PUBLIC ADMINISTRATORS’ MAINTENANCE MANAGEMENT PRACTICES UNDER THE IMPACT OF MATERIAL PRICE FLUCTUATIONS

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ABSTRACT

In the second half of 2020, there was a strong increase in building material prices on world markets, which continued in 2021. Given the unstable geopolitical and epidemiological circumstances, future price fluctuations are unknown. Construction projects are sensitive to such oscillations as contracts and plans are concluded at a time when price changes cannot be predicted with certainty. Given the degree of environmental construction, maintenance projects of existing buildings are becoming increasingly important. Public-funded institution maintenance projects under regional and local self-governments are particularly at risk. Public administrators make maintenance decisions based on existing priority systems and available budgets, which are already limited and pressured due to rising material prices. To mitigate the disturbances, this paper aims to analyze fluctuations in the market of frequently used maintenance materials and provide support to public administrators, i.e., decision-makers, in the form of maintenance management recommendations, in the context of activating the price increases risk. The research consists of two parts, a review of the theoretical background and the processing of material cost data. From the available literature, insight was gained into the current way of planning, budgeting, and way of maintenance performing of public institutions in the Republic of Croatia. The problem of fluctuation in construction material prices and its impact on maintenance was recognized. Often used maintenance materials prices data were collected and analyzed, the resulting changes were graphically and numerically presented, and the problems these changes cause within the maintenance process were identified. Finally, recommendations were made to mitigate the identified disorders that public administrators will be able to apply.

KEYWORDS

Maintenance management, Public institutions, Public administrators, Building material, Prices changes.
1. INTRODUCTION

The value of the construction project largely depends on the building materials price (Ugochukwu and Chioma 2015; Obeng-Ahenkora and Danso, 2020). Projects are particularly risky today because the material market is in an uncommon situation. Namely, in the second half of 2020, there was a substantial increase in building material prices on world markets, which continued in 2021 and 2022. Market disruptions were mainly affected by the Covid-19 pandemic, which was subsequently followed by the war situation in Ukraine. Future price fluctuations cannot be predicted with certainty, but due to all circumstances in Europe and the world, there is an inevitable trend of continuing market turmoil and uncertainty in implementing construction projects.

In the last few decades, investment indicators in developed countries show that the financial resources invested in building maintenance exceed those invested in the construction of new ones (Cerić and Katavić, 2000), which is a direct indicator of the growing importance of maintenance projects in the construction sector. Building maintenance can be defined as a set of all activities undertaken to preserve, protect and improve buildings to serve their intended functions during the exploitation phase (Tijanić Štrok et al., 2022). Maintenance management determines strategies, goals, responsibilities, ways of performing maintenance, and their implementation through planning, organizing, directing, and controlling (Tijanić Štrok, 2021). Managing maintenance means making the right decisions and optimizing the management of physical assets while minimizing overall life cycle costs and other critical factors and risks such as operational continuity, all of which need to be objectively considered (Ali et al., 2016). Due to limited budgets and risk factors sensitivity, projects for maintaining public institutions within regional and local governments are particularly endangered. These are institutions that include social, school, health, and similar facilities, where maintenance decisions are made by public administrators - most often department heads for the maintenance of facilities under the authority of public administration. Public administrators make maintenance decisions based on their priority systems and available financial resources (Tijanić Štrok, 2021), which are already restricted and currently under additional pressure due to the rising prices of building materials.

In order to identify and mitigate the difficulties related to the increase in prices of building materials for the maintenance of public buildings, this paper aims to analyze the maintenance management of public institutions, analyze fluctuations in the market of frequently used materials, and provide support to public managers, i.e., decision-makers, in the form of maintenance management recommendations, in the context of reducing the impact of price increase risk.

The research hypothesis is as follows:

It is possible to single out building materials often used in the maintenance of public buildings and whose prices most impact the total cost of their maintenance. The prices of these materials have increased many times over the past year, which hurts the performance of maintenance in public buildings and makes it challenging to make maintenance decisions.
Stated will be examined in the example of the City of Rijeka data.

The paper is organized as follows: the paper begins with an Introduction within which the research's problem, aim, and hypothesis is highlighted. Chapter 2 deals with the theoretical background of the study, which examines how public administration works in terms of maintenance, the trends in prices of building materials, and their impact on public building maintenance. Chapter 3 presents the applied research methodology. Within Chapter 4, the collected data on maintenance building materials prices as well as the results of data processing are presented. The results were discussed in Chapter 5, and there are recommendations for public administrators. The last chapter (Chapter 6) consists of conclusions.

