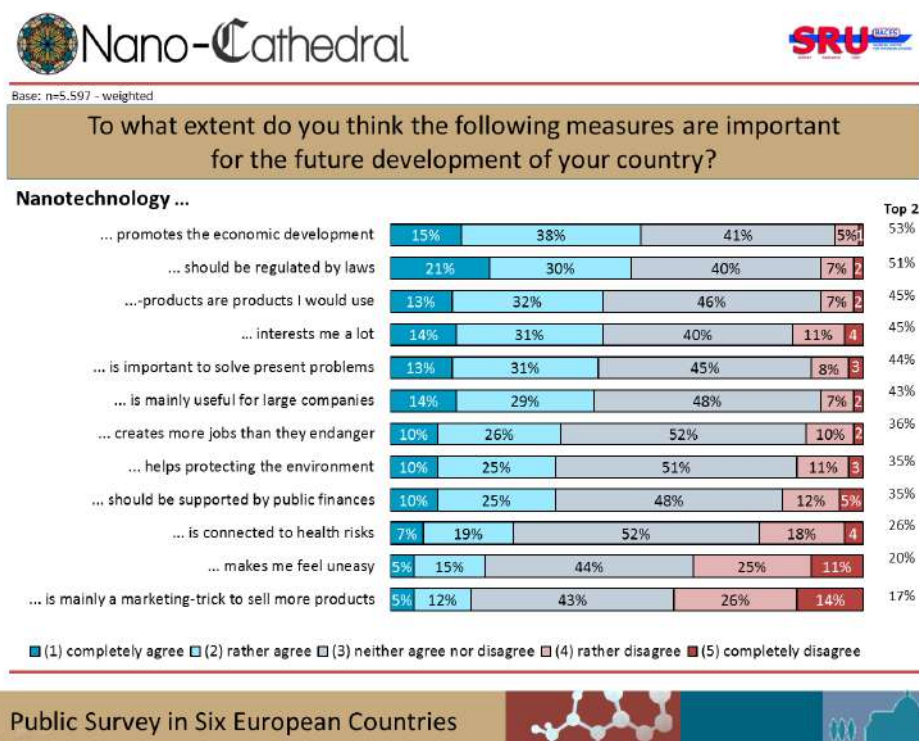
Since the respondents did not were not overly fearful of the risks of nanotechnology, it is unlikely that the public would block the introduction and use of nano-products or refuse to buy products with nano-particles. However, ensuring the safety of products seemed to be an important precondition



for people to accept nano-products, to minimize their fears and hence for nano-products to be successful.

The mean of ($\bar{x}=2,20$) indicates that respondents averagely perceived the benefits of nanotechnology as rather big. On average, biogenetics, biotechnology and nuclear energy were seen as less beneficial than nanotechnology. Considering how high for instance the economic relevance of nuclear energy is, people seemed to be very optimistic about the future development and importance of nanotechnology.

In order to gain additional insights into how respondents came to their evaluation of nanotechnology's benefits and risks, further items concerning the impact of nanotechnology on health, the economy, the job market, the environment were included in the questionnaire.



Source: based on data gathered in Germany by BACES within the NANO-CATHEDRAL project

More than half of the respondents believed that nanotechnology would benefit the economic development in their country (53%). An almost equal part was still unsure about nanotechnology's economic impact (41%) however only a minority doubted that nanotechnology would profit the economy (6%). Moreover, almost half of the respondents believed that nanotechnology will help to solve a wide range of current problems. So they were not only optimistic about nanotechnology's impacts on the economy but also trusted that it might open up new potential solutions for other contemporary problems.

Since the introduction of new technologies always changes the working world, the public's view on nanotechnology's impact on the job market was measured as well. Again, most respondents partly agreed, partly disagreed with the statement that nanotechnology creates more jobs than is endangers (52%). 13 percent of the respondents believed that nanotechnology would endanger more jobs than it creates. Nevertheless, more than a third did agree to the statement that



nanotechnology would have a positive impact on the job market and create more jobs than it would endanger (36%).

More than twice as many respondents believed that nanotechnology might benefit the environment and help to limit environmental damage (35%), while only 15% doubted. The rest was indecisive about the impact on nanotechnology on the environment. However, the results show that respondents were not too worried that nanotechnology might have a negative impact on the environment, since only three percent stated that nanotechnology would not benefit the environment at all.

One point that is central when wanting to measure the economic potential of nano-products is the public's assessment of health risks of nanotechnology. If people fear that using nano-products might be harmful to their health they avoid buying or using them. Most of the people partly agreed and partly disagreed with the statement of nanotechnology being connected to health risks (52%). This might have to do with their unfamiliarity with the novel technology. About a quarter of respondents did not fear health risks at all (23%), while an almost equal part believed that nanotechnology was connected to risks for their health (26%). It is essential to ensure the safety of the products developed within the NANO-CATHEDRAL and communicated to the public that they are not connected to health risks.

Considering the potential risks it is understandable that every other respondent (51%) agreed that the use of nanotechnology should be regulated through laws. At the same time, respondents had varying standpoints on whether nanotechnology should be supported by public finances. Almost half of the respondents were unsure whether to agree or disagree with it (total: 48%), but more agreed to public financial support (35%), than disagreed with this statement (17%).

3.1.4 Tourists

Tourists or even citizens of the city where the monument is located will be potentially affected by the application of nano-products, therefore they can be considered as indirect end-users. This is why their possible impact on the economic success of nano-products was evaluated as well.

The attractiveness of a city can increase through the improved appearance and condition of relevant monuments and tourist attractions when using nano-products. Also, due to the longevity of nano-products, the monuments will have to be restored less frequently. This enhances the attractiveness of monuments and limit costs for restoration. If tourist numbers and sales through tourists increase, positive feedback is given, and the impact on the citizen's living satisfaction is positive, the opinion of these target groups can significantly influence how successful the application of nano-products will be seen and therefore, how content the buyer will be with the product.

Should there be a lack of recognition of the improved condition of the monument by tourists and citizens, the novel technology will not develop its full economic potential because buyers might not see the benefits of repurchasing or recommending the products. In the worst case, tourists might visit the monument less regularly because the "authentic, ancient look" might be preferred over the clean look of the heritage building or because they fear risks connected to the use of nanotechnology. However, it is unlikely that tourists would hold back from visiting monuments due to the use of nano-products since only very few will know and in addition only a minority fears

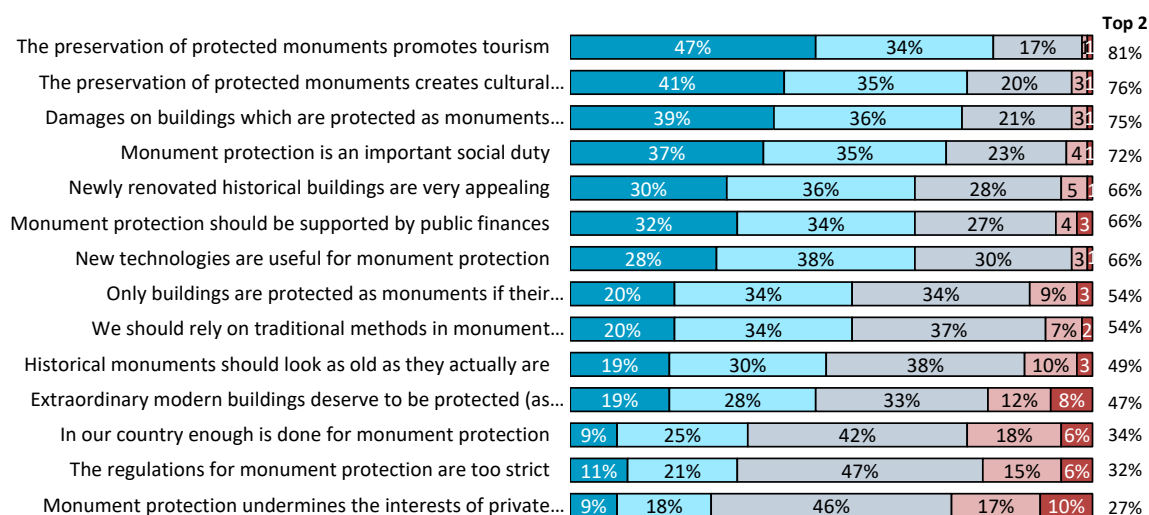


health risks or felt uneasy about nanotechnology. Since these findings are only based on the public opinion, definite conclusions cannot be drawn yet.

Tourists might learn about the nano-products when visiting monuments which were treated with the nano-protectives and -consolidants. They would only find out about the use of nanotechnology for monument protection if the products were applied during the time of their visit, if there was a sign or brochure referring to the nano-products or if the press or tourist information picked up on the topic and communicated it to the tourists and citizens.

Base: n=5.597 - weighted

To what extent do you agree with the following statements regarding monument protection?



■ (1) completely agree ■ (2) rather agree ■ (3) neither agree nor disagree ■ (4) rather disagree ■ (5) completely disagree

Public Survey in Six European Countries

In the public survey respondents were asked about the effects of monument preservation on tourism. A majority believed that the preservation of protected monuments is an important societal task (72%) and that it promotes tourism (81%). A similarly large proportion also agreed that the preservation and protection of monuments creates cultural identity (76%). Preservation means keeping the monuments in good condition and damage needs to be cured (75%). However, about half of the respondents (49%) believed that a historic building should also look its age. Maintaining the “authentic, ancient look” seems to be important when restoring monuments through the application of the novel nano stone-treatment products. Respondents were also asked how important factors concerning heritage protection (like the condition of the monument, clean external fronts, repair of damages accrued by the age of the monument, reconstruction of the previous state of the monument) were to them, compared to other factors (guided tours, information flyers, souvenir booth, visitor numbers...) when visiting a monument.



Most of these aspects were important to the respondents when visiting a monument. Some of those factors played an important role: for example meaningful flyers (64%) and competently guided tours (62%). The information that a monument was treated with nano-products could therefore reach a lot of tourists if it was mentioned in information flyers and by tourist guides. Other aspects like a limited number of visitors (33%), the access to restaurants (36%) and souvenir booths (16%) were less important to the respondents. In contrast, the condition of the building (66%), the reconstruction of the building (61%), and a clean external front (55%) were important to a vast majority of respondents.

3.1.5 Visual Perception of Monuments

Three quarters of the respondents agreed that the clean façade of the historic building should be preserved as long as possible through the application of protectives. The majority also believed a clean façade to enhance the attraction of the building for tourists, as the majority believed that historic monuments (68%) were less attractive to tourists when soiled or damaged. 63 percent also was convinced that a clean façade to be enhancing the building's cultural value. Only a small percentage stated that they found the old condition of the building more appealing than its new, clean condition (12%). On the issue of a clean façade looking less authentic than its old condition the opinions were more divided: 36 percent agreed, 33 percent disagreed and 31 percent neither agreed nor disagreed.



Base: n=5.597 - weighted

Visual Perception – Historic Monuments

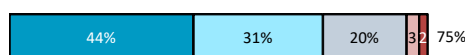
Before



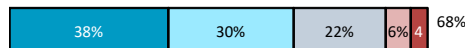
The cleaned facade of the historic building ...

