sustainability

Article

Priorities in Croatian School Building Maintenance: A Comparison of the Main Stakeholders' Views

Ksenija Tijanić Štrok [1,*], Diana Car-Pušić [1] and Saša Marenjak [2]

[1] Department of Construction Management and Technology, Faculty of Civil Engineering, University of Rijeka, Radmile Matejčić 3, 51000 Rijeka, Croatia; diana.car.pusic@uniri.hr
[2] PPP Centar d.o.o., Mlinarska Cesta 61a, 10000 Zagreb, Croatia; sasa@pppcentar.com
* Correspondence: ksenija.tijanic@uniri.hr

Abstract: This paper aims to examine the opinions of the main recognized stakeholders in the maintenance of school buildings (i.e., the construction experts within the founders' organization, the school staff, and the students), compare their views on the maintenance priorities, and identify certain differences. These data provide information about user needs, can help school founders make maintenance decisions, and are the basis for developing a new, balanced system of maintenance priorities. In the research, the survey questionnaire method was used to collect the data, whereby three groups of stakeholders evaluated the priority of eliminating certain defects in school buildings on a 5-point scale. For the purposes of the questionnaire, a model of 32 defects of the school buildings was created. In the questionnaire, 76 experts, 338 school staff, and 297 students participated. The research is limited to the Republic of Croatia. By conducting non-parametric statistical tests (Kruskal–Wallis and Mann–Whitney), it was shown that there were statistically significant differences in the stakeholders' attitudes towards most maintenance priorities. There were also defects where statistically significant differences were not recognized, namely, regarding faulty lighting fixtures, faulty toilets, faulty sinks, faulty space cooling systems, faulty space heating systems, and faulty hot water heating systems. According to the experts, it is most urgent to remove faulty electrical installations, while according to the school staff, the highest priority is faulty sewage installations. The students believe that the priority is faulty toilets. The lowest priority is removing damage to the external environment (experts) and the facade (school staff and students).

Keywords: school buildings; maintenance; maintenance priorities; stakeholders; comparison of views; non-parametric tests

Citation: Tijanić Štrok, K.; Car-Pušić, D.; Marenjak, S. Priorities in Croatian School Building Maintenance: A Comparison of the Main Stakeholders' Views. *Sustainability* **2023**, *15*, 11767. https://doi.org/10.3390/su151511767

Academic Editor: Antonio Caggiano

Received: 21 June 2023
Revised: 24 July 2023
Accepted: 25 July 2023
Published: 31 July 2023

1. Introduction

The school teaching and learning process is more effective and of higher quality if it is supported by appropriate maintenance of the school space and infrastructure [1–6]. Making decisions on school maintenance and priorities is very demanding, primarily due to the complexity of the educational system and the number of stakeholders involved [7].

The school end users and owners (founders) are the main stakeholders in school building maintenance. The founders, within the maintenance department, usually have engineers (experts) who take care of the maintenance of all buildings under their jurisdiction. They are the ones who traditionally make most of the decisions regarding the maintenance of school buildings [4]. On the other hand, the end users, i.e., the school staff and students, are the most numerous stakeholders and are the ones most affected by the aforementioned decisions; therefore, maintenance should be initiated to enable the buildings to function according to their requirements. The need to identify the differences between what the maintainers (construction experts within the founder) provide and what the end users (i.e., school staff and students) need is emphasized.

This paper aims to examine the views of the main stakeholders in the school maintenance process, namely the construction experts, school staff, and students, on the maintenance priorities and to compare their opinions. It is important to know the differences in opinion regarding the maintenance priorities so that these differences, if any, can be reconciled and a system can be created that meets the needs of all stakeholders. The stakeholders' expectations and demands should be managed, as they could have conflicting interests. The users' opinions and satisfaction with the performance of the building are crucial and should be listened to and taken into account. By gathering the opinions of key stakeholders on the maintenance of school buildings, this research will provide valuable insights into the different perceptions of the end users and experts, thereby presenting a balanced view on school maintenance issues. The research hypothesis assumes no significant differences in the attitudes of the selected stakeholders (experts, school staff, and students) regarding the maintenance of school buildings. In other words, the stakeholders will agree on the school buildings' maintenance priorities. This statement will be examined based on a database and statistically proven. The study is limited to the territory of the Republic of Croatia.

The paper is organized as follows. It begins with Section 1, in which the problem, aim, and general hypothesis of the research are highlighted, as well as a concise overview of the previous research. Within Section 2, the way in which the research is conducted and the scientific methods and statistical tests used are explained. Within Section 3, the results from processing the collected data are presented, the results obtained are discussed, and the direction of future research is given. The last Section 4 includes our conclusions.

Previous Research

According to [8], building maintenance is a set of activities undertaken to preserve, protect, and improve buildings to serve the desired functions throughout their lifetime. The authors of [9] state that maintenance aims to extend the life of the building, i.e., to maintain it as long as possible in its initial functional, structural, and aesthetic condition [7]. Building maintenance is a complex task within facilities management that includes planning, organizing, directing, and controlling maintenance activities [4,10]. Maintenance management means making decisions and establishing strategies, policies, goals, maintenance responsibilities, and ways of performing maintenance [4]. The authors of [8] state that inadequacies in the current approaches to maintenance lead to inadequate service provision, unnecessary cost increases, and user dissatisfaction. Due to the above reasons, many studies have been conducted in the last decade to propose new principles and methods of maintenance management, such as the studies by the authors of [4,8,11–17].

Public educational buildings, i.e., public elementary and secondary schools [4], which are the subject of this research, are particularly sensitive to maintenance problems. School buildings are specific and deteriorate quickly due to their age and extensive use [11,18], and a great challenge is the diverse components of buildings with different requirements for repairs [11]. Additionally, schools have significantly higher capacity and occupancy rates than any other types of building [19], and school users spend as much as 25% of their time in them [18]. Furthermore, school institutions have significant physical and psychological impacts on their users [20,21].

Decisions about the maintenance of school buildings (and other buildings) ensure that the building systems, components, and equipment work effectively together [9]. Making decisions and prioritizing which aspects should be maintained is one of the demanding activities within the maintenance management process [4], and according to [22], it represents the basis of effective building management. The authors of [23] stated that such decisions are challenging for most facilities management and maintenance experts.