2. THEORETICAL BACKGROUND

2.1 Public buildings' maintenance management

Public facilities are buildings in which activities such as upbringing, education, science, culture, sports, health, social welfare, state bodies and organizations, bodies and organizations of local and regional self-government, associations of citizens and religious communities, and other related activities, are performed (Tijanić et al., 2019).

Management of public buildings in the Republic of Croatia is mainly carried out through local and regional self-government units. Local self-government represents municipalities and cities, while regional self-government belongs to counties. At the head of local and regional self-government units are municipal mayors, city mayors, or county prefects, who have executive power. To implement authority and management more systematically and efficiently, authority is further divided into administrative departments, each of which performs and oversees activities within its scope. It is common for the public administration to have a department that deals with the buildings' maintenance under their jurisdiction. One such authority division is shown in the example of the City of Rijeka, shown in Figure 1. The figure highlights the method of managing the maintenance of buildings under the city government (the method of management may vary from public administration to public administration but is mostly based on similar principles).
As can be seen in Figure 1, the city government is divided into several administrative departments headed by heads. The departments are then divided into several divisions, led by directors. Public buildings maintenance is carried out within the Division for the construction and maintenance of facilities of public, business, and residential purposes. A maintenance manager (public administrator - director of the Division) is a person who performs technical, administrative, managerial, and maintenance control tasks. For individual tasks within the Division are appointed associates responsible to the Division director. Director makes all critical decisions about the building’s maintenance (with the head's and the mayor's consent). The Division implements and is responsible for capital investments, reconstructions, renovations, and investment and buildings' current (and urgent) maintenance. Investment and current maintenance include funds for predictable and planned maintenance, emergency interventions, current repairs, and elimination of deficiencies identified by authorized legal entities and other competent authorities (City of Rijeka, 2022b), which are planned within the public administration financial plan. Maintenance funds mostly mean maintenance materials, so changing/increasing the prices of these materials is a significant problem for public administration, given the available budgets.

The scope of the maintenance department within the public administration is broad and includes performing activities and making decisions related to:
• emergency interventions, monitoring of the caused damages on the facilities and reporting,
• analysis, needs planning, the scope of works and services, and estimates of current and investment maintenance costs,
• performing reconstructions and upgrades on facilities,
• preparation of project documentation and procurement of works,
• cooperation with other administrative departments to consolidate investments in facility maintenance,
• and other similar activities (City of Rijeka, 2022c).

The public buildings' maintenance within the public administration is financed through the available budget and is planned within the maintenance plan/program annually. The budget is filled based on the public administration's revenues, standard taxes, grants, joint revenues, and equalization support for decentralized functions. Part of the income tax for decentralized tasks in primary and secondary education, social welfare, and health, is set aside. Units that do not receive sufficient funds to finance decentralized functions are provided a share of income tax for equalization grants for decentralized functions (Mršić, 2021). In this way, the Republic of Croatia finances the material operations of these public institutions, current and investment maintenance, and adaptation and rehabilitation (City of Rijeka, 2022d).

Based on the City of Rijeka data in 2022, it will be shown how decisions are made regarding adopting a plan for maintaining public facilities under their jurisdiction. The City budget and decentralized resources for the needs of buildings' maintenance provide certain financial resources for the purchase of necessary materials and performance of works by workers, as well as other ancillary costs. However, it is already stated in the introductory plan note that the maintenance needs are much higher and that they require more extensive financial resources, which cannot be realized based on available funds in the budget. Public facilities covered by the plan include kindergartens, cultural facilities, sports facilities, health and social care facilities, youth homes, administration and self-government facilities, and primary school facilities. The works considered for entry into the maintenance plan are determined based on the expressed needs of public institution users in the received requests and the verification of their justification by the professional services. The plan includes public facilities on which it is necessary to perform maintenance works that will not change the area or the facility's purpose. These are continuous activities that maintain the property for regular operation, servicing devices and equipment, arranging interior and exterior walls and floors, repairing worn-out parts, replacing installations, and the like. The primary criteria for inclusion in the plan of current and investment maintenance are facilities' condition, the functionality of the space, manner of use by the user, regularity of payment of fees for the use of space, etc. The planned cost amount mainly refers to current and investment maintenance, emergency interventions, and transitional works from previous years. Requests from users who are not included in the plan are included in the plans for some future periods (City of Rijeka, 2022f).