Top 2

... should be preserved as long as possible through the application of protectives.



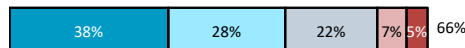
... enhances the attraction of the building for tourists.



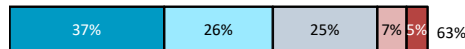
After



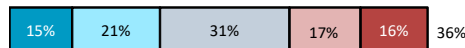
... I find more appealing than the old condition of the building.



... enhances the cultural value of the building.



... looks less authentic than the old condition of the building.



■ (1) completely agree ■ (2) rather agree ■ (3) neither agree nor disagree ■ (4) rather disagree ■ (5) completely disagree

Public Survey in Six European Countries



The sizeable majority of the respondents believed that damaged sculptures should be restored to recreate their old condition and also found clean sculptures to be more attractive than those that had not been cleaned yet (60%). 58 percent also found the contrast between the cleaned and uncleaned sculptures irritating. On the statement of the uncleaned sculptures not looking more authentic, opinions were divided, with a third choosing to neither agree nor disagree. Only 22% agreed that sculptures should be replaced with copies to ensure their long-term preservation.



The vast majority (82%) stated that they wanted the original building material maintained as far as possible. However 53 percent also stated that damaged parts may be replaced by new material, which to a certain extent contradict the previous statement. When asked whether historic monuments should not be entirely cleaned to maintain the impression of an old/historic building, opinions divided again on the matter. However, there was a slight tendency towards the cleanliness of the building not being related to it seeming modern or historic.

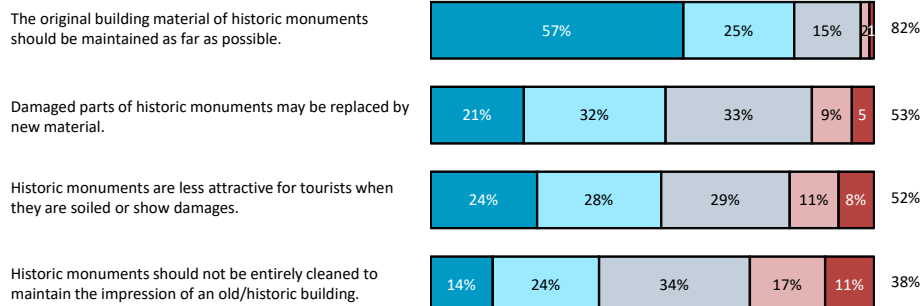
When comparing modern and historic buildings, there were only a small percentage of people that believed modern monuments to not be as attractive to tourists as historic buildings. Concerning modern monuments there was a consensus about them being less attractive to tourists when soiled or damaged, as well as that they should always look “as good as new”. Concerning historic monuments and historic sculptures the majority did also consider soiling and damages to be rather unappealing. Those who believed monument protection to be of high importance thought even more frequently that soiling and damages on historic or modern buildings are unappealing. Around 70 to 80 percent of those who found soiling and damages unattractive were people who found monument protection very important, while the numbers of those who believed monument protection to be of low or medium importance were between 55 to 65 percent.

Base: n=5.597 - weighted

Visual Perception – Historic Monuments

To what extent do you agree with the following statements?

Top 2



(1) completely agree (2) rather agree (3) neither agree nor disagree (4) rather disagree (5) completely disagree





3.2 Survey on Participants of Nano-Cathedral Public Workshops

Within the Nano-Cathedral project the perspective of all stakeholders that the project might have had an impact on has been explored. The participants of the workshops were an important target group for the following reasons:

Firstly, within the workshop, they heard about the current project status, the latest findings and research results as well as about the evaluations of the project partners. Therefore, their perceptions of the project gave an unbiased view from an external perspective. Through sharing their views, the participants enabled the project partners a constant evaluation and continuous improvement process over the course of the project. This again helped to create a larger positive impact by making adjustments.

Secondly, the majority of the participants were practitioners or restorers who were, directly, handling stone treatment products or making the decisions concerning the need and choice of products in their work routine. Thus, they will be directly affected by any new methodological refinement and product developments. Therefore, the broader introduction and spreading of nano-products for stone treatment will impact their working processes and choices of products.

Thirdly the participants were people who were interested and involved enough with the Nano-Cathedral project and the novel nano-products to attend a workshop over the course of a whole or even two days. Thus, they could also create a positive impact: if the information and data shared in the public workshops convinced them of the Nano-Cathedral project, they were potential first-hand buyers when the products were introduced to the market or could spread knowledge and awareness of the novel stone treatment products and the connected services among their colleagues involved in heritage protection. The interested public increased therefore not only the impact of the Nano-Cathedral project's reputation in the public and among professionals but also affected the acceptance of the novel products would be accepted on the market and therefore, how economically successful they would be.

3.2.1 Implementation of the survey with practitioners

The surveys were conducted at the public workshop in six different cities representing five different participating countries. The workshops were open to the interested public and attracted professionals involved in restoration, architecture, construction, sciences and more.

The first survey was conducted at the workshop in Rome on the 3rd of March 2017 with N=18 completed questionnaires. This survey functioned as a trial for the following surveys. After the Rome Workshop, the written questionnaire was improved and further extended in order to gather more in-depth information.

This improved version functioned as a basis for the remaining five workshops. Slight country-specific adjustments were made and some questions were added since their relevance showed itself over the course of the project.

For Vienna and Cologne the BACES team created a German version of the survey. For Ghent, Pisa and Vitoria the project partners in the respective countries (Ignace Roelens, Simona Raneri and Pablo Garcia) assumed the responsibility for the translation into Flemish, Italian and Spanish. At the workshops all participants – excluding the Nano-Cathedral project partners – were handed a questionnaire when registering for the workshop.



They were reminded to fill out the survey over the course of the workshop and hand them back to the BACES team or the workshop organizers. In Vitoria particularly, many participants handed back the questionnaire since they were given the incentive to receive a certificate of attendance in return which was very beneficial for the data exploitation.

The topics ranged from the evaluation of the workshops, over to the perception of nanotechnology and heritage protection to more specific topics such as the assessment of conventional and nano products for stone consolidation and protection. This data allowed to draw valuable findings on the potential impact of the products on the working processes and approaches in heritage protection but also on the market for stone treatment products.

3.2.2 Public workshops in Vienna, Ghent, Pisa, Vitoria and Cologne

At the public workshops in Vienna, Ghent, Pisa, Vitoria and Cologne 157 practitioners filled out the standardized written questionnaires and gave insight into their perceptions and evaluations. The workshop “Arte è Scienza”, held in Pisa, constitutes an exception since it was not an official public workshop organized within the Nano-Cathedral project. However, it was dedicated to the European project Nano-Cathedral, which is why the opportunity was taken to include an even bigger audience in the impact analysis.

The sample size of $n=157$ allowed to analyze the data quantitatively. However, the sample was not randomly selected and not big enough to draw conclusions which could be generalized for all practitioners from a certain country or with a certain socio-demographic background. They surely can give insights into trends but in the following will only be interpreted with regards to the practitioners who attended the workshops and noted down their attitudes in the survey.

3.2.2.1 Socio-Demographics

Out of the 157 participants of the workshops in Vienna, Ghent, Pisa, Vitoria and Cologne who filled out the questionnaire, 57 percent were female and 43 percent male. Especially, young women took part and filled out the questionnaire: 38% of females were younger than 30 years old, compared to 26% of men. Correspondingly, 60 percent of the practitioners over 45 were male and only 40 percent female. Some of the practitioners had only started their career and had no more than three years of work experience (26%), others had been in the job for four to ten years (22%), while others had collected eleven to twenty (25%) or even over twenty years of work experience (27%). The respondents from the workshops in Vienna and Cologne had the most work experience, while many participants of the workshop in Pisa were still students with little to no experience. Thus, a broad variety of practitioners and members of the involved audience was represented.

3.2.2.2 Learning and training opportunities

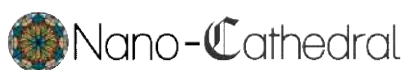
The public Nano-Cathedral workshops served as valuable learning and training opportunities for the expert audience but also for the interested public. The audience consisted of a broad variety of people – including restorers/practitioners, architects, engineers, scientific researchers, members of administrative and organizational institutions, students and the broader public.

The training workshops as a platform offered the great opportunity to educate and update the participants on the current state of the project, demonstrate results and findings, exchange views and assessments with the audience and increase knowledge about the project and the novel nano-products by targeting questions of the attendees of all ages.



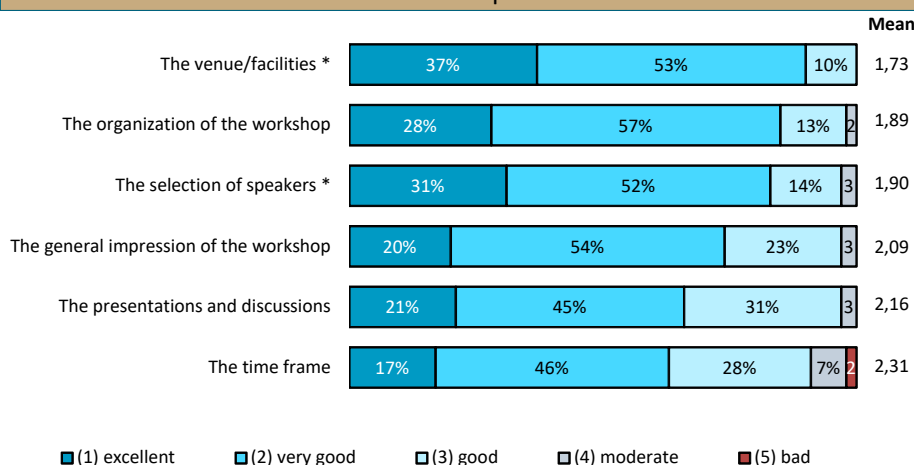
The novel approach of the handling of highly specialized products was brought to general knowledge through on-site demonstration of application routines and procedures and presentation of the performance of the nano-products. This also offered the opportunity to involve and inform the attendees as well as to discuss findings and exchange views (for instance on the application modes and different approaches and principles in heritage preservation). The exchange between project partners from all participating European countries and the scientific community, practitioners and the interested public showed that the value of contributing towards the sustainable protection of built heritage goes beyond simply the economic aspect.

During the workshops the participants already showed high satisfaction with the presented papers, the demonstrations of application methods, and analysis techniques. In order to evaluate and quantify how the participants perceived the workshop, they were asked to rate their general impression of the workshop, the organization of the workshop, the venue and the facilities, the time frame and the selection of speakers. In general, the workshop participants in Cologne, Ghent, Pisa, Vienna and Vitoria were very satisfied with the offered learning and training opportunities.



Base: n=157 - unweighted

How would you rate the following aspects around the Nano-Cathedral workshop?



* Results are only based on surveys conducted at workshops in Vienna and Cologne

Survey at Public Workshops - Practitioners



On average, the general impression of all workshops was described as “very good”. Thereby, the workshops in Cologne ($\bar{x}=1,83$) and Vitoria ($\bar{x}=1,95$) were rated the best. Two aspects – the organizational dimension (venue, time frame) and the content-related dimension (presentations, discussions, speakers) – were covered in more detail.