Numerous authors [4,8,24–32] confirm that in maintenance decision making, along with experts, the users' views should also be heard. According to [4], neglecting the users' views when making maintenance decisions can affect their satisfaction with the maintenance processes and the institution's functioning. It will also affect their productivity and work results in the long run. Also, the quality of the building will be better if the users contribute to creating the building management policy. In this way, transparency in determining maintenance priorities will increase, users' awareness of maintenance will increase, and thus the quality of buildings will increase. The authors of [31,33] highlight the stakeholders of school buildings, such as founders, maintenance representatives, teachers, parents, and students, and consider their involvement in the maintenance planning process very necessary. According to [4,10,25], building users have no influence on maintenance management practices. The author of [4] states that maintenance plans for public schools are drawn up by their founders without consultation with their principals and users, who, in the end, are not even aware of the funds intended to be invested in their facilities. The authors of [24] claim that consultation with the end users should be an instrument for establishing a proactive maintenance management process. The authors of [4,34], however, state that although user satisfaction should be considered, one should be careful because they do not possess the necessary maintenance knowledge to be able to set priorities correctly; therefore, their contribution to the development of the priority system should be carefully designed and valued.

The authors of [34] investigated the maintenance priorities of public housing users. It was found that the most important reasons for initiating maintenance activities are the safety and health of the users and the preservation of the habitability and operational condition of the building. It was also determined that users' three main maintenance priorities are installation failures, sanitation failures, and pipe leaks [34]. According to [35], in residential buildings, the highest priority is removing faults in elevators, plumbing, power supply, and security systems. A study [36] found that facility maintainers prioritize work that affects safety, service interruption, and maintenance budgets. The authors of [37] showed that building users generally prioritize health, safety in use, and functionality as the three most important aspects of maintenance. The authors of [38] showed that in social housing, users consider heating, plumbing systems, hinges, and locks on windows and exterior doors, as important aspects of maintenance.

Furthermore, the authors of [24] found that in the case of commercial buildings, users emphasize cleaning, safety and security, and air conditioning as priorities, and according to maintenance managers, safety and security, cleaning, and elevators are the most critical maintenance priorities. According to the authors of [8], the main stakeholders in maintaining university buildings include the maintenance organization and the end users, i.e., university students. The authors of [8] also state that there are specific opinion differences between the two stakeholder groups in ranking maintenance priorities. According to the maintenance organization, the highest priorities are maintenance work on elevators, electrical installations, roofs, and fire protection systems. At the same time, according to the university students, the maintenance priorities are maintenance of electrical installations, air conditioning, roofing, water supply and sewage [8]. According to [39], the maintenance plan for educational facilities is drawn up exclusively by the founder according to the available financial resources and their priorities, which are works according to inspection solutions, works on heating systems, works on sewage and plumbing installations, works on roofs, works on electrical installations, works on windows and doors.

According to [8], recognizing and meeting user expectations is an integral part of an effective maintenance process, especially since user needs are increasingly demanding. Furthermore, those who understand buildings best are the people who use them every day; therefore, there is a need for the organization to learn from its users when and how maintenance should be carried out.

No research was discovered that would include and compare the opinions of end users (primarily students) and experts regarding maintenance priorities of school buildings (elementary and secondary). However, it is recognized in the literature that school buildings' conditions and quality greatly influence end users [20,21]. Adequate maintenance of school facilities supports upbringing, teaching and learning processes, making them more efficient and of higher quality [1–6], which consequently impacts the development of the entire society. What end users and the maintenance department consider important for maintenance may differ, and disagreement about the order of priorities for maintenance may result in user dissatisfaction with the condition of the building [34]; therefore, their views should be examined in more detail and integrated into the maintenance policy of school buildings [4].

2. Materials and Methods

A research flowchart was developed consisting of five main steps, as shown in Figure 1.

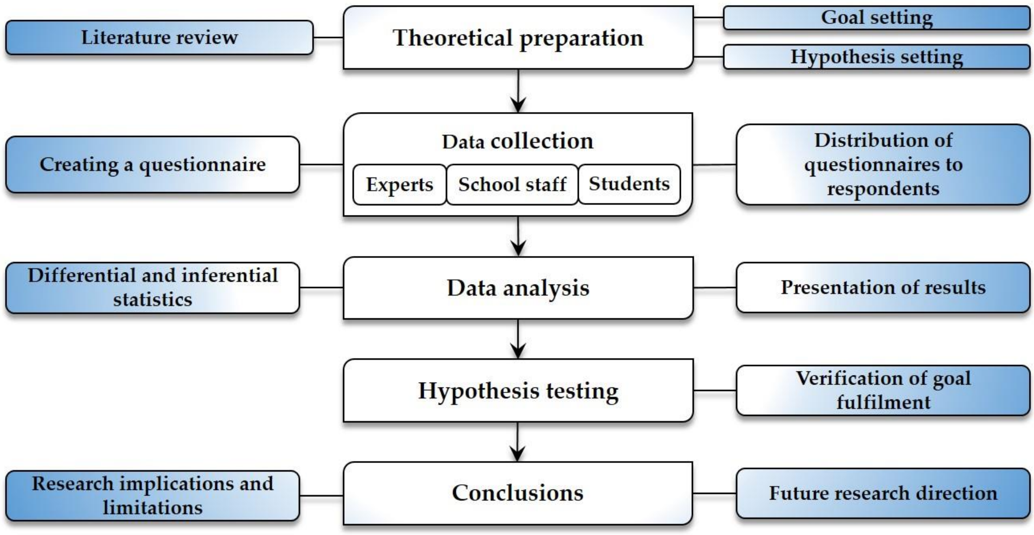

Figure 1. Flowchart of the research.

During the theoretical preparation, the importance of school buildings to the social community was established. Also, the impact of schools on end users was recognized. The main stakeholders in the maintenance of school buildings were identified, namely the construction experts (within the founder), the school staff, and the students (end users). It was observed that the views of the most numerous stakeholders, i.e., end users, are not highlighted anywhere and are not considered when making decisions and priorities consideration. School staff refers to persons employed within the school institution, including teaching, professional and technical staff. Students include minors who attend elementary or secondary school for their upbringing and education. Because of the different roles in the school system, the different sizes, and the different needs and expectations of the school system and buildings, these two end user groups are viewed as separate entities. A research goal was created, including the discovery and comparison of the views of prominent stakeholders on the priorities of maintaining school buildings, and a general hypothesis was defined. The hypothesis assumes that significant differences in stakeholders' views do not exist. After the goal and hypothesis of the research were defined, a concise but detailed analysis of the literature was carried out, where important discoveries by previous researchers related to the discussed issue were highlighted.