Minor maintenance, servicing, and replacement works within public facilities are performed by janitors/craftsmen. In contrast, more complex and valuable works are performed by
external contractors and, depending on the value, are most often procured through simple or public procurement.

Among the research dealing with maintenance management in public buildings, the doctoral dissertation of the author Tijanić Štrok (2021) stands out. Based on the survey research and case studies, on the example of the Primorje-Gorski Kotar County in the Republic of Croatia, the mentioned dissertation established the following (Tijanić Štrok, 2021):

- Public buildings are old and have an inadequate design solution; no life cycle cost analysis has been conducted for them.
- The public administration does not keep detailed buildings' condition records and damage to them.
- There is no clearly defined maintenance policy and maintenance standard.
- Education and training of maintenance staff are not carried out often enough.
- Computer support is not used for maintenance management (Computerized Maintenance Management System, CMMS),
- The financial resources available to the public administration are insufficient for all maintenance needs.
- Maintenance management is not cost-effective.
- Maintenance cost planning is unsystematic and imprecise, there are significant deviations from the realized costs, and there are many unplanned works.
- The maintenance plan is prepared by the public administration, according to the reported needs, and according to its priorities, not cooperating enough with the institutions and their users.
- There is no long-term maintenance plan.
- There is no maintenance performance measurement system.

2.2 Fluctuations in building material prices

Building materials make up between 50 and 60% of the total cost of construction works (Ugochukwu and Chioma 2015; Obeng-Ahenkora and Danso, 2020; Musarat et al., 2021). Such a significant share of material costs has a major impact on construction projects (Musarat et al., 2020), where unforeseen circumstances may jeopardize their successful realization. One such circumstance is undoubtedly the considerable increases in the prices of building materials that the construction industry is currently struggling with. Materials such as aluminum, copper, steel, wood, and plastic suffered extreme price increases. Increasing prices is dangerous because the construction projects' costs are exceeded, work is interrupted, and disputes over contracts occur because construction companies cannot meet all obligations, ultimately leading to stagnation of the entire construction sector. In addition, construction materials' fluctuating market value usually causes high project risk for all other stakeholders (suppliers, clients, investors) involved in construction production (Alabi and Fapohunda, 2021).

There are many factors involved in the occurrence of fluctuations in building material prices, such as: supply and demand, market conditions, transport and energy costs, raw materials,
labor costs, crude oil prices, exchange rates, import duties, and inflation (Musarat et al., 2021). However, the main reasons for the current increase in prices of building materials are attributed to rising raw material prices due to reduced production, rising oil prices as raw materials and fuels for transport, the crisis in Europe, and rising demand due to increased construction (Shibani et al., 2022; Bljesak, 2022).

According to the Croatian Bureau of Statistics (2022), producer prices of building materials on the Croatian market in March 2022 were 1.20% higher than in February 2022 and 8.10% higher than in March 2021 (Figure 2). If we compare the producer prices of building materials on the market in March 2022 with the average of 2015, they are higher by 14.00%.

The changes in Figure 2 are shown by the producer price index of building materials. This index measures changes in the level of producer prices of building materials produced and sold on the Croatian market. This index is an essential short-term indicator of the business cycle that shows the monthly dynamics of changes in producer prices. Moreover, according to the European Union concept, this indicator can indicate inflationary trends before reaching consumers (Croatian Bureau of Statistics, 2022).

To mitigate global disturbances in the building materials market, the Government of the Republic of Croatia (2021) adopted a Conclusion on actions to reduce the consequences of disruptions in the prices of building materials and products, which allows correcting the
costs of existing construction contracts with an agreed fixed price. For public procurement procedures, it enables the determination of the variable price of the bid as well as the ways and conditions of changing the price during the contract execution. The Croatian Chamber of Commerce (2022) has also developed guidelines in which frameworks and recommendations are given to clients and contractors in circumstances of possible recognition of the difference in the price of construction works. These documents can also be applied within the contract on maintenance works of public institutions (procured by public procurement, agreed fixed price), where the contractor, if he meets the conditions, has the right to request an increase in the works price.