The organization of the workshop was also averagely rated as “very good” whereas the older participants rated it even better than the younger ones. In Cologne and Vienna, the vast majority of participants rated the facilities and the venue where the workshop took place as “excellent” or “very good” (92% in Cologne; 83% in Vienna). Similarly, the time frame was generally considered appropriate: on average, it was rated “very good”. Only the younger participants were a bit less



satisfied and averagely rated the time frame as “good”. Hence, it was possible to present the Nano-Cathedral project professional in a very good organizational frame to the targeted audience.

The content-related aspects also convinced almost all workshop participants. The presentations and discussions of all workshops convinced the participants: averagely, they rated them to be “very good”. In Vitoria and Pisa, around a quarter even considered the presentations and discussions to be “excellent” (28% in Vitoria; 23% in Pisa). Consistent with that the vast majority of participants rated the selection of speakers in Cologne and Vienna as “very good” or even “excellent” (83% in Cologne; 80% in Vienna). Thus, the targeted audience was satisfied with the way the content was shared and presented. Through the good selection of speakers and lively discussions, the participants were able to exploit the full potential of the offered learning and training opportunities. These good ratings prove that it was possible to reach, involve and convince the interested audience of the performance achieved within the Nano-Cathedral project.

3.2.2.3 Technology affinity

The participants of the workshops saw themselves as rather technology friendly: on average they rated themselves a 2.88 on the eleven-point-scale running from 1 “very positive feeling towards new technologies” to 11 “very negative feeling towards new technologies”. At the same time, they believed their fellow practitioners to feel less enthusiastic but still positive towards new technologies: on average, they rated them a 3.79 on the detailed technology-friendliness scale.

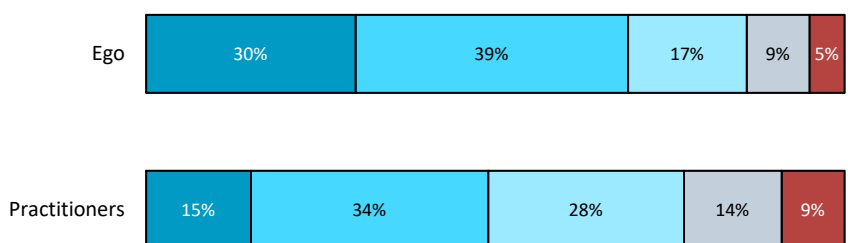
In order to get a better overview of the information contained in the data, the eleven-point technology-friendliness scale was narrowed down to five categories: everyone who placed themselves on the positive extreme of the scale (1 “very positive”) was classified as “enthusiastic towards new technologies”. A 2 or 3 on the scale was summarized under “positive towards new technologies”, a 4 or 5 under “rather positive towards new technologies”, a 6 under “neutral” and everything between 7 and 11 under “negative towards new technologies”.



Base: n=157 - weighted

Technology Affinity – Groups

How positive or negative do you personally feel towards new technologies?



■ (1) enthusiastic ■ (2-3) positive ■ (4-5) rather positive ■ (6) neutral ■ (7-11) negative





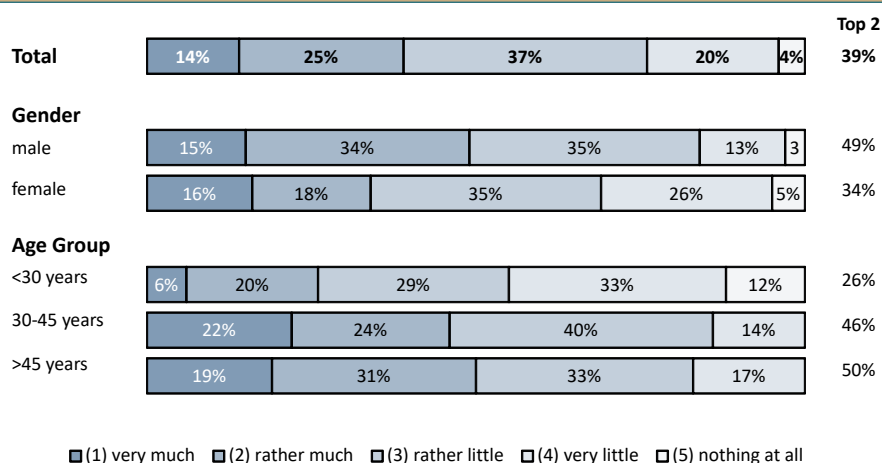
The vast majority of the participants placed themselves on the positive side of a scale (86%). Out of these, almost a third felt enthusiastic about new technologies. About nine percent felt neutral about new technologies and only five percent took a negative stance. Thus, the restorers were definitely open towards technological innovations. Interestingly, they estimated that their fellow restorers/practitioners were averagely less technology-friendly than themselves. All in all, the vast majority of questioned practitioners felt friendly towards new technologies, thus, a basic openness for the introduction of novel products and methods can be assumed.

3.2.2.4 Nanotechnology

Subsequently, the practitioners were asked some questions about their perception of nanotechnology in general. Topics reaching from their knowledge, acceptance and evaluation of risks and benefits were targeted.

Base: n=157 - unweighted

How much did you hear or read about nanotechnology?



Survey at Public Workshops - Practitioners



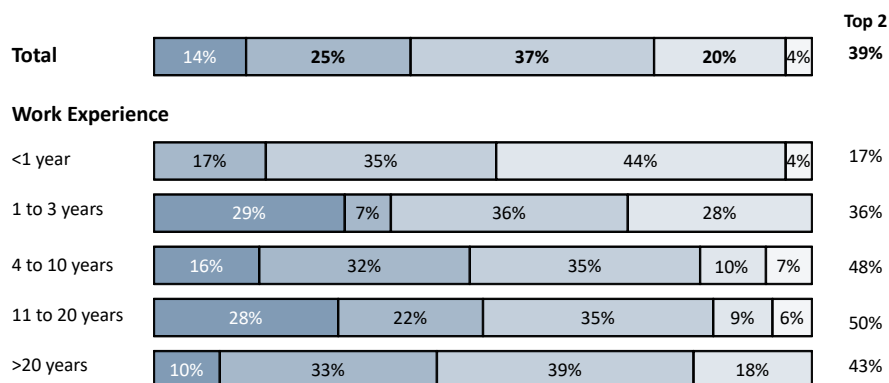
Knowledge

Almost all participants had heard or read something (reaching from “very much” to “very little”) about nanotechnology before (96%). About every sixth participant had already heard or read “very much” about the novel technology. At the same time, most claimed that they had heard or read “rather little” about nanotechnology (37%). 41 percent of male respondents had heard or read “very much” or “rather much” about nanotechnology while it was only 28 percent of the female respondents. Remarkably, younger participants of the workshops (under 30 years) had been exposed less to information about nanotechnology than older ones.



Base: n=157 - unweighted

How much did you hear or read about nanotechnology?



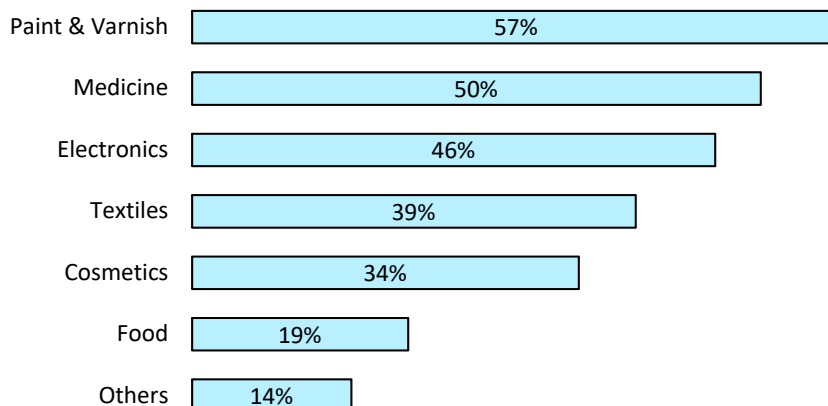
☐ (1) very much
 ☐ (2) rather much
 ☐ (3) rather little
 ☐ (4) very little
 ☐ (5) nothing at all

Survey at Public Workshops - Practitioners



Base: n=157 - unweighted

Which areas of application for nanotechnology do you know?



Survey at Public Workshops - Practitioners



Those with a work experience of less than three years were not very aware of the technology as well, while again almost half of those with more than three years of work experience had heard or read rather to very much about nanotechnology. It can be concluded that the younger generations and those with little work experience are not very aware of nanotechnology leaving the possibility to target the older and more experienced practitioners to buy the technology and to educate the younger ones more about it.



When asked which areas of application of nanotechnology they knew, the majority of practitioners knew that nanotechnology was used in paint and varnishes (58%). This might have been the case because this field of application is quite close to their field of work. Many had also heard about nanotechnology being used in medicine and electronics, textiles and cosmetics and a few knew about nanotechnology being used within food.

3.2.2.5 Attitudes of Practitioners



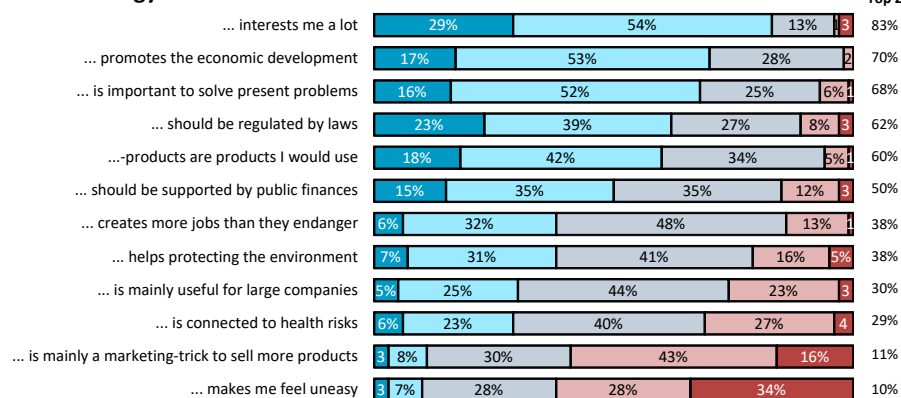
Nano-Cathedral



Base: n=157 - unweighted

To what extent do you agree with the following statement?

Nanotechnology ...



■ (1) completely agree ■ (2) rather agree ■ (3) neither agree nor disagree ■ (4) rather disagree ■ (5) completely disagree

Survey at Public Workshops - Practitioners



The majority of the questioned practitioners were interested in nanotechnology which was not surprising as they were attending a workshop covering the application of nanotechnology in their working sphere. The practitioners showed a rather high acceptance of nano-products: 60 percent would use nano-products, a third had not made up their mind yet and only six percent stated that they would (rather) not use nano-products. Only very few felt uneasy about nanotechnology. This data suggests that they are positive towards nanotechnology in general and would be open towards using nano-products which is a great precondition for the introduction of the Nano-Cathedral products.