The necessary data will be collected utilizing a survey questionnaire. The survey approach was chosen because it follows this research's requirements. It can be used to obtain data for achieving the set goals effectively and relatively easily. Along with some general questions, within the questionnaire, it is planned that three groups of respondents (experts, school staff, and students) rate how urgent, in their opinion, it is to remove a particular defect in a school building. The respondents are from the territory of the Republic of Croatia. A scale with ratings from 1 to 5 was used, with the meanings of the ratings as follows:

- 1 = not urgent at all;
- 2 = not urgent;
- 3 = fair;

- 4 = urgent;
- 5 = very urgent.

Within the rating scale, each qualitative response has an exactly associated quantitative value.

A simplified model was developed for the questionnaire, dividing the building into four groups of elements (structural, architectural, electrical, and mechanical). The model also contains the main wear and tear defects that may appear within the observed elements. The model includes 32 defects derived from several literature sources [4,8,24,34,35,38–46], as well as from the reflections of the author of this work. Defects may have different meanings for different people. However, according to the literature [8], they are defined as undesirable or inadequate building conditions that affect usability, performance, structural conditions, or aesthetics. The appearance of defects is a sign that the building is no longer in its initial state, which indicates the need for maintenance. Defects within the developed model (Table 1) refer to the primary, well-known elements of the building that can be damaged, broken, faulty, etc. These defects' occurrence is mostly visible and easily recognizable. The severity of a particular defect depends on the understanding and perception of the respondents.

Table 1. The model of buildings defects.

Group Number	Building Element Group (Building Elements)	Defect Number	Defect	References that Support the Choice of a Particular Defect
1.	Structural (bearing walls, pillars, beams, floor and mezzanine panels, roof construction, stairs)	1.1.	Deep cracks	[41,43,45]
		1.2.	Surface cracks	[40,41,43,45,46]
		1.3.	Peeling/chipping	[43,46]
		1.4.	Moisture in elements	[40–43]
		1.5.	Exposed reinforcement	[43]
		1.6.	Buckling/twisting	[4]
2.	Architectural (flooring, wall and ceiling coverings, roof coverings, partition walls, gutters, façade, windows and doors, furniture and equipment, external environment)	2.1.	Damaged floor coverings	[8,34,41,43–46]
		2.2.	Damaged wall and ceiling coverings	[8,34,41–43,46]
		2.3.	Damaged roof coverings	[38,39,41,43,45,46]
		2.4.	Damaged partition walls	[8,42–45]
		2.5.	Damaged gutters	[8,38,41,43,46]
		2.6.	Damaged facade	[38,43,44]
		2.7.	Broken windows and doors	[8,34,38,39,43–46]
		2.8.	Damaged sashes, frames, or locks on doors and windows	[8,34,38,39,43,46]
		2.9.	Damaged furniture or equipment	[8]
		2.10.	Damage to the external environment	[24,35,38]
3.	Electrical (electric wires, switchboard, lighting fixtures, switches, sockets, lightning rod)	3.1.	Faulty electrical wiring	[8,24,34,39,43,44,46]
		3.2.	Faulty switchboard	[8,24,34,39,43,44,46]
		3.3.	Faulty lighting fixtures	[8,24,44]
		3.4.	Faulty switches	[8,34,43,44]
		3.5.	Faulty sockets	[8,34,43,44]
		3.6.	Faulty lightning rod	[4,44]
4.	Mechanical (sanitary equipment, plumbing and sewage installations, space heating system, space cooling system, hot water heating system, chimney, fire protection system, elevator)	4.1.	Faulty toilets	[8,34,38,43]
		4.2.	Faulty sinks	[8,34,43,46]
		4.3.	Faulty plumbing installations	[8,34,35,38,39,44,46]
		4.4.	Faulty sewage installations	[8,34,39,44,46]
		4.5.	Faulty space cooling system	[8,24,43]
		4.6.	Faulty space heating system	[38,39,43]
		4.7.	Faulty hot water heating system	[8,38]
		4.8.	Damaged chimney	[4]
		4.9.	Faulty fire protection system	[8,35,43,44,46]
		4.10.	Malfunctioning elevator	[8,24,35,43]

The building defect model developed in this paper and used in the survey questionnaire is shown in Table 1. Table 1 also indicates references that support the selection of an individual defect tested.

The list of 32 defects may not be exhaustive, but it indicates the primary deficiencies affecting the school building's performance and users. This division applies to most high-rise buildings and can be used for further research. Some other specific defects can easily be added to the above list, depending on the type and purpose of the building being tested. Therefore, the list of defects in school buildings listed here is limited, and some building elements were not considered, such as unseen structural elements, more complex technological, mechanical, and communication systems, building details, etc. Additionally, defects were not observed in detail through their causes, treatment methods and consequences. The list given in this study was created keeping in mind the respondents for whom it was intended without going into more complex analyses of building defects.

Questionnaires were forwarded to 147 construction experts who work for school founders (counties, cities) via email. The survey questionnaires were also forwarded through social networks to groups that gather school staff and students from elementary and secondary schools. In the mentioned groups, 87,346 school staff and 27,621 students are represented. It should be considered that a certain number of examinees belong to several different social network groups, so the actual number of the surveyed population is smaller.

Elementary schools are compulsory for all children in Croatia, while secondary schools are still not. These two types of schools also differ in size, equipment, and primarily, in the age of the children who attend them, so their needs and experiences may vary. As for the maintenance of these schools, they share similar issues, are maintained using the same procedures, from the same funds, and the same founders make maintenance decisions. For these reasons, elementary and secondary schools as educational institutions for children will be viewed as one unit. Due to the highlighted differences, observing elementary and secondary schools separately in future research is recommended.

Data were collected intermittently from mid-2020 until the beginning of 2023.

The questionnaire was returned by 76 experts and 635 end users (338 staff members and 297 students) after several rounds of sending requests. Considering the size of the respondent population, the collected data samples give a margin of error of about 5–8% at a confidence level of 95% (Table 2), which, according to [47], is satisfactory.

Table 2. The response rate of the questionnaire.

Examined Stakeholders	Examined Population Number	Response Number	Margin of Error (%)
Experts	147	76	7.86
School staff	87,346	338	5.32
Students	27,621	297	5.66

Furthermore, according to [25], the sample should be between 32 to 500 respondents to be statistically relevant. Considering that some authors [2,8,12,30,31,48] have worked with a similar or smaller number of respondents, the number of respondents collected here is considered acceptable for continuing the research.

The questionnaires are anonymous. The Cronbach's alpha test was used to measure the reliability, that is, the consistency of the questionnaire measure, which shows the size of the measurement error in the questionnaire. Questionnaire results with a Cronbach's alpha coefficient above 0.700 are usually acceptable [49].

The collected data were statistically processed using Microsoft Excel 2016 software with the add-in of Real Statistics (for Excel 2016), and the results are presented visually and in tabular form.