Maintenance costs cover the materials, labor, and other related expenses incurred to maintain the building or its parts in a condition in which it can perform its required functions (Marović et al., 2012; Ogunmakinde et al., 2014). According to Ali et al., (2010), building materials are the second most dominant factor affecting maintenance costs (the first is user expectations). Ogunmakinde et al. (2014) state that building materials significantly affect maintenance costs, but the available budget mainly dictates maintenance performance. Adequate building maintenance requires sufficient resources such as staff and finances for maintenance work, so it is the responsibility of the maintenance manager to give additional importance to the allocation of maintenance costs to achieve a good maintenance result. The accuracy of maintenance cost planning depends on the information available, the nature and scope of the work, the conditions under which it will be performed, the method of execution and labor costs, and material prices (Ali, 2009; Tijanić Štrok et al., 2022). We have seen that the budget for the maintenance of public buildings is restricted and that it is impossible to carry out all the necessary work due to a lack of funds. Frequent changes in the prices of construction materials will further complicate and aggravate the situation. Maintenance costs are planned based on works from previous years, based on bills of quantities, they are often inaccurate, and there are overruns and abandonment of works (Tijanić Štrok, 2021). Due to the long duration of the construction projects implementation, planning results in one price, the contractor is contracted with another price, while during the execution itself, due to price increases, results in a third price. Because of this market conditions, more maintenance work can be expected to be stalled, and additional funding will be awaited. All this will lead to reduced quality of service and greater customer dissatisfaction. The task of the public manager is to identify potential risks and, by the risks, make decisions about the maintenance work to be performed.

Scientific research dealing with the fluctuation of building material prices and the impact on maintenance costs and maintenance decisions has not been conducted so far.

3. METHODOLOGY

After a systematic authors' consideration of the research problem, a methodological framework was developed based on which this research is conducted.
The research was carried out through several segments, which are in a meaningful way divided within the chapters of this paper. First, the methodological framework shows how the impact of building material price fluctuations on the maintenance management of public institutions will be analyzed, as shown in Figure 3.

Figure 3. Methodological framework

Once the problem caused by changes in material prices on maintenance management in the public sector is identified, the aim of the research was set, and the research hypothesis was formulated (both stated in the Introduction). The study consists of two distinct fields, a theoretical overview of the study area; and data collection and processing.
The theoretical overview identified the main principles and methods of managing the maintenance of public institutions and the form of decision-making, the role of building materials prices on maintenance, and the impact of changes in these prices on maintenance performance.

To analyze the building maintenance materials price movements, the necessary data were collected through the study of available documentation. Then, after processing, the main statistical parameters are presented in tables and graphs.

Based on the in-depth literature review findings and the data processing results, the working hypothesis was tested, recommendations were given to public administrators, and conclusions were drawn.

4. DATA ON MAINTENANCE BUILDING MATERIALS PRICES AND DATA PROCESSING RESULTS

The necessary data were collected by a study of documentation where publicly available official public administration documents were used, as well as invoices and price lists of building materials and products.

Given the range of building materials used in building maintenance, the goal was first to single out and analyze those materials that are most used and whose prices have the greatest impact on maintenance costs. For this purpose, the data on the planned maintenance work of public institutions that were carried out in the period from 2018 to 2022 was first analyzed. The documentation was taken over for the City of Rijeka from their official website, which, within the plans for the maintenance of public, business and residential purposes and emergency accommodation facilities, states which works will be performed and in what value. Only construction and craft work that could clearly be placed in one of the categories of works, shown in Table 1, were analyzed.

Table 1. Value of maintenance works on public buildings from 2018 to 2022 for the City of Rijeka