Over two thirds of the respondents agreed with the statement that nanotechnology was important to solve present problems (68%). On average, the practitioners believed that nanotechnology's overall benefits were rather great ($\bar{X}=2.16$) while the risks were perceived as moderate ($\bar{X}=2.93$). The practitioners especially saw benefits for the economic development. Thus, the practitioners believed in the positive economic impact of nanotechnology. Also, more people agreed with the statement that nanotechnology would create more jobs than it would endanger them (38%). Only 14% disagreed with that statement. However, almost half were still unsure about nanotechnology's impact on the job market. Especially for the people working in a field where novel nano-products were being introduced, it was essential that they did not have to fear to lose their jobs. Similarly,

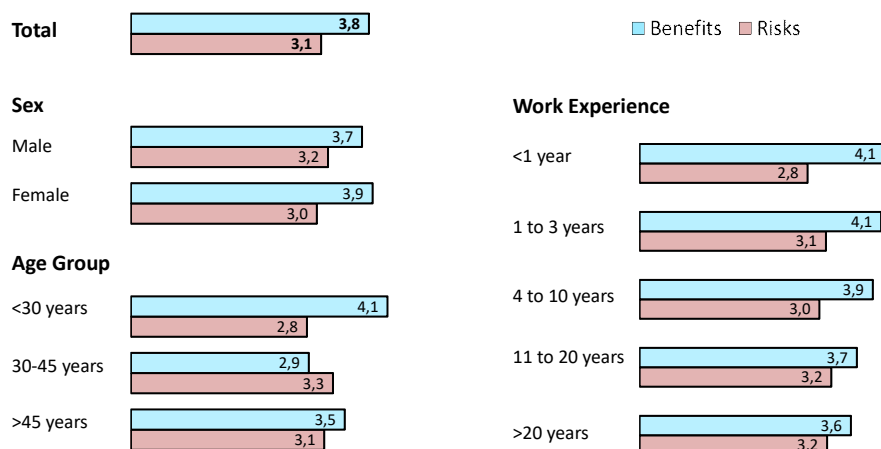


some practitioners believed in the positive impact nanotechnology could have on environmental protection (38%) while others disagreed (21%). A considerable number of practitioners believed that nanotechnology was connected with health risks (29%). Even though even more practitioners did not see risks for the health (31%), it was essential to take people's fear of potentially negative effects of nanotechnology on people's health.



Base: n=157 - unweighted

How do you evaluate the benefits / risks of nanotechnology?



Survey at Public Workshops - Practitioners



Even though nanotechnology's benefits seemed to outweigh its risks according to the questioned practitioners' perceptions, the majority agreed that the use of nanotechnology should be regulated by laws (62%). At the same time, half of all respondents believed that the government should not only regulate but also financially support nanotechnology.

All in all, the practitioners' attitudes towards nanotechnology were rather positive: they were interested in the novel technology, showed a rather high acceptance of the use of nano-products and in general, they perceived the benefits of nanotechnology to outweigh its risks. Also, many practitioners chose the middle category (*neither agree nor disagree*) when asked about their attitudes towards nanotechnology. This indicates that many were still indecisive in their evaluation of some issues around nanotechnology. Convincing these people will be essential when trying to maximize nanotechnology's potential.

Overall, female respondents evaluated the benefits of nanotechnology higher and its risks lower than the male respondents: while three quarters of the female respondents rated the benefits of nanotechnology "very" or "rather great", it was only 64 percent of the males and while only 22 percent females rated the risks to be "very" or "rather great", it was 34 percent of the males. Concerning age and work experience it can be said that the younger generation, as well as those with less work experience evaluated nanotechnology to have many benefits and did not consider it to be very risky.



While the majority of the older generation and those with more work experience did state that they believed nanotechnology to have many benefits, they were still quite wary of its risks.

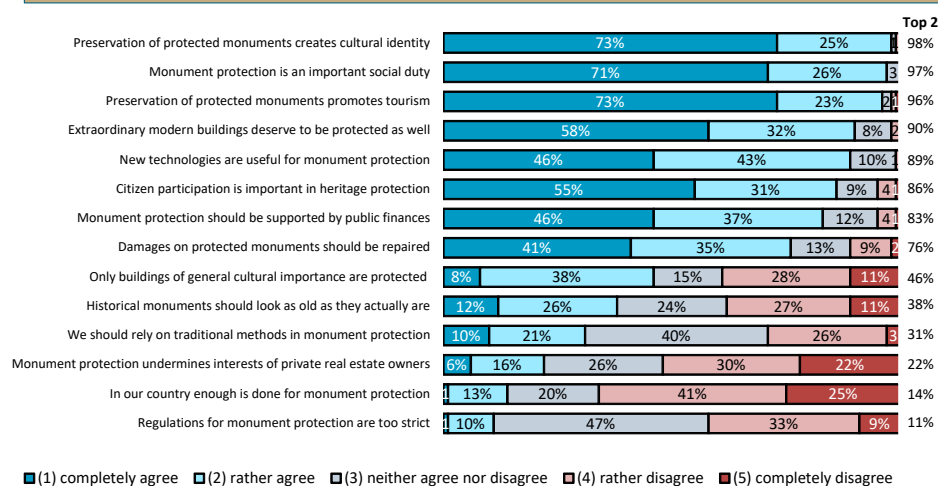
3.2.2.6 Heritage Protection

Almost all participants were highly involved in heritage protection – whether it as students, architects, restorers or simply as an interested part of the public. Consequently, they were confronted with issues around this topic on a daily basis which is why it is highly relevant to include their perceptions of monument protection in order to measure the social impact.



Base: n=157 - unweighted

To what extent do you agree with the following statements regarding monument protection?



Survey at Public Workshops - Practitioners

There was a consensus among the practitioners that monument protection is an important social duty (97% agree). Since most of the workshop participants committed their career to this purpose, this finding is not surprising. They also believed that preserving protected monuments created cultural identity (98%). In order to involve the public, most believed that citizen participation was relevant in the field of heritage protection (86%). Since they saw the high relevance of monument protection, most did not agree that enough was done for monument protection in their respective countries yet (66%). Therefore, most were in favor of monument protection to be supported by public finances (83%).

The majority did not see monument protection undermining the interests of private real-estate owners (52%). Nevertheless, there seemed to be country-specific differences: while even more respondents in Vitoria and Pisa were convinced that there was no conflict between private real-estate owners and monument protection (Vitoria: 73%; Pisa: 64%), two thirds of respondents in Cologne and Vienna saw a conflict of interest. This might have been due to different country-specific regulations. In fact, only very few believed regulations to be too strict in monument protection (11%). While there was a rather high uncertainty on that issue (47% are indecisive), the greater part believed that monument protection should not be less regulated (42%).



While the vast majority of the workshop participants agreed that monument protection did and should play a predominant role, there were slightly more disparities on which and in which way built heritage should be protected and treated. Not all believed that only buildings that are of general cultural importance were protected as monuments (39%). Here, a generational gap became visible: while most respondents aged up to 45 believe that not all buildings that were protected as monuments were of general cultural importance, most over the age of 45 agreed to the statement that buildings were only protected if their preservation was of general cultural importance (67%). Similarly, some did not categorically agree that damages on protected buildings should be repaired (11%). Especially, the visual ideal divided the workshop participants: while 38 percent agreed that historic monuments should look as old as they actually were, just as many disagreed (39%). Whilst most participants of the workshops in Cologne and Vienna agreed that a building should have patina and look according to its historic age (64% in Cologne and 50% in Vienna agreed), the majority of respondents in Vitoria (61%) and Ghent (54%) disagreed. While even within the Nano-Cathedral project the share of historic built heritage (the cathedrals in Cologne, Ghent, Pisa, Vienna, Vitoria) outweighed the modern monuments (the Oslo Opera House), the respondents were in high agreement that extraordinary modern buildings deserved to be protected as monuments as well (90%). Female participants felt even stronger about this point than their male colleagues (96% of women and 80% of men agreed).

Even though the workshop audience was highly involved with the protection of built heritage, the approaches to reach this goal varied. One conflicting line that will be targeted later on in this report, as well, is the decision whether new technologies and methods such as nano-products for stone consolidation and protection should be applied on the heritage buildings or whether one should rely on the old approaches to be safe. Here, the practitioners had ambivalent approaches: many believed that new technologies could be useful for monument protection (89%) while almost none disagreed (1%). At the same time about a third of the respondents stated that one should rely on traditional methods in monument protection (31%). Almost as many believed that we should not fall back on only the old methods (29%). Altogether, it shows that many were divided on this topic since most stated that they were indecisive on this issue (40%).

The workshop participants were convinced that the preservation of protected monuments promoted tourism (96%). Reaching such a high agreement amongst people who were involved with the topic is a strong indicator that heritage protection attracts visitors and tourists and therefore, that a substantial external impact and economic potential lies within the protection of prominent built heritage.

Subsequent to the block of questions targeting attitudes towards new technologies in general, nanotechnology in specific and heritage protection, only the participants who had actually worked with the stone treatment products for consolidation and protection before, were asked to answer some more specific questions where some experience and expertise was required. To filter out everyone who did not have experience with using products yet, the following statement was printed on the questionnaire before the before specified block of questions:

"In case you have already used consolidants or protectives for stone conservation, please reply to the following questions. If not proceed to the last page."



All chapters below (Chemical Treatments, Consolidants and Protectives and Nano-Products for Stone Consolidation and Protection) are based on the data gathered from practitioners who had had experience in working with stone treatment products.

3.2.2.7 Chemical Treatments

In order for the nano-products to be accepted, the general openness towards the application of chemical stone treatment products was a premise. The workshop participants, who had already worked with consolidants and protectives before, were asked whether they believed that the application of chemical products was essential for the consolidation and protection of stones. The data suggests that there was no broad agreeance on this issue.



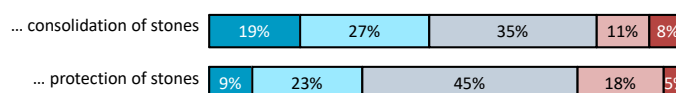
Nano-Cathedral



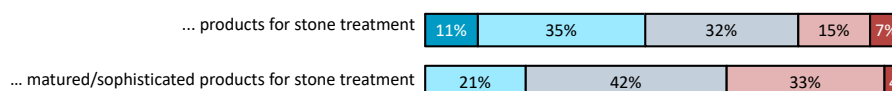
Base: n=157 - unweighted

Stone Treatment Products

The application of chemical products is essential for the ...



The industry offers a broad range of ...



■ (1) completely agree ■ (2) rather agree ■ (3) neither agree nor disagree ■ (4) rather disagree ■ (5) completely disagree

Survey at Public Workshops - Practitioners

Many practitioners claimed that they “neither agree[d] nor disagree[d]” with that statement (36% for consolidants and 45% for protectives). Also, a significant share of the practitioners agreed, to some extent, that the application of chemical products was essential for the consolidation (46%) and protection (32%) of stones. Especially male and younger practitioners took that position. On the other hand, a not inconsiderable share of practitioners (rather or completely) disagreed that chemical treatments were essential for stone protection (24%) and consolidation (19%). While not one male practitioner completely disagreed that chemical treatments were essential, several female respondents were in strong disagreement with that statement: 14 percent completely disagreed that chemicals were essential for the consolidation and nine that they were for the protection of stones.