Appropriate statistical tests are used for data processing and comparison. The study's primary goal is to examine the existence of statistical differences between the views of independent groups of stakeholders. The statistical tests applied for these purposes primarily depend on the distribution of the collected data. If the data are normally distributed, parametric tests such as the *t*-test are usually used to test for differences between two groups of data, and ANOVA tests are used for differences between more than two data groups. There are also equivalent, non-parametric tests such as the Mann–Whitney test (differences between two data groups) and the Kruskal–Wallis test (differences between more than two data groups), used for data deviating from the normal distribution [50]. Within this research, the data collected are of ordinal type (not normally distributed); therefore, inferential statistics were applied, including the non-parametric Kruskal–Wallis and Mann–Whitney tests, which test statistical hypotheses. Thus, using the Kruskal–Wallis test, it is possible to conclude the existence of differences among the three tested data groups. However, it is not possible to know which groups differ. For this purpose, it is necessary to perform an analysis using the Mann–Whitney test to compare the two groups [50,51].

The following statistical null hypotheses are established:

H_0. *There is no statistically significant difference in the views of stakeholders (experts, school staff, and students) on the priority of removing individual defects in the school building.*

H_0. *There is no statistically significant difference in the views of experts and school staff on the priority of removing individual defects in school buildings.*

H_0. *There is no statistically significant difference in the views of experts and students on the priority of removing individual defects in school buildings.*

H_0. *There is no statistically significant difference in the views of school staff and students on the priority of removing individual defects in school buildings.*

Statistical significance indicates a relationship between variables that is not due to chance. A statistically significant difference tells whether the responses of one group are significantly different from those of another group by performing statistical testing. The significance level (p) was set at 5% (α = 0.05). Using the Kruskal–Wallis test, the null hypothesis is rejected if $p < 0.05$. With the Mann–Whitney test, it is recommended to lower the significance level to reduce the possibility of a type 1 error. A type 1 error is rejecting the null hypothesis even though it is true. For this purpose, the Bonferroni formula can be used, where the critical p-value (α = 0.05) is divided by the number of comparisons made [50,51].

Based on the obtained results of data processing and hypothesis testing, the conclusions of this research will be made.

3. Results and Discussion

The shares of surveyed experts by profession are shown in Figure 2, and by years of professional experience in Figure 3.

The most examined experts are those with a degree in civil engineering (graduate), comprising 41 of the expert respondents (53.95%). The group, "other", includes experts whose titles are mechanical engineering graduate, electrical engineering graduate, geodesy engineer, etc. The professional experience of 11 to 20 years of service has the most significant number of examined experts at 25 respondents or 32.89%. Twenty-two (28.95%) of the examined experts had more than 20 years of experience. Given the complex issue being discussed, it is very favourable that most of the examined experts have many years of experience in this field.

The experts were also asked in the questionnaire whether end users should be involved in defining maintenance priorities. The answers were in the form of "yes" or "no". About 91% of the experts answered affirmative (Figure 4). These results confirmed the thesis from the literature review that the user's contribution in this segment of decision-making is very important for maintenance. This finding confirms that the research conducted here is relevant and significant and will contribute to the appreciation of the end users' opinions in maintaining school infrastructure.

End user respondents include students and school staff, i.e., teachers, professors, and principals. Both groups of respondents are from elementary and secondary schools, and information on the numbers of individual respondents by type of school is shown in the graph in Figure 5.

Of the 338 surveyed school staff, 250 (73.96%) worked in elementary schools, and 88 (26.04%) worked in secondary schools. Of the 297 students who answered the questionnaire, 79 (26.60%) attend elementary schools, and 218 (73.40%) attend secondary schools. In this research, elementary and secondary schools are considered together.

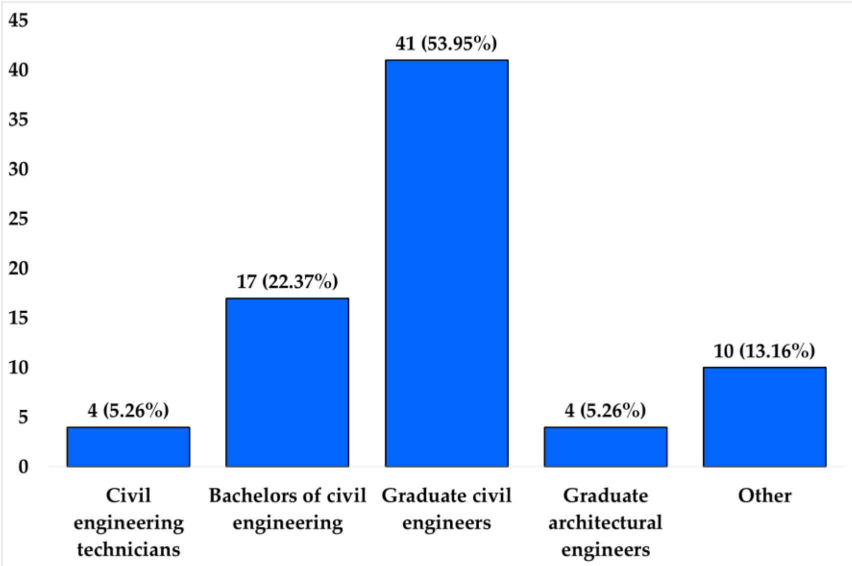

Figure 2. Share of examined experts by profession.

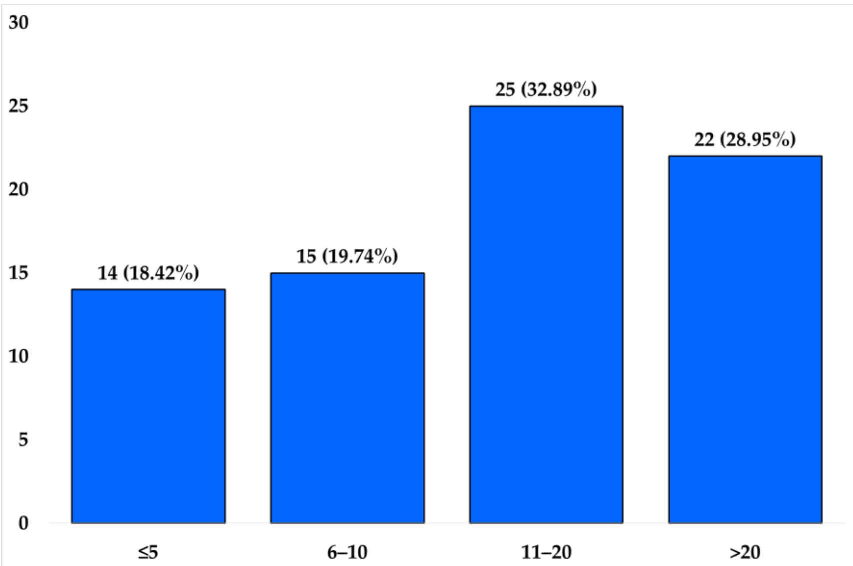

Figure 3. Share of examined experts by years of professional experience.