<table>
<thead>
<tr>
<th>Work type</th>
<th>Cost (€)</th>
<th>SUM (€)</th>
<th>Share in total cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpentry work</td>
<td>0.00 0.00 4,666.67 2,666.67 4,000.00</td>
<td>11,333.34</td>
<td>2.20%</td>
</tr>
<tr>
<td>Ceramics works</td>
<td>0.00 0.00 2,400.00 10,666.67 6,666.67</td>
<td>19,733.34</td>
<td>3.82%</td>
</tr>
<tr>
<td>Concrete works</td>
<td>0.00 0.00 15,333.33 4,000.00 0.00</td>
<td>19,333.33</td>
<td>3.75%</td>
</tr>
<tr>
<td>Demolition and dismantling</td>
<td>0.00 0.00 0.00 7,333.33 0.00</td>
<td>7,333.33</td>
<td>1.42%</td>
</tr>
<tr>
<td>Earthworks</td>
<td>500.00 2,666.67 5,600.00 0.00 0.00</td>
<td>8,766.67</td>
<td>1.70%</td>
</tr>
<tr>
<td>Facade works</td>
<td>0.00 0.00 10,000.00 12,666.67 0.00</td>
<td>22,666.67</td>
<td>4.39%</td>
</tr>
<tr>
<td>Glazing works</td>
<td>0.00 0.00 0.00 0.00 0.00</td>
<td>4,000.00</td>
<td>0.78%</td>
</tr>
<tr>
<td>Insulation works</td>
<td>0.00 3,333.33 0.00 0.00 0.00</td>
<td>3,333.33</td>
<td>0.65%</td>
</tr>
<tr>
<td>Joinery works</td>
<td>24,416.67 17,333.33 22,200.00 33,333.33 16,666.67</td>
<td>113,950.00</td>
<td>22.09%</td>
</tr>
<tr>
<td>Locksmith works</td>
<td>4,666.67 8,666.67 0.00 5,333.33 3,333.33</td>
<td>22,000.00</td>
<td>4.26%</td>
</tr>
<tr>
<td>Masonry works</td>
<td>0.00 0.00 0.00 1,333.33 0.00</td>
<td>1,333.33</td>
<td>0.26%</td>
</tr>
<tr>
<td>Painting works</td>
<td>14,666.67 6,666.67 0.00 30,666.67 14,666.67</td>
<td>66,666.68</td>
<td>12.92%</td>
</tr>
<tr>
<td>Plasterboard works</td>
<td>2,666.67 0.00 0.00 0.00 0.00</td>
<td>2,666.67</td>
<td>0.52%</td>
</tr>
</tbody>
</table>
From the plans, 17 groups of construction and craft works were identified, within which maintenance works are performed at public institutions. According to the obtained results, it is evident that the largest share in the total maintenance costs has joinery works, which are mainly related to the replacement of joinery (doors, windows) on buildings, while the smallest share is of masonry work.

From the set of works categories, those that participate in the total maintenance costs of more than 3% through the observed period are further separated, and these are in order: joinery, underlayment, painting, roofing, sheet metal, preparation, facade, locksmith, ceramics, and concrete works.

To analyze changes in materials prices from prominent groups of construction and craft works, one characteristic material from each group was selected, which according to literature (Marović, 2022) and practical experience, is most often used and bears the most costs in a particular group of works. Selected materials whose prices were analyzed are shown in Table 2.

Table 2. Increase in prices of observed maintenance materials

<table>
<thead>
<tr>
<th>Work type</th>
<th>Observed material</th>
<th>Unit</th>
<th>04/2021</th>
<th>10/2021</th>
<th>04/2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceramics works</td>
<td>Ceramic tiles</td>
<td>m2</td>
<td>13.87</td>
<td>18.17</td>
<td>14.40</td>
</tr>
<tr>
<td>Concrete works</td>
<td>Concrete</td>
<td>m3</td>
<td>82.67</td>
<td>116.67</td>
<td>122.67*</td>
</tr>
<tr>
<td>Facade works</td>
<td>Styrofoam</td>
<td>m2</td>
<td>3.73</td>
<td>6.35</td>
<td>6.42</td>
</tr>
<tr>
<td>Joinery works</td>
<td>PVC joinery</td>
<td>piece</td>
<td>831.03</td>
<td>1,462.97</td>
<td>1,582.94*</td>
</tr>
<tr>
<td>locksmith works</td>
<td>Steel</td>
<td>kg</td>
<td>1.73</td>
<td>4.33</td>
<td>5.63*</td>
</tr>
<tr>
<td>Painting works</td>
<td>Wall paint</td>
<td>kg</td>
<td>0.46</td>
<td>0.58</td>
<td>0.66</td>
</tr>
<tr>
<td>Preparation works</td>
<td>Scaffolding</td>
<td>m2</td>
<td>16.00</td>
<td>30.67</td>
<td>32.14*</td>
</tr>
<tr>
<td>Roofing works</td>
<td>Timbering</td>
<td>m3</td>
<td>200.00</td>
<td>346.67</td>
<td>386.67</td>
</tr>
<tr>
<td>Sheet metal works</td>
<td>Galvanized sheet</td>
<td>m2</td>
<td>6.67</td>
<td>12.00</td>
<td>13.61</td>
</tr>
<tr>
<td>Underlayment works</td>
<td>Screed</td>
<td>kg</td>
<td>0.07</td>
<td>0.10</td>
<td>0.13</td>
</tr>
</tbody>
</table>

| SUM (€/unit)       | 1,156.23          | 1,998.51 | 2,165.27 |
| Percentage price increase | 0% | +72.85% | +87.27% |