These figures indicate that practitioners were more convinced of the necessity to use chemicals for the consolidation than for the protection of stones. For one thing, this could lead to the conclusion that the impact created by nano-consolidants is higher than by protectives because people see chemical products as more essential for stone consolidation. But at the second glance, this also offers the window of opportunity for the Nano-Cathedral products to convince skeptical



practitioners of the advantages and the superiority of nano-protectives over conventional ones, to pressure into a market niche and therefore to create a larger (economic) impact.

This is supported by the fact that a lot practitioners believed that the industry offered a (rather) broad range of stone treatment products (46%) but did not agree that these products, currently available on the market, were also matured/sophisticated (38%)*. Especially, female and young restorers were not convinced of the maturity of currently available stone treatment products. Also, over a fifth of respondents did not believe the industry to offer a broad, let alone sophisticated, product range. Accordingly, convincing all, but in particular the young, future practitioners that Nano-Cathedral products are better developed could significantly increase their impact.

**Note: This question was only included in the questionnaire for the workshops in Vienna, Vitoria and Cologne. Thus, the data analyzed above, only refers to the 24 practitioners who attended one of these three events and responded to this question.*

3.2.2.8 Consolidants and Protectives

In order to understand the market and the practitioners' decision-making processes when deciding on how to treat the stone, it is essential to understand the choices the potential end-users of the market currently have. Thus, the practitioners were asked to rate currently available consolidants and protectives. This will also give valuable insights into the performance of the conventional products that the novel Nano-Cathedral stone treatment products will compete with.

Satisfaction

For the evaluation of the potential of the novel Nano-Cathedral products, it is essential to understand how practitioners like the products that are currently available. If they are satisfied with the available conventional products in every aspect, they would not have any motivation to swap this satisfactory product for a new nano-product that they do not know yet. Therefore, it is essential that practitioners see room for improvement in the performance and characteristics of conventional products. This would allow the Nano-Cathedral products to occupy that market niche.

Most practitioners were neither satisfied nor unsatisfied with the currently available consolidants (52%; $\bar{x}=2.74$) and protectives (51%; $\bar{x}=3.07$). While the practitioners who were to some degree satisfied with the available consolidants (34%) outweighed the dissatisfied ones (13%), more practitioners were unsatisfied (28%) than satisfied (21%) with the protectives. The younger practitioners and the ones with less work experience were more satisfied than the average respondent. In summary, the vast majority of the questioned respondents were not very satisfied with the currently available consolidants and protectives. Thus, there is definitely room for improvement and unused potential. If the Nano-Cathedral products overcome the shortcomings of currently available stone treatment products, they could have a major impact on the market and the status quo in heritage protection.



Horizon 2020



Nano-Cathedral

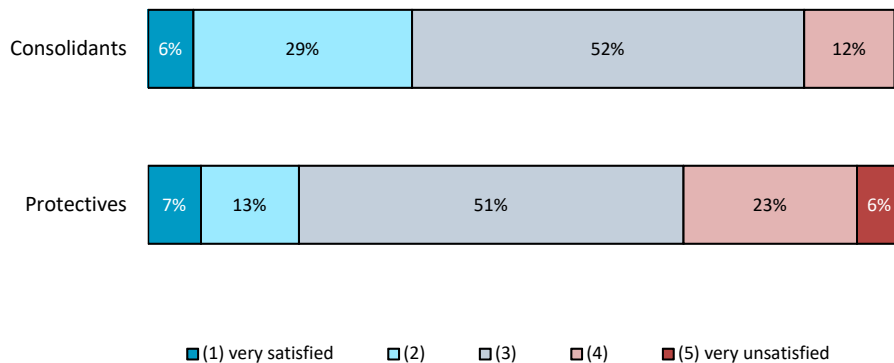


Nano-Cathedral



Base: n=157 - unweighted

How satisfied are you with the currently available consolidants / protectives?



Survey at Public Workshops - Practitioners

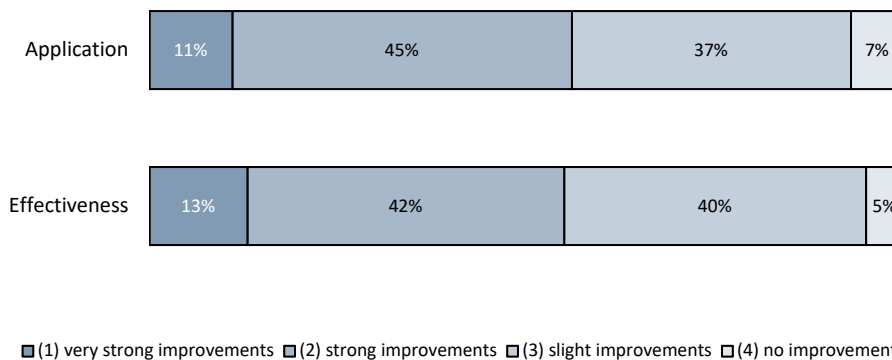


Nano-Cathedral



Base: n=157 - unweighted

In your opinion, how much will the quality of consolidants and protectives improve regarding their application / effectiveness?



Survey at Public Workshops - Practitioners

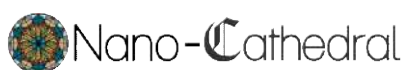


Improvements in Application and Effectiveness

The practitioners were prepared for product developments and saw improvements coming: most expected strong improvements in the effectiveness (43%) and application (45%) of consolidants and protectives in the future. Almost just as many were slightly more hesitant and only expected slight improvements in effectiveness (40%) and application (37%). Few assumed that there would even be very strong improvements (13% for effectiveness and 11% for application) and even less did not see the consolidants and protectives improving their effectiveness (5%) and application (7%) in the future.

Price Development

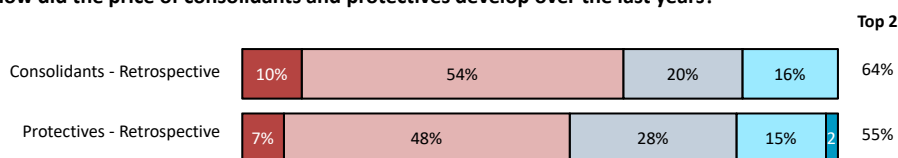
On average, the questioned practitioners felt like the prices for consolidants as well as protectives had slightly increased over the last years. Only about one in six respondents perceived a price fall (16% for consolidants and 17% for protectives). And they did not expect that development to stop: the majority assumed a slight or even strong increase of prices for consolidants (66%) and protectives (63%). Some believed that the prices would stay the same (17% for consolidants and 20% for protectives) and some even expected a slight price fall (16%). Even though most practitioners were prepared for an increase in prices, a competitive price would surely help nano-products to be accepted onto the market.



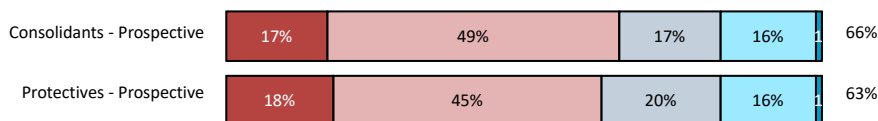
Base: n=157 - unweighted

Price Development of consolidants and protectives

How did the price of consolidants and protectives develop over the last years?



How do you think the price of consolidants and protectives will develop in the coming years?



(1) strong increase (2) slight increase (3) stayed the same (4) slight price fall (5) strong price fall

Survey at Public Workshops - Practitioners



3.2.2.9 Nano-Products for Stone Consolidation and Protection

When asked whether they had already used nano-products for stone conservation before, a good third stated that they already had (35%). The majority of practitioners did not have any experience with nano-products (58%) while a small share was unsure whether they had already handled nano stone treatment products (7%).



The share of the practitioners who had already worked with nano-products increased with their age and years of work experience: while only twelve percent with up to three years of work experience had used nano-products before, a whole of 42 percent of practitioners with eleven or more years of experience had already worked with them. Also, women were more likely to have already worked with nano-products than men: 39 percent of women compared to 31 percent of men had already used nano-products.

The participants of Vitoria's workshop were the most experienced with nano-products: half of the people working with stone treatment products had already used nano-products. The practitioners in Vienna and Ghent were in touch with nano-products the least: 80/81 percent of practitioners had not used nano-products yet.

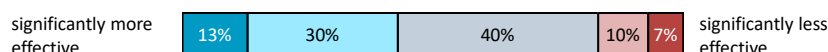
Following, the practitioners were asked to rate certain characteristics – such as the effectiveness, safety, costs and required workload – of nano-products compared to conventional products. This rating is based on their subjective personal experiences or assessments.



Base: n=157 - unweighted

In comparison to conventional stone treatment products,
how would you rate nano-products'...?

... effectiveness



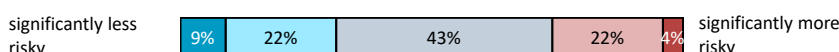
... risk to damage the buildings



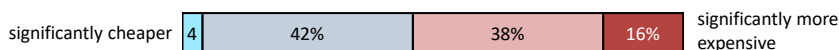
... required workload when applying



... risks for the safety of restorers/users



... costs



Survey at Public Workshops - Practitioners



What becomes clear at first glance is that most practitioners selected the middle category for all surveyed aspects. This indicates that conventional and nano-products were evaluated the same. At least partly, this might be due to a phenomenon called the *tendency to the center* in social sciences. According to this, people have a tendency to choose the middle category if they are unsure of their answer but do not want to admit that they do not know or skip the question. This would implicate that some respondents do not truly believe that conventional and nano-products are similar regarding a certain aspect but instead that they are unsure. Thus, we might overestimate the share of people who actually believe those to be equal. Nonetheless, these numbers implicate that a high share of practitioners did not make up their mind on their evaluation of nano-products.



This can be seen as a chance for nano-products since many do not have set and rigid perceptions yet. Therefore, it is still possible to convince these practitioners of the advantages of nano-products if they are successfully marketed and prove themselves.

Quality

First and foremost, the quality of the novel products counts. Only if practitioners are convinced that the nano-products will positively impact the condition of stones, they will consider changing their working processes and exchanging conventional products they might have used so far with the novel Nano-Cathedral products. Thus, the economic impact the project can have, will significantly depend on the effectiveness of the products and if potential buyers can be convinced of their superiority.

The data suggests that the practitioners who trusted nano-products to be more effective than conventional products outweighed (43%) the ones that believed that nano-products were less effective (17%). About 13 percent even believed that nano-products were significantly more effective. Nonetheless, a significant share of the surveyed practitioners stated that nano-products were neither more nor less effective than conventional products (40%). With rising years of work experience the percentage of practitioners who believed that conventional and nano-products were equally effective rose. Possibly, the more experienced practitioners were not as optimistic that product innovations would bring significant improvements as the younger unexperienced ones who trusted technological progress.

Even though the younger professionals with less work experience claimed to have had the least experience with nano-products, they were the most optimistic about the effectiveness of nano-products: 75 percent of practitioners with up to three years of work experience trusted in the nano-products' superior effectiveness and only one in twelve believed that conventional products might be more effective (8%). At the same time, only 30 percent of people with more than ten years of experience believed that nano-products outperformed conventional products' effectiveness.