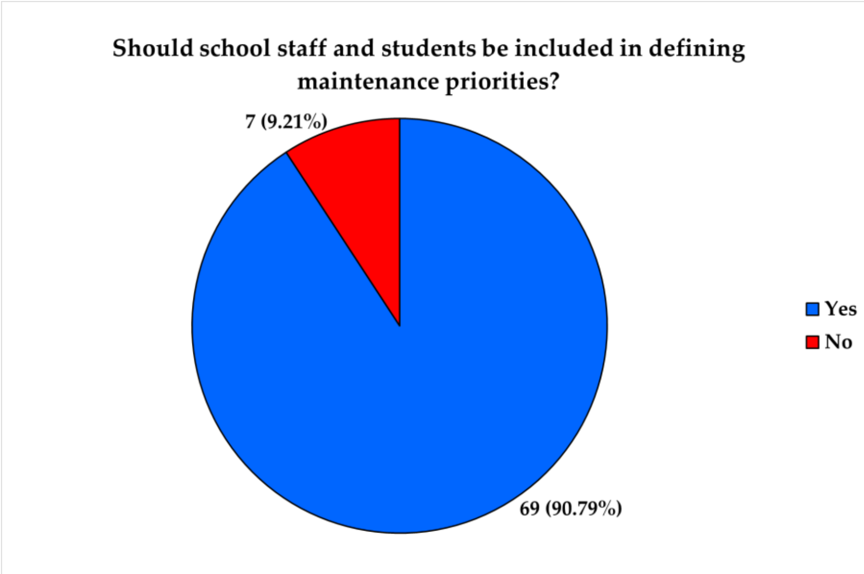

Figure 4. Share of responses to experts' agreement with end users' involvement in defining maintenance priorities.

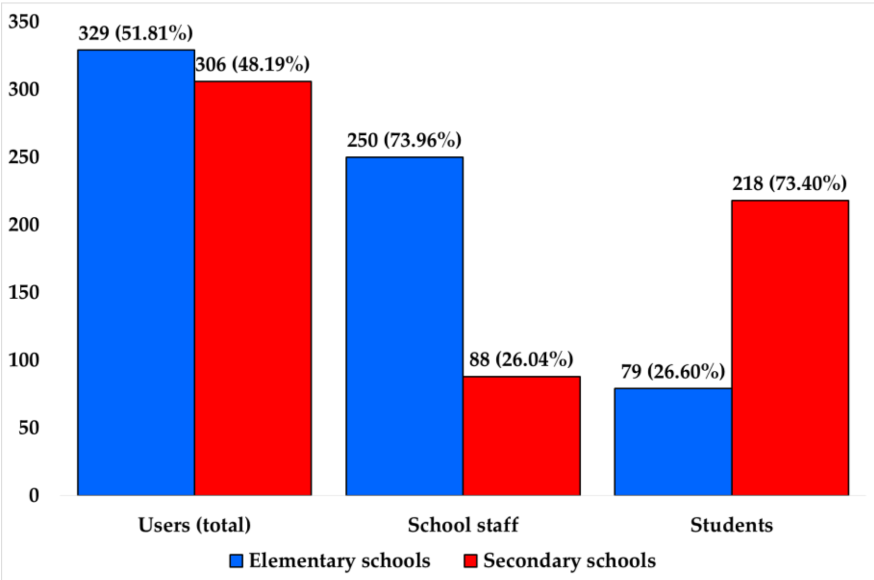

Figure 5. Share of surveyed school end users by type of school.

The central part of the questionnaire refers to the investigation of attitudes toward the priority of removing certain defects in school buildings. Although the end users' knowledge of maintenance processes cannot be compared to that of construction experts, this does not mean that they cannot make a specific contribution from their point of view and assess how much priority is given to removing individual defects. During this evaluation, users were guided by the effect that a particular defect has on them and how it affects their safety, health, comfort, the reliability and quality of education, productivity, the aesthetics of the space, etc. The experts will rank the defects primarily by looking at how each defect works on the essential requirements of the building and by assessing maintenance costs and the available budget. Maintenance cost is a critical prioritization criterion because the available budget for maintenance is limited [52–54]. On this side, the development of the priority system should be carefully optimized, considering all requirements, limitations and involved stakeholders.

The reliability of the completed questionnaires was measured using Cronbach's alpha coefficient. The value of this coefficient for the questionnaire filled out by experts is $\alpha = 0.957$; for the questionnaire filled out by school staff, $\alpha = 0.972$; and for the questionnaire filled out by students, $\alpha = 0.975$; and concerning the results, the questionnaires are considered sufficiently reliable (the set limit is $\alpha = 0.700$).

Experts, school staff, and students were tasked to rate how urgent it is, in their opinion, to remove certain defects in the school building. The questionnaire was a scale with ratings from 1 = not urgent at all to 5 = very urgent. The frequency of respondents' answers by individual defects is shown in Figures 6–8.

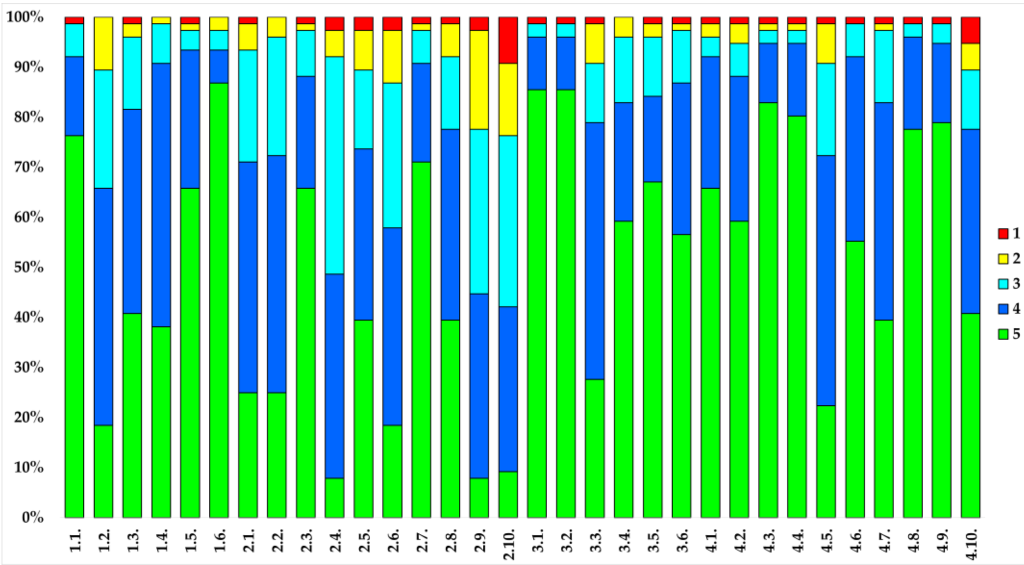

Figure 6. Frequency of priority ratings by individual defects—experts.