*Prices were not available from the store; approximate prices were determined based on world stock market movements (Department for Business, Energy and Industrial Strategy, 2022)

Price changes were analyzed in the period from April 2021 to April 2022, with an additional cross-section in the middle, i.e. in October 2021. All listed prices are per unit of product, without VAT. They were taken from a building material store whose name and the exact specifications of the selected materials can be obtained from the corresponding author of this paper. Prices that were unavailable for some reason were determined approximately based on the movement of world markets for each building material (Department for Business, Energy and Industrial Strategy, 2022).
The results show that material prices rose through 2021, as well as through the period of 2022. Compared to April 2021, prices in October 2021 were on average 72.85% higher, and in April 2022, as much as 87.30% higher. The average price of materials increased by 8.34% from October last year to April this year. The price increase of each material compared to April 2021 is shown in the graph in Figure 4.

![Figure 4. Percentage increase in prices of observed building materials compared to 04/2021](chart)

The most significant price increase in the one year was recorded in steel, as much as 225.43%. Galvanized sheet metal and scaffolding, which is most often made of steel pipes and sheets, also have a jump in the price by over 100%. The smallest price increase in the observed period was recorded in ceramic tiles, 3.82%, whose price decreased slightly compared to October 2021.

Figure 5 graphically shows the growth trend of prices for observed materials in one year.
Figure 5. The growth trend in prices of observed maintenance materials per unit price
Figure 5 shows the unit price growth curves of individual materials, and it can be recognized that almost linear price growth in the past year had steel, wall paint and screed.

5. DISCUSSION AND RECOMMENDATIONS

The results indicate that the increase in building materials prices for maintenance is very pronounced. In the circumstances of uncertainty and the risk of additional price increases, the overall maintenance management of public buildings is complex, especially the planning and completion of maintenance work, provided that it contains the anticipated performance quality and does not endanger users, and ensures their satisfaction. According to economic experts, it is not known when the market will stabilize. Given that public managers depend on the available maintenance budget, decision-making in such circumstances is further challenging, as they must be aware of potential risks and, in the future, consider how to include them in the plan and perform the highest priority works. There is a great danger in stopping the started investments. If there is an increase in costs and additional funds are not available, the state should undoubtedly intervene since these are buildings of public and social importance. Funds in the budget can be further increased by increasing the prices of services and taxes - citizens giving and collecting donations.

Given the above and the presented results, the set research hypothesis can be confirmed. Frequently used materials in the maintenance of public buildings were singled out, such as: ceramic tiles, concrete, styrofoam, PVC joinery, steel, wall paint, scaffolding, wood, galvanized sheet metal, and cement screed. Unfortunately, the prices of these materials increased many times from April 2021 to April 2022, which negatively affects the performance of maintenance in public buildings and makes it challenging to make maintenance decisions, given the rather limited budgets for current and investment maintenance of these buildings.

It is necessary to consider how such events with prices can be mitigated, i.e., how public managers should make decisions and manage the entire maintenance process in public institutions. Long service lives characterize public buildings, they are social buildings, with many users, which have almost no income during their lifetime, and therefore depend on public financial resources and should be spent rationally. Through the theoretical background review, it was noticed that the entire management system for the maintenance of the public buildings has shortcomings, from neglect of maintenance during the design phase, to the lack of clear policies and standards for maintenance, lack of clear priority systems, non-use of computer support, excessive reliance on reactive maintenance, etc. The underlying problems need to be addressed, which will make the maintenance management process less vulnerable to the activation of risk factors, such as price fluctuations. The overall maintenance management should be more cost-effective and should start from the earliest stages of the construction project - from design.
Public administrators can apply certain measures to make maintenance management more resilient in unforeseen situations. Some of the actions are as follows:

- Record in detail the condition of public facilities based on which a rational system of investment priorities will be developed. A priority system will provide for implementing the most critical and necessary works at the beginning of maintenance plans and will ensure more transparent planning of projects and maintenance works. In addition, a well-planned maintenance strategy based on a rational assessment of priorities will ensure better performance and optimize available resources.