Closely connected to the perception of the products' effectiveness is the assessment of the risks and benefits ratio of the nano-products. Since some bad experiences had been made with the application of chemical on heritage buildings where the products had ended up causing more damage than good, it is essential that the practitioners do not fear that the application of nano-products could negatively impact the condition of the stone. Thus, the practitioners were asked whether they believed that there was a higher risk for nano-products to damage the buildings than for conventional protectives and consolidants.

On average, the practitioners had a slight tendency to believe that nano-products were less risky to the condition of the building than conventional products ($\bar{x}=3.26$). Nevertheless, 17 percent estimated nano-products' risks as higher. Especially, younger practitioners and the ones with less work experience were skeptical. On average, practitioners from Cologne ($\bar{x}=3.62$) and Vienna ($\bar{x}=3.50$) perceived nano-products as less risky to the building in comparison to conventional ones than in Ghent ($\bar{x}=2.84$). The restorers in Vitoria ($\bar{x}=3.29$) and Pisa ($\bar{x}=3.20$) ranked in the midfield.



Costs

Practitioners would only decide to use nano-products if they expected a positive benefit-cost ratio. Thus, the costs they expected should not exceed their financial opportunities. The data shows a clear trend that the restorers expected nano-products to be more expensive than conventional products (54%). Barely anyone estimated the cost of nano-products to be slightly cheaper in comparison to conventional products (4%). Most respondents believed that conventional and nano-products' costs did not differ significantly (42%). Especially practitioners under 30 (67%) and with very little work experience (86%) did not expect price differences.

Since the practitioners already expect a higher price, there are two ways to convince them of the products: either the price would have to be surprisingly cheap or the effectiveness of the products would have to be so high that the higher investments would pay out for them.

Safety

Since nanotechnology is still a relatively new technology, the practitioners might fear potential safety risks when working with nano-products. The perceived risk could have a significant impact on the acceptance and willingness to work with these products since no one would want to take unnecessary and inestimable risks for their own health and safety.

The data shows that over a quarter of practitioners feared that nano-products were more risky to their own safety than conventional stone treatment products and out of these 26 percent only five percent thought that nano-products were significantly more risky. But the share of practitioners who believed that nano-products were less dangerous for their own health was even higher (31%).

The male restorers had even more trust in the safety of nano-products: 37 percent believed that they were less harmful to health than conventional products. The younger practitioners saw more risks to their safety than the older ones. Almost half of the practitioners with over 20 years of work experience estimated nano-products' risks as comparatively smaller (46%). The practitioners from Vienna ($\phi=3.75$) and Cologne ($\phi=3.55$) felt like the risks of nano-products were much lower than those of conventional products, whilst the practitioners from Vitoria ($\phi=2.81$) and Ghent ($\phi=2.76$) were more skeptical about user safety.

In summary, most practitioners perceived the nano-products as similarly or even less risky. Thus, this aspect should not hinder them from wanting to work with novel nano-products. However, user safety has to be assigned the highest priority – clear user guidelines and studies on the products' safety are essential to dispel any existing concerns and give the end-users trust in the products.

Required Workload

Practitioners can handle their application and if the workload required to apply the products is compatible with their working processes. Therefore, the practitioners were asked whether they believed that nano-products were easier or harder to apply*. Only if the practitioners are willing and able to incorporate the use of nano-products in their restoration practice, the novel nano-products are able to reach their full potential and have a significant impact.

The gathered data implies that most questioned practitioners believed that there was no difference between conventional products and nano-products regarding the workload that is required to apply them (56%).



Only very few (7%) feared that nano-products might be harder to apply while a significantly greater share trusted that the nano-products would be easier to apply (37%). The male practitioners seemed to be more convinced that nano-products were easier to apply than the conventional ones than female practitioners: while half of the men believed that nano-products were easier to apply, not even a third of the women shared that perception (30%).

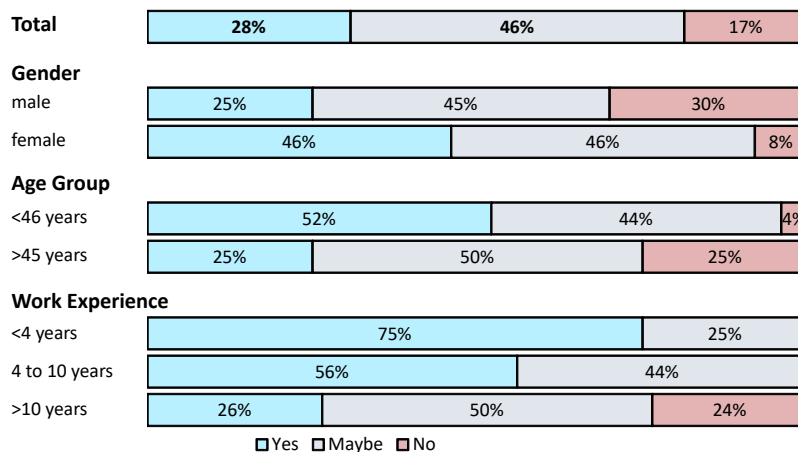
In conclusion, most practitioners perceived the workload to apply nano-products as equally high or even lower. Thus, the practitioners expected that the introduction of nano-products might actually positively impact their working processes – or at least not make them harder.

**Note: This question was only added to the questionnaire before the workshop in Vitoria and Cologne. Thus, the data analyzed above, only refers to the 41 practitioners who attended one of these two events and responded to this question.*

3.2.2.10 The Nano-Cathedral Products

Finally, in the last two workshops that took place in 2018 in Vitoria and Cologne, the practitioners were asked an additional question: could they imagine using the products developed within the Nano-Cathedral project themselves? This question was only added to the questionnaire later since at the beginning of the project, the products were not selected yet and not all necessary testing results and information were made available yet at that point of time.

Could you imagine using the Nano-Cathedral products?



Results are only based on the 48 participants of the workshops in Vitoria and Cologne who answered this question

Survey at Public Workshops - Practitioners

The results give an optimistic outlook on the project: 83 percent stated that they could possibly imagine using the Nano-Cathedral products, while only 17 percent could not imagine using them. While some surely could imagine using the innovative products (38%), even more said that they would maybe use them (46%). When asked, why they could not imagine using the Nano-Cathedral products or why they were unsure, some responded that more long-term research had to be conducted before they could trust the products' performance and safety.



3.2.3 Public Workshop in Rome

Since the questionnaire was revised and modified after the first survey was conducted in Rome on the 3rd of March 2017 the results of this first survey are analyzed separately.

Out of all attendees, 18 filled out the written survey.

Table: Public Workshop Rome – Socio-Demographics

	Absolute	Relative
Gender		
Male	3	17%
Female	15	83%
Age Group		
< 30 years	14	78%
30-45 years	4	22%
> 45 years	0	0%
Occupation		
Restorer	0	0%
Architect	0	0%
Student	17	84%
Other	1	6%
Total	18	100%

The vast majority of the respondents was female, under 30 and still enrolled in university. Thus, the data gathered at the Rome workshop cannot serve as a source of information for the perceptions of experienced restorers but instead can deliver valuable information on the attitudes of the next generation of restorers. Novel methods, approaches and products in heritage protection will particularly have an impact on these future professionals' work life.

Half of the attendees were already familiar with the Nano-Cathedral project before the workshop while the other half had only learned about the project. All participants' expectations for the workshop had at least been met partly. The majority perceived the Rome workshop as "excellent" (22%) or "very good" (39%). No one rated the overall impression as only "moderate" or "bad". Likewise, the organization of the workshop was perceived as "excellent" or "very good" by 83 percent of respondents. In addition, everyone rated the technical equipment as at least "good".

A central goal of the Nano-Cathedral workshops was to offer valuable learning and training opportunities to the interested audience. It becomes clear that it was possible to educate the participants: two thirds agreed that the workshop had given them a great amount of new information. While some people were able to connect with interesting people at the Rome workshop, others did not have that experience. However, the interest in the Nano-Cathedral project was sparked: almost everyone stated that they would keep following the project (88%) which is why it is essential that the goal to start a dialogue and educate people was reached.

When asked about their perceptions of monument protection, the participants of the Nano-Cathedral workshop in Rome showed enthusiasm: 16 out of 18 believed that the preservation of NMP-21-2014: Materials-based solutions for protection or preservation of European cultural heritage



Horizon 2020



protected monuments created cultural identity. Most also believed that not enough was done for monument protection in Italy (72%) and that monument protection should be supported by public finance (83%). Only few agreed that regulations for monument protection were too strict (17%) whereas more disagreed (33%). Also, three out of four respondents did not see a conflict between monument protection and the interests of private real-estate owners. Most seemed to like patina on built heritage and agreed that historic monuments should look as old as they actually were (76%). Also, the vast majority seemed to not only appreciate the cultural value of historic buildings but also of modern monuments and agreed that extraordinary modern buildings should also be protected as monuments (83%). Lastly, no one disagreed that the preservation of protected monuments promotes tourism. This shows again that a positive social and economic impact can be created through improving the state of built heritage.

A positive image presented itself, when the interviewees were asked how they perceived the risks and benefits of nanotechnology in general: on the whole the benefits are averagely perceived as “rather great”, the risks are only seen as “rather small” to “moderate”. This positive benefit-risk ratio implies a general trust in and acceptance of nanotechnology. Accordingly, many participants agreed that nanotechnology helps protecting the environment (59%), has a positive effect on the economic development (50%) and even creates more jobs than it endangers (47%). Especially the last point is relevant since nanotechnology’s effects on the job market might have a direct impact on the practitioners. But the data suggest that only very few feared a negative impact and believed that more jobs would be endangered than won through the introduction of nanotechnology (two out of 18 respondents). Also, only very few believed nanotechnology to be connected to health risks (17%) whilst the majority was not concerned (61%). Correspondingly, 13 out of 18 respondents believed that nano-products could be useful for them. This is a good sign for the introduction of nano-products into the market.

Lastly, people are optimistic about the positive impact the Nano-Cathedral project could have: almost everyone (88%) believed that the project would considerably increase the quality of consolidation and conservation of stones. Most of the other findings were in line with the interpretations and conclusions drawn from the analysis of the data gathered at the workshops in Vienna, Ghent, Pisa, Vitoria and Cologne.



3.3 Audience Analysis: Practitioners of Cathedral Workshop

Within the Nano-Cathedral project, an in depth case study was conducted at cathedral workshops to provide detailed illustrations of how the restored and nano-protected built heritage might deliver on a social, as well as a cultural level. Thus, the perspectives of different stakeholders, that the project might have an impact on, were explored. People working on the heritage buildings and with the stones on a daily basis would be affected by changes in the working processes and methods and products used in heritage protection directly. In order to gain an understanding of the impact on the stone masons and the traditional craftsmanship, the stone masons were asked to express their opinions, hopes and concerns.

3.3.1 Group Discussion with Practitioners at Cathedral Workshop in Cologne

Within a group discussion at the cathedral workshop (*Dombauhütte*) in Cologne, stone masons and sculptors gave insights into the working processes, the main technical innovations, the risks and benefits of new technologies and in specific chemical stone treatments, their views on nanotechnology, the characteristics of historic stone and the particularities of cathedrals.