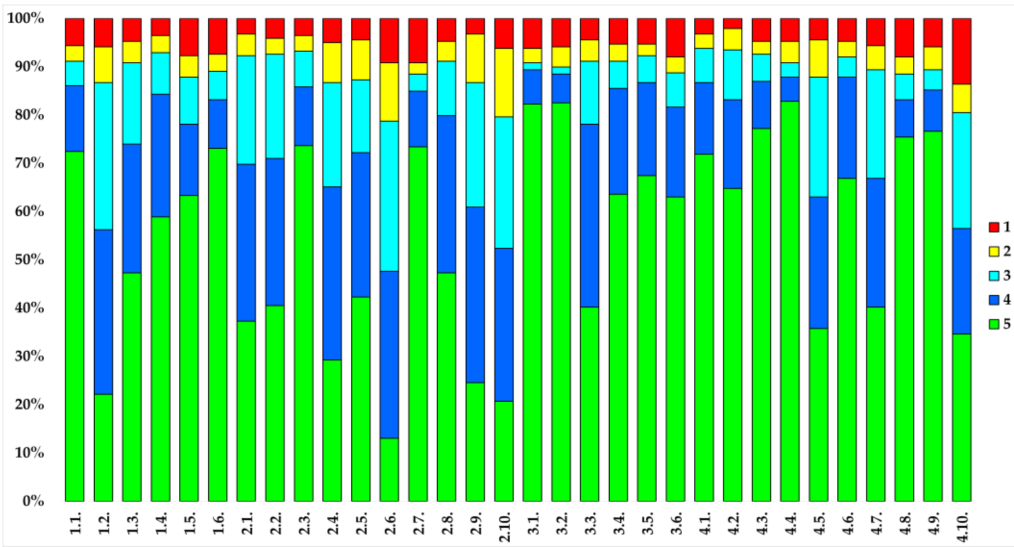

Figure 7. Frequency of priority ratings by individual defects—school staff.

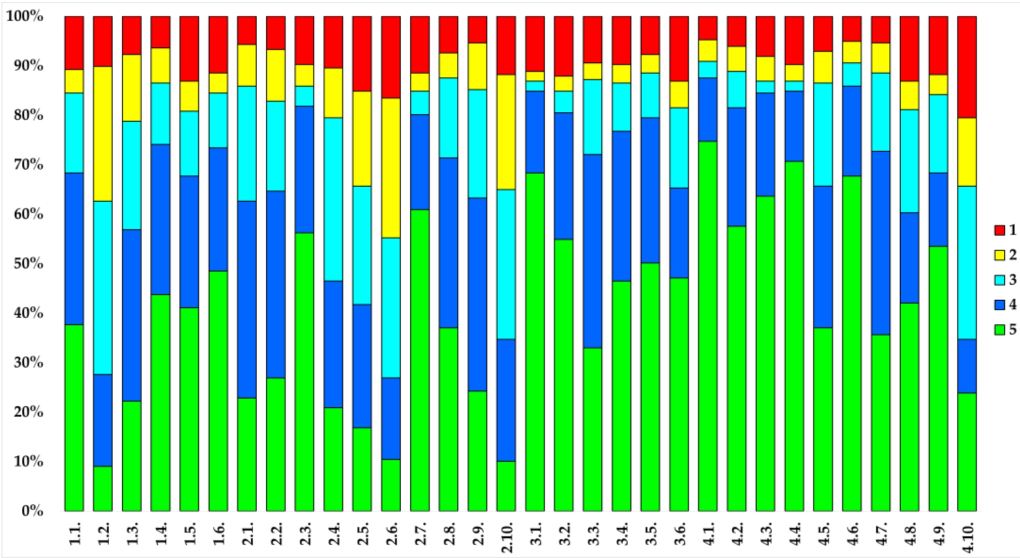

Figure 8. Frequency of priority ratings by individual defects—students.

A look at the given graphs reveals that in the case of experts, most of the tested defects should be removed very urgently (5) or urgently (4). The response with the lowest was that individual defects are not urgent at all (1). Looking at school staff, the frequency of the answer, very urgent (5), was slightly lower, and the answer, not urgent at all (1), slightly higher. This is more prominent among students, who, to the greatest extent, compared to the other two groups of respondents, evaluated certain defects as not urgent at all (1) and not urgent (2). In all three groups of respondents, however, the answers that certain defects should be removed very urgently (5) predominate.

The descriptive statistical results of the priority ratings for individual defects in schools are presented in Table 3. The results are presented according to stakeholder groups.

Table 3. Ratings of the maintenance priorities by stakeholder groups.

Defect Number	Experts			Schools Staff			Students		
	Mean	St. Dev.	Rank	Mean	St. Dev.	Rank	Mean	St. Dev.	Rank
1. Structural elements									
1.1.	4.6579	0.7221	5	4.4408	1.1048	7	3.7980	1.2891	20
1.2.	3.7368	0.8850	25	3.5917	1.0917	28	2.8923	1.1037	31
1.3.	4.1711	0.8701	17	4.0740	1.1152	19	3.5017	1.1972	26
1.4.	4.2763	0.6653	15	4.3254	1.0165	15	3.9798	1.1938	12
1.5.	4.5526	0.7553	7	4.2160	1.2484	17	3.7643	1.3846	21
1.6.	4.7763	0.6450	2	4.3787	1.2077	12	3.9495	1.3384	13
Average	4.3618	0.7571	3	4.1711	1.1307	3	3.6476	1.2511	3
2. Architectural elements									
2.1.	3.8816	0.8939	23	3.9615	1.0343	23	3.6566	1.0951	25
2.2.	3.9342	0.8056	22	4.0000	1.0619	21	3.6768	1.1726	23
2.3.	4.5000	0.8246	9	4.4911	1.0110	5	4.1414	1.2814	8
2.4.	3.4605	0.8237	27	3.7604	1.1132	26	3.3636	1.2175	27
2.5.	4.0000	1.0583	20	3.9734	1.1436	22	3.0909	1.3107	28
2.6.	3.6053	0.9944	26	3.3018	1.1259	31	2.7609	1.2137	32
2.7.	4.5789	0.7876	6	4.3757	1.2461	13	4.1448	1.3491	7
2.8.	4.0789	0.9628	18	4.1361	1.0782	18	3.8855	1.1799	16
2.9.	3.2763	0.9605	28	3.6893	1.0512	27	3.6734	1.1048	24
2.10.	3.1842	1.0919	29	3.4645	1.1505	30	2.9798	1.1652	30
Average	3.8500	0,9203	4	3.9154	1.1016	4	3.5374	1.2090	4