- The most accurate assessment and planning of maintenance work and their costs, with the calculated risk of price changes. Planning is necessary to use human and material resources appropriately and avoid confusion, uncertainty, risks, waste of resources, etc. In addition, more accurate maintenance plans would provide better insight into budget allocation, help control and control costs, and enable adequate use of available funds.

- Develop a long-term maintenance plan. It is recommended to have a plan covering several decades in which maintenance costs are planned. This plan would be useful to develop at the design stage as part of the life cycle cost analysis, where the maintenance of the building would be planned for a certain period of use to determine maintenance expenditures during the observed period. This would have a positive impact on the dynamics and the total amount of operating costs. From the long-term plan, more detailed maintenance plans are developed later, during the use phase.

- Turn to a strategy of preventive planned maintenance. This reduces maintenance costs in the long run because it avoids problems leading to higher reactive maintenance costs. Planned maintenance should be the main activity in the field of building maintenance. In the case of unplanned maintenance, the exposure to higher costs for the implementation of such works is higher. Therefore, unplanned maintenance should be kept to a minimum to allow for optimal management of maintenance costs.

- In the event of a delay in particular maintenance work or if some critical work cannot be started due to a lack of financial resources, try to obtain additional financial resources in the budget. If this is impossible, it is necessary to evaluate the planned spending and redirect the available financial resources to the most priority maintenance interventions. Reducing the quality of materials and works must not be allowed.

- Provide continuing education and training for all persons involved in the maintenance of public buildings, from technical staff to maintenance managers. In this way, they will expand their knowledge and will be able to perform a broader range of work, handle more equipment, and get acquainted with the application of new technologies. In this way, the involvement of external contractors will be somewhat reduced. Public administrators must have a good knowledge of the scope
of maintenance to ensure that the maintenance strategies applied are appropriate for public buildings.

- Identify which smaller materials and products for maintenance are most often used in the maintenance of public buildings, procure a certain amount, and create stocks of materials and parts for current maintenance that can be used immediately.

- The work to be performed by external contractors should be performed under longer-term contracts, in which cooperation will be concluded with one contractor who will perform most of the work. This will enable more efficient and faster maintenance work and less exposure to risk factors.

- Implement CMMS to manage the entire maintenance process to facilitate maintenance management. The system serves as an aid to decision-makers. The software will enable more efficient communication and faster and easier maintenance planning, directing staff to activities, planning resource consumption, monitoring maintenance costs and durations, keeping maintenance records, and documenting failures, damage, causes, etc. Successful implementation of CMMS facilitates adoption decision-making, reduced material costs, and more efficient management is achieved.

- When designing public buildings, maintenance experts should be engaged to develop a solution that will have the most cost-effective effect during the use phase of the building. It can often be found that facilities are expensive to maintain due to wrong priorities during the design phase. On the other hand, a lot can be saved in the use phase with the right design, so experts should be consulted from the earliest stages of the project.

These measures are general and valuable for all maintenance decision-makers and all types of buildings as they aim to improve the overall management process. In this way, maintenance would be approached in a way that increases the proactivity and quality of implementation of maintenance activities while minimizing the consumption of resources, primarily maintenance costs, which will make maintenance less susceptible to market changes.

6. CONCLUSION

The research was conducted on the public buildings maintenance process and changes in prices of frequently used building materials for maintenance, as well as the impact of changes in these prices on the maintenance management process conducted by public managers. As a result, the research goal was met, and the set hypothesis was confirmed.

The price of building materials for maintenance has increased many times in the last year. From April 2021 to April 2022, an increase of 87.30% was recorded. Public administrators, whose decisions on the use of maintenance funds are mainly based on the available budget, are highly affected by this situation. Works are planned based on one price, contracted based on another, and already when performing works is a new situation with prices, which leads
to the fact that public managers due to increases cannot perform all planned works, give up some interventions, which makes users dissatisfied, and reduces the quality of services provided. The maintenance of public buildings requires considerable financial investments, the allocations of public bodies for maintenance are limited, and there is no framework/model for effective management of resources in current practices. As time goes on, the age and condition of public buildings cause an additional increase in maintenance costs.

The increase in prices has recently been expressed in all markets, the prices of all raw materials, products, labor, real estate, and the cost of living have increased. When the situation will stabilize, economic experts are only guessing.

Since changes and price increases cannot be influenced, public institutions' overall maintenance management model needs to be changed to become more cost-effective. In order to achieve this, recommendations were given to make maintenance management more robust in unpredictable situations.

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