3.3.2 Implementation of Group Discussion with Stone Masons

The group discussions were held on the 14th of March 2018 in the facilities of the Cologne cathedral workshop (*Dombauhütte*). In total, ten stone masons participated in the group discussions. They were divided into two groups: The first group, consisting of six stone masons, had a discussion from 10:00 to 11:30, while the second group, consisting of four stone masons, had its discussion from 12:30 until 14:00.

The stone masons from the first group were more occupied with restoration works and stone replacement works. The stone masons from the second group were mainly entrusted with the production of workpieces within the cathedral workshop (*Bauhütte*) and helped out, seasonally, at the exterior building sites. In the first group, only male stone masons took part in the discussion, whereas the second group consisted of half men and half women.

Different levels of experience were represented among the stone masons. Some were still absolving their apprenticeships, others were journeymen with a few years of experience, who, however, mentioned that they still had a lot to learn. There were also master craftsmen and craftsmen with a maximum of over 40 years of work experience. A couple of stone masons had learned the job or worked within private companies or had a slightly different background (e.g. in church restoration or sculpting) but most completed their job training to become a stone mason within the Cologne *Dombauhütte*.

The group discussions were organized in cooperation between the representatives of the Cologne Cathedral and BACES. The project partners from Cologne undertook the invitation of the stone masons. At first, the stone masons showed skepticism towards such a discussion since they had not been involved in the Nano-Cathedral project so far. However, it was possible to convince ten stone masons with different levels of experience and different backgrounds to participate and actively take part in the group discussions. The stone masons had the explicit permission from their supervisors to stop work for the group discussions. It was emphasized that they should openly share their opinion and that their replies would be anonymous.



BACES undertook the implementation of the group discussions. Through employing externals, it was avoided that the stone masons' statements were affected by their supervisors' presence. Dr. Juhász led and moderated the discussion whilst Alexandra Schmölder and Tamara Bock assisted in the preparations and kept time on the group discussions.

3.3.3 Aesthetic Perception

When looking at the visibly damaged parts of 'their' monument, the stone masons reacted rather negatively. Their comments reached from "it is getting worse" over "not okay" and "not nice" to "alarming".

For some, the original condition of the monument was the ideal. According to them, the monument should be restored while keeping the original vision of the creators of the cathedral in mind. They saw it as their job to keep the building in a "perfect" and "flawless" condition. Thus, they supported cleaning the stones and exchanging damaged parts as soon as it was necessary. However, they admitted that realizing this ideal might be impracticable. They were aware of the fact that there were not enough resources and workforces available to actually keep up with all the necessary restoration works to actually keep the building in its best possible condition and that therefore, it was unfeasible.

Others stated that the ideal to keep a building in its original state was unrealistic because there was never such a thing as the original appearance: even during construction, the cathedral was already blackening. And even after cleaning the cathedral would, rather quickly go back to a soiled state again. Thus, striving for a clean and new-looking heritage building would be unfeasible. These masons believed that the natural stone was allowed to age and that the patina had its own character and value as well. Still, one had to react correspondingly, if something was damaged in a way that was harmful to the stone or the structural condition of the building. They saw the static as the main interest and therefore the aging should never go as far as that the building might decay or suffer long-term damages. Lastly, it should also be mentioned that the questioned stone masons were not majorly irritated by the contrast between new/cleaned sculptures or building sections and the old ones.

3.3.4 Tourism

When asked about the potential impact of the condition and aesthetics of the cathedral on tourism, most stone masons agreed that the opinion of tourists was insignificant to their work. They were working, primarily, having the best interest of the building in mind. The only aspect they included in their considerations was the safety aspect: clearly, the building had to be kept in good condition so that visitors were able to safely admire the heritage. In summary, the cultural interest was clearly superior to economic interests for the masons in the cathedral workshop.

3.3.5 Heritage Protection and Preservation

The stone masons' perception of heritage protection and preservation was very positive. They believed it to be an important social task and that the protection of those culturally important buildings allowed connecting with past generations as well as their way of working and crafting. It was stated that not only historic monuments but also significant modern buildings should be protected.



The practitioners of the cathedral workshops were aware that the cathedral workshops were in a privileged position since they had sufficient financial supply as the maintenance of such significant historic buildings will always get enough funding. Therefore, they said, they had access to better equipment and technical possibilities. They were aware that the job and financial pressure was much higher in private companies, which is why these are often involved in various fields of work. Other than that they did not see major differences between the working processes in cathedral workshops and private companies.

From time to time, during the discussions, it came to light that there were disaccords between the stone masons, sculptors, and the restorers. When asked whether they could bring in their own views into the decision-making process on the restoration techniques, it was mentioned that the problem was that the restorers decided whether and which products were applied and what the right treatment for which stone was – the craftsmen did not know these things. Some stated that they had to follow these instructions whether they agreed with the approach or not and that there wasn't a high accordance with the restorers.

Even though the stone masons and sculptors attributed a major importance to heritage protection and preservation, they were aware that it was not always clearly defined what should be preserved since the definition of what is worthy of protection was also a political question that every generation answers differently. They believed that preserving a stone solely for the sake of doing so, was not reasonable since keeping a crumbling stone in the monument could be dangerous.

The masons were aware of the change of paradigm from renewing to preserving and that the definition of their occupation as a stone mason stood in conflict with the restorers' paradigm of reversibility. A stone mason wants to carve a new stone and replace an old damaged stone with the new piece. However this is not reversible. They did, however, state that it is impractical to maintain the built heritage when all changes are reversible. They agreed on the fact that reversibility might be desirable and a good principle, but that it was simply not feasible for such big buildings.

Furthermore, the question was raised whether it could even be clearly defined what the "original" condition of the building was. In the history of the heritage building, parts of it had always been renewed and exchanged. Therefore, it was not easy to say which parts were authentic and which were not. When using original stones from the original quarries they could not see any objections to exchanging parts of the building. For these practitioners exchanging or renewing stones and sculptures did not mean an alienation from the original idea of the building but instead saw traditional methods and crafting as part of the cultural heritage.

The stone masons were aware that mistakes in the restoration were made in the past. However, some masons saw those mistakes as evidence of a constant learning process and stated that as long as everyone acted to the best of their knowledge and belief, even those mistakes could be considered progress, since doing nothing was guaranteed to be the wrong thing to do to a constantly aging monument. Even though there was a clear tendency towards the traditional approaches it became clear that the daily working processes of stone masons and sculptors have been and are constantly evolving. Which role the introduction of new technologies, methods, and products has played and will play, will be targeted in the following chapter.



3.3.6 Relationship between Traditional Craftsmanship and New Technologies

The practitioners which participated in the group discussion were convinced that the old traditions and accumulated knowledge about the stone and the building were the basis for the development of all new technologies in heritage protection.

Even though there now is the paradigm to preserve as much as possible instead of exchanging it, they stated that parts had been removed and replaced on the monument throughout its history. They believed that the process of renewing damaged parts and replacing stones and sculptures with new ones, crafted from original substance/material, was part of the cultural heritage. Some said that replacing stones or sculptures through traditional handcrafting complied much better with the thought of preserving the cultural heritage than when old stones and sculptures were treated with novel chemicals since those lead to a change in the stone's structures. They believed that forcing to keep "dead stone" alive through the application of stone treatment products was illogical and therefore called for the renewal of stones or sculptures, in the sense of their creators.

Due to the unique nature and the size of the cathedral, one only gets the chance to work in a certain area of the monument once every couple of decades. This is why the stone masons preferred to actually renew everything instead of applying products which's performance was not certain. The products also lead to the masons not being able to predict the condition the building would be in the future when they would access it again.

They stated that some new methods and products had been integrated into their working life. However, their working processes had fundamentally stayed the same over the last decades. The stone masons were in agreement that the traditional craftsmanship was an important cultural good and should be maintained for the future generations.

3.3.7 New Technologies

When asked about their attitudes towards new technologies, the practitioners of the Cologne cathedral workshop stressed that they did not have fundamental reservations towards the introduction and use of new technologies. They were willing to try out various new methods, techniques, and products but believed that a more conservative approach never hurt when working on such a famous cultural heritage. Due to the different conditions and structures of the stone, there was not one solution that fit all stones. That was why a lot of times individual decisions had to be taken on whether traditional handcraftsmanship or innovative approaches should be applied.

The participants of the group discussion considered the biggest changes in technological innovation in the last decades to be in mechanical methods, techniques or tools. The application of chemical products was not associated with significant technological innovation over the last years as often as other innovations.

They stated that these mechanical technological improvements – such as working with compressed air or sandblasting – could simplify and reduce the workload considerably. While some were grateful that less hard physical work was necessary, some seemed to be afraid of what future innovations could mean for their profession. Their profession and the orientation towards traditional methods stood in conflict with the improved efficiency and precision through technical innovations, which was why some seemed worried that their work might become redundant.

In that case, the introduction of new technologies might have a major negative impact on job opportunities and the future of craftsmen and craftswomen.



However, the masons experienced that even back when those new methods, which are now established in their daily working procedures, were introduced, some of the senior stone masons were very skeptical. This shows that skepticism and concerns can also fade over time and that technologies that were once seen suspiciously are now well-integrated into the daily working life of stone masons.

3.3.8 Chemical Treatments

Some of the stone masons and sculptors of the *Dombauhütte* in Cologne saw chemicals as potentially beneficial add-ons, while others believed that the damages on buildings should only be eliminated with traditional methods.

Some masons clearly rejected the application of chemicals because they believed that they could impair the quality of the stone and change the substance of the building. They had concerns about what would happen during weathering processes: which chemicals would degrade and which would stay in the stone?

Others were more open-minded and supported the testing of chemical treatments, even on “*their*” monument. Those stone masons considered it their job to work *for the monument*. Thus, they were open to trying out new approaches in order to find the best possible methods and treatments to maintain and improve the monument’s condition. Still, they said that it was dangerous to rush things and to use new methods on a large scale too quickly. Products should be tested on small parts of the cathedral over a longer period of time. In that sense, not even ten years are seen as a long testing-period for historic monuments. Instead, the stone masons thought generations ahead: Constant monitoring was considered essential to learning, and in case of need appropriate countermeasures could be taken.

After a long testing-period, the stone masons who were more open towards chemical treatments thought that then every generation had to decide and act according to the best of their knowledge and beliefs. However, most found it unrealistic that the products would perform well over a century. They ironically remarked that if the products were actually that effective that not only would they find themselves unemployed but the producers as well. Here, they saw a conflict: between keeping the best interest of the monument in mind – finding long-term solutions and procedures that do not have to be renewed every few years – and the economic interest of the producers – who strive to continuously sell products and not only one in a century.

3.3.9 Consolidants and Protectives

The participating practitioners had similar attitudes towards consolidants and protectives as they had towards chemical treatments in general: some were very sceptical, others open-minded as long as the application happened in all conscience and served the building.

Consolidants

The practitioners seemed to be more familiar with consolidants than with protectives. They named silica (KSE) as an example. Some of the stone masons believed that the application of consolidants was sensible if the loss of substance on a stone was too big. However, someone mentioned that if the products only performed for around 15 years the effort spent on the application was not proportional to the benefits. The more optimistic practitioners stated that it could generally be worthy to apply those products when good experiences had been made previously. Others saw a



consolidation as a resuscitation procedure for dead stone. They believed that one could not work on stone that had been weathered and then consolidated. Some believed the consequential damages of applying such products to be higher than the benefits. Also, there was concern about what would happen when the consolidants would be washed out.