Table 3. *Cont.*

Defect Number	Experts			Schools Staff			Students		
	Mean	**St. Dev.**	**Rank**	**Mean**	**St. Dev.**	**Rank**	**Mean**	**St. Dev.**	**Rank**
3. Electrical elements									
3.1.	4.7895	0.6179	1	4.5621	1.0965	2	4.2896	1.3063	4
3.2.	4.7895	0.6179	1	4.5503	1.1132	3	4.0808	1.3432	10
3.3.	3.9605	0.9157	21	4.0503	1.0537	20	3.8283	1.2000	17
3.4.	4.3816	0.8636	14	4.3491	1.0933	14	4.0000	1.2628	11
3.5.	4.4605	0.9010	10	4.4112	1.0672	9	4.1044	1.1965	9
3.6.	4.3947	0.8339	13	4.2544	1.2206	16	3.8081	1.4143	19
Average	4.4627	0.7916	1	4.3629	1.1074	1	4.0185	1.2872	1
4. Mechanical elements									
4.1.	4.5263	0.8079	8	4.4911	0.9812	5	4.4848	1.0720	1
4.2.	4.4079	0.8821	12	4.3935	0.9815	10	4.2189	1.1636	6
4.3.	4.7368	0.6999	3	4.5207	1.0455	4	4.2694	1.2336	5
4.4.	4.7105	0.7083	4	4.5680	1.0688	1	4.3266	1.2805	3
4.5.	3.8421	0.9100	24	3.8225	1.1340	25	3.8215	1.2018	18
4.6.	4.4474	0.7375	11	4.4201	1.0455	8	4.3906	1.0977	2
4.7.	4.1842	0.8280	16	3.9083	1.1532	24	3.9158	1.1133	15
4.8.	4.7105	0.6494	4	4.3905	1.2331	11	3.7037	1.3997	22
4.9.	4.7105	0.6696	4	4.4527	1.1527	6	3.9428	1.3853	14
4.10.	4.0263	1.1072	19	3.5799	1.3698	29	3.0370	1.4244	29
Average	4.4303	0.8000	2	4.2547	1.1165	2	4.0111	1.2372	2

Descriptive statistical measures (mean value and standard deviation) are shown in Table 3. Additionally, the priority of defects is ranked by the size of the mean value, which was conducted for all three groups of stakeholders. The standard deviations are around 1.0000, which is considered acceptable in this type of research when applying survey questionnaires and the associated rating scale [49]. Looking at the values of the standard deviations, which provide information about the dispersion of the data around the arithmetic mean, it is evident that the most agreement is in the experts' answers. In the case of students, the standard deviation values have the highest value, and the data around the arithmetic mean are the most scattered; in this group of stakeholders, there is slightly less consensus regarding the priority of maintaining certain defects.

When looking at the results, it is interesting to note that experts, school staff, and students all rank the urgency of particular building elements' need for repair in the same order. However, the order of individual defects within them is not the same. Therefore, looking at all three groups of surveyed stakeholders, the priorities are listed in the following order: (1) electrical elements, (2) mechanical elements, (3) structural elements, and (4) architectural elements. Again, school staff, and especially students, gave, on average, lower ratings for elements and defects than the experts.

The highest priority for removing defects belongs to electrical elements. This result is not surprising since damage to electrical elements is hazardous to human life, and from this point of view, they must be removed as soon as possible. The school staff and students are also aware of this danger. Moreover, a school cannot operate if electrical elements are not in proper condition. Second in priority are mechanical elements, where faulty plumbing (4.3.) and sewage installations (4.4.), faulty toilets (4.1.), faulty space heating systems (4.6.), damaged chimneys (4.8.), and faulty fire protection systems (4.9.), received high ratings for removing. These elements create a comfortable, healthy, and hygienic space, and removing these defects makes it a safe space for users. Damages to chimneys (4.8.) and faulty fire protection systems (4.9.) stand out here, which can be very dangerous for users, as recognized by experts, and less so by school staff and students. Defects that belong to structural elements are the third to be removed. Certain defects are identified as needing to be quickly removed, such as buckling/twisting of elements (1.6.) and deep cracks (1.1.). These defects can threaten the mechanical resistance and stability of the building, which experts recognize. Since the school staff and students do not have professional knowledge in the construction field, it is unsurprising that they gave these defects lower ratings. Architectural elements received the lowest ratings for urgent removal. Among these elements, the highest priority is broken glass in windows and doors (2.8.) and damaged roof coverings (2.1.). In this group of elements, some defects received the lowest average priority ratings from all groups of surveyed stakeholders.

The graphs in Figures 9 and 10 show the first three and the last three defects that, according to the respondents, are the most and least urgent to remove.