Protectives

The practitioners did not mention having experience with the application of protectives. Some stated that protectives should be tried out on small parts of the building and that if they still did their job in a few decades, one could apply them on a larger scale. The more skeptical practitioners raised concerns about the warranty and durability of the products (“The producers themselves don’t know how long the protectives will perform”). They reported that bad experiences with such products had been made in the past and that they were unsure whether the products had actually improved over the time.

3.3.10 Nanotechnology in General

When asked what came to mind when thinking about *nanotechnology*, almost all stone masons were able to associate something with the term. Some brought up characteristics of nano-particles (e.g. their size), the application of nanotechnology in daily life or their thoughts about nanotechnology’s potential impact on our future. Connections to their own working sphere and monument protection were not instantly made.

One stone mason mentioned that “nano” simply is a size scale and many others also connected nano-particles with their size: “very small”, “smallest particles”, “tiny particles”. Another stone mason claimed that “the field of nanotechnology is present throughout our daily life”. The stone masons mentioned some daily-life products such as shower gel, toothpaste and other cosmetics, car paint, impregnation products of shoes, etc. as known applications of nanotechnology.

When looking into the future, most stone masons felt like nanotechnology’s risks outweighed its advantages. Many were concerned about environmental pollution and also compared nanotechnology’s dangers to the negative impact of microplastics. Some were also concerned about potential health risks since they believed that those small particles could penetrate everything (such as particulate matter). Thus, they believed that one should be careful when using nano-products in daily life (for instance when using impregnation sprays on shoes). One young stone mason was more optimistic and associated nanotechnology with future and progress.

All in all, the stone masons were able to connect nanotechnology with its characteristics and areas of application. Most had a tendency to be rather skeptical towards the new technology. They did not immediately draw the connection to their work and stone protection when thinking about nanotechnology. Therefore the moderator steered the conversation into that direction and asked the participating craftswomen and craftsmen about their experiences with nanotechnology within their working sphere.



3.3.11 Nanotechnology in Heritage Protection

When asking the stone masons about their perception of nanotechnology in their own field of work – monument and heritage protection – they seemed rather skeptical. Even though most had had no experience with the use of nano-products, they still had reservations about its effectiveness and safety concerning the building. It was also mentioned that the application of such products did not suit the occupational profile of stone masons (“we are not plasterers”).

The stone masons did, reportedly, not know much about nano-products concerning stone treatment and stated that the decision of which product to use, fell to the restorers (“We do not decide anything here – if our bosses tell us to apply nano-products, we will.”). Some did not know about the application of nano-products in heritage protection whilst others knew about nano-products that were utilized against biological infestation or graffiti. Some believed that “nano” could be helpful against graffiti.

For some stone masons, the use of nanotechnology in heritage protection had a negative connotation because they were unsure if and how the nano-products could deteriorate the building and what would happen with particles that were washed out. The lack of long-term studies was mentioned as well as that the testing periods would have to be substantially longer than those of other products.

However, barely anyone was concerned about the health risks of nano stone treatment products. The masons reported work safety measures in the cathedral workshops to be very good, but also mentioned that work safety might be less regulated in the private sectors.

It can be concluded that the participants of the group discussions in Cologne were much more concerned about the possible negative impact of nano products on the built heritage than on themselves. Even though they were not convinced of the application of nano-products on heritage buildings most believed that testing them could pay out in the future. If the products proved themselves to be effective, most would be open to using them as an addition to the traditional methods. However, only after an extensive testing period.

3.3.12 The Nano-Cathedral Project

The stone masons at the Cologne Cathedral were not really involved in the Nano-Cathedral project and therefore did not know too much about it. They were quite skeptical towards the novel products because they doubted that the products would perform well. The stone masons also seemed disillusioned towards chemical innovations in general: “every five years a *new miracle cure* comes onto the market but it never keeps its promises (e.g. short half-life). However, some stated that it was good that the products were being tested at the moment and that results would show in the future. Notwithstanding the above, they would not apply the Nano-Cathedral products on a larger scale on the Cologne Cathedral unless more experience with the products was gained; the masons called for longer testing periods to ensure a qualitative performance of the nano products.

When asked whether they believed that the Nano-Cathedral products could be useful on new stones and modern buildings the masons were skeptical as well. They believed that the products would not pay off because nowadays new buildings are not restored and conserved over decades but instead demolished when they are getting too old. Thus, they concluded that targeting owners/caretakers of new buildings would not be economically profitable.



The masons would not support Nano-Cathedral products marketed under a “tested on Cologne” label even though other companies had done the same before. Some believed that such a label would not make a big difference on the market for stone protection since buyers of such specialized products were more interested in hard facts than in marketing labels. Since the buyers/appliers normally are deeply involved in the topic and do not make an on-the-spot, uninformed decision for a certain product they would rather accustom their buying behavior to the damage patterns and the product’s effectiveness (“it is not as easy to promote a stone treatment product as to promote toothpaste”).

All in all, some masons were quite skeptical that the Nano-Cathedral products could completely change the status quo in heritage protection and the market since there already is an immense variety of products out there. They could only imagine the Nano-Cathedral products to occupy a market niche.

3.4 Survey with Practitioners of Cathedral Workshop in Pisa

Within a smaller scale survey in Pisa, practitioners of Pisa’s cathedral were asked to answer some questions regarding the Nano-Cathedral project. Three practitioners with different backgrounds – a restorer/stone mason, an archaeological restorer and an engineer – shared their perceptions.

For all three practitioners the project and the technology were interesting. Especially, if the results were good and the nano-products were used correctly so they could serve the final aim to improve the conservation of the cathedral. Also, interest and curiosity for the project were sparked through the connection with innovation, progress and the increase of knowledge about materials.

The practitioners of the Pisa cathedral seemed to be quite well-informed about the Nano-Cathedral project: they knew that the exchange of knowledge, research and study between different professionals who were involved with the conservation of cultural heritage occupied the center of the project and that a novel technology was being used to conserve stones on heritage buildings. There was also an awareness that the findings and gains of the project would be exhausted all over Europe. Collecting knowledge about the project was considered an enrichment. While one noted that there could have been a stronger involvement of the people who worked in the restoration field through a video communication system, another practitioner was highly satisfied with the communication around the project: “there were many events for the dissemination which have enabled the understanding of the project for the people.”



4 Conclusion

The analysis of the stakeholder's attitude shows, that a sizeable part of the public in the participating countries is already aware of nanotechnology and of certain nano-products, and expects the technology to be further developed to the benefit of the population. Compared to other new technologies, nanotechnology has a fairly positive standing in the public. The perceived benefits usually outweighed the perceived risks in all countries. While the majority thinks that nanotechnology should be regulated there is also a widespread readiness to use products with nanoparticles. The perceived overall impact of nanotechnology is positive, particularly on the economy, and somewhat less on the job market and the environment. Insofar, the development of novel nano-products for stone treatment is likely to be widely accepted in the public.

The preservation of built heritage and historic and modern monuments is of high importance for the public. Therefore there is also a substantial support for financial aid for preservation activities. The major finding about the public perceptions of built heritage is that they clearly prefer clean facades and restored buildings. The nice and undamaged visual appearance of monuments and sculptures is highly valued; particularly among those who think protection of cultural heritage is an important political task.

Although heritage protection is generally valued, it is unclear if the results of the treatment of historic monuments with nano-products will have a direct impact on tourism and the appraisal of these monuments. The public is primarily concerned with the good condition of the monuments and access to meaningful information. It is less important how this state of condition is achieved. However the more a person values the issue of heritage conservation as being important, the more they are disturbed by soiling and damages to the buildings. Insofar, the tourist industry is dependent upon well preserved monuments. And although the public probably does not care too much about how monuments are well maintained, it is clear that the novel nano-products can make a significant contribution to reaching the goal of preserving historic and modern monuments and keeping this state for a longer period after treatment.

The public workshops that took place within the frame of the Nano-Cathedral project were a thorough success. Not only the participants were very satisfied with the organization of the workshops, they also appreciated the offered opportunity to learn and to educate themselves through the presentations and discussions.

Practitioners and the interested public are involved with the protection of built heritage. Nevertheless, it became clear that even these professionals, who strive towards a mutual goal, do not always have one common approach to care for built heritage. Almost all interviewed workshop participants agreed that new technologies could be useful for monument protection. Altogether, the practitioners showed themselves open-minded towards new technologies, in general, and nanotechnology, in specific. Insofar, the remaining reservations are unlikely to hinder the introduction of nano-products for stone treatment. However there is a demand for studies and experiences that prove that the novel products will not be harmful and will not cause health or environmental problems in the future.

The practitioners who had already worked with stone treatment products before had a wide range of experiences with these products and had special expectations towards nano-products for stone consolidation and protection. There was an agreement that the range of available stone treatment



products was already quite broad but not yet well-developed and that there is great potential for additional improvement. So the majority was not completely satisfied with the available products, especially with the protectives. The question remains whether the newly developed Nano-Cathedral products can meet the demand. Additionally, consolidants were perceived as more essential for stone treatment than protectives. This could either be a disadvantage for the market potential of the nano-protectives or it could be seen as a chance. If the protectives developed within the project can convince end-users, they would stimulate the market.

Overall, the practitioners believed that nano-products had the potential to outdo conventional stone treatment products in many aspects. Most thought that nano-products were just as or even easier to apply than conventional products. The majority was also convinced that nano-products were more effective than conventional products. Additionally, in comparison to conventional stone treatment products, most practitioners rated nano-products as similarly risky or even less risky to their own health and to the state of the built heritage. At the same time almost all practitioners believed that nano-products would be more expensive than conventional products. Since they also expected protectives and consolidants to become more expensive in the next years they were prepared to accept higher prices – especially if the performance of the products was convincing. The relatively high share of stakeholders not having a clear opinion on nano-products yet holds the potential for the future acceptance of nano-products: positive experiences with nano-products for stone consolidation and protection should convince. Therefore, it is essential to market the novel nano-products well and communicate their advantages over conventional products to the potential end-users who have not shaped a set opinion yet.

The social and economic impact of the novel nano-products for stone treatment cannot be forecast in detail and with certainty at this time of the development of these products. The starting position is however very promising. The impact on the economy, on the work conditions of practitioners and also on tourism and the public in general is positive. The general acceptance of novel nano-products is present in all investigated stakeholder groups and the need for improved products in stone treatment is visible among the practitioners. There is some reservation because of potential health and environmental risks but these reservations are no serious handicaps for the introduction of nano-products. Whether the novel nano-based consolidants and protectives will have a major and lasting effect on the way built heritage is treated is dependent upon the long term results. Restorers and practitioners are open for innovation but due to past experiences they are also cautious in the introduction of new techniques and products. Therefore it will be of great relevance to monitor the long term effects of treatments and to publish these results for the different types of stones, so that the effectiveness of tailor made products and treatments in times more extended than the project duration can be demonstrated.