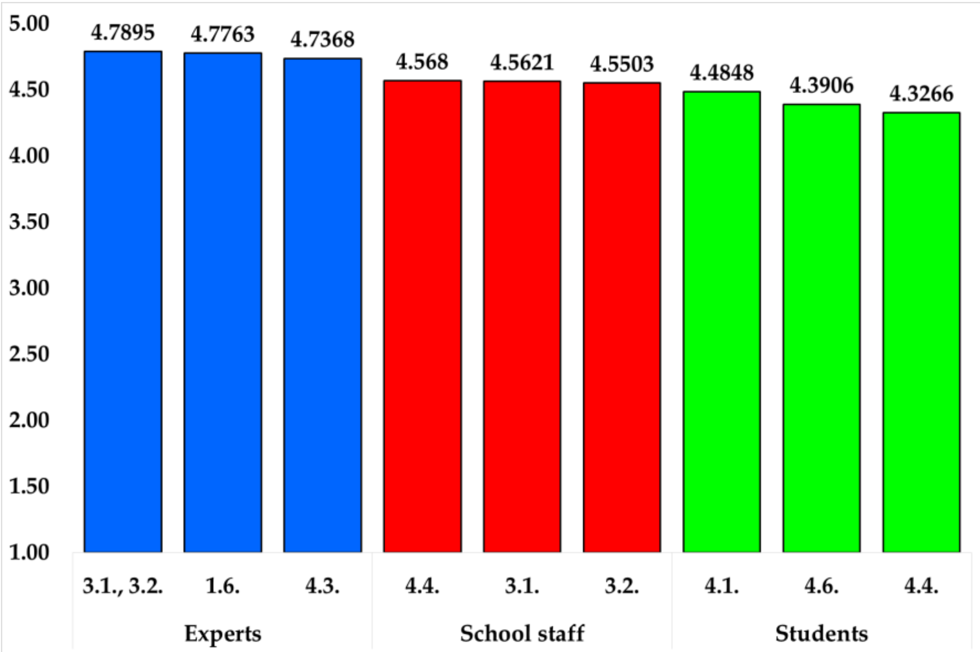

Figure 9. Defects with the highest priority ratings.

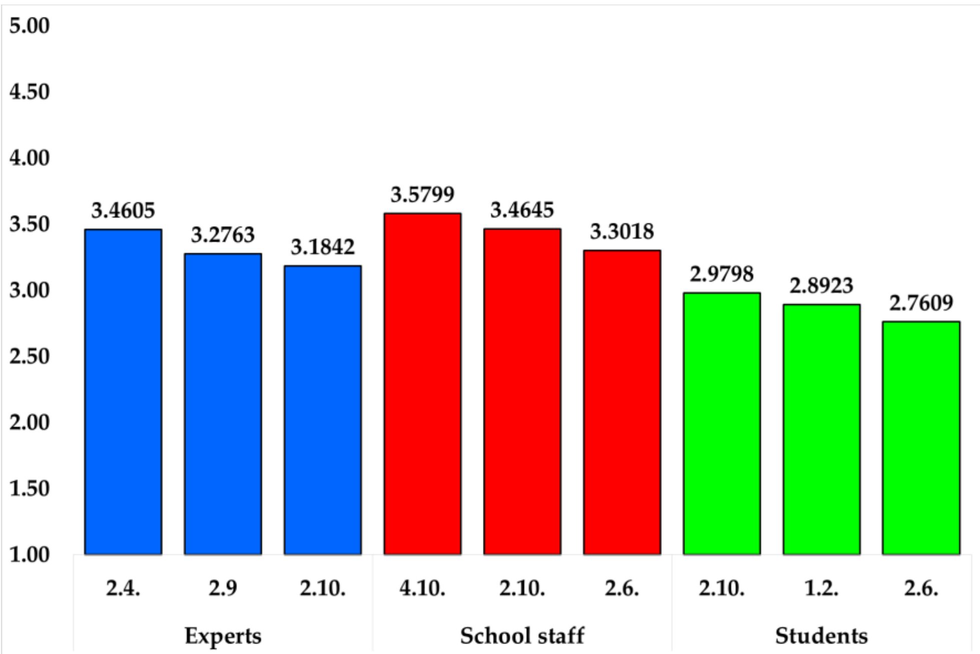

Figure 10. Defects with the lowest priority ratings.

Regarding the highest rating, the experts believe removing faulty electrical wires (3.1.) and faulty switchboards (3.2.) to be the most urgent priority. After that, according to the experts, repair of buckling/twisting of structural elements (1.6.) and then repair of faulty plumbing installations (4.3.) follow. According to the school staff, the highest priorities for repair are faulty sewage installations (4.4.), faulty electrical wires (3.1.), and faulty switchboards (3.2.). The students think that the top three priorities are faulty toilets (4.1.), faulty space heating systems (4.6.), and faulty sewage installations (4.4.). According to the experts, it is least urgent to remove damage to partition walls (2.4), damage to furniture or equipment (2.9), and damage to the external environment (courtyard, parking lot, playground, garden) (2.10.). In the case of school staff, malfunctioning elevators (4.10.), damage to the external environment (2.10.), and damaged facades (2.6.) are the least urgent priorities. The students think the least urgent priorities are damage to the external environment (2.10.) and surface cracks on the elements (1.2.). They also agree with the school staff that solving the damaged facade (2.6.) is the least urgent. According to users, damage to a facade, in this case, obviously refers to minor damage that does not endanger people's lives.

The needs and focus of end users compared to experts are somewhat different. There is a certain difference in the order of priorities between end users and maintenance experts. This is due to the various dimensions of importance the examined stakeholders attach to certain priorities based on their experience and knowledge. Whether the resulting differences in maintenance priorities are statistically significant is reviewed in the continuation of the paper.

Testing of Statistical Hypotheses

Whether there is a statistically significant difference between the views of stakeholders (experts, school staff, and students) on the priority of removing individual defects in the school building was examined.

First, the type of the distribution of the collected data was confirmed. This was determined using the Shapiro–Wilk test at a significance level (p-value) of 5% ($\alpha = 0.05$). By conducting the Shapiro–Wilk test with the help of Real Statistics for Excel 2016 software for all groups of respondents and all defects, results showed that the normal distribution condition was not met ($p < 0.05$, normal: no). This result indicates that the use of non-parametric tests within inferential statistics is justified.

The Kruskal–Wallis determines the difference between all three data groups. In comparison, the Mann–Whitney test will determine the existence of a difference between two groups of data. In the case of the Kruskal–Wallis test, at a significance level (p-value) of 5% ($\alpha = 0.05$), the results will indicate that the null hypothesis should be rejected if $p < 0.05$ is obtained, i.e., in this case, there is a statistically significant difference between the views of school stakeholders on the priority of removing individual defects in the school building. In the case of the Mann–Whitney test, the result will indicate that the null hypothesis should be rejected if $p < 0.017$, which is obtained based on the Bonferroni formula, in which the critical p-value (α) is divided by the number of comparisons made ($0.05/3 = 0.017$).

The set statistical hypotheses can be seen in Section 2, and they are set separately for each observed defect in the school building.

The hypothesis testing procedure will be presented in more detail on the example of defect number 3.1. (faulty electrical wires). The following statistical null hypothesis was established:

H_0. *There is no statistically significant difference in the views of stakeholders (experts, school staff and students) on the priority of removing faulty electrical wires (3.1.).*

The results of the Kruskal–Wallis test from Real Statistics are shown in Table 4.

Table 4. The Kruskal–Wallis test for defect 3.1.

Indicator	Experts	School Staff	Students	Value
median	5	5	5	
rank sum	29,686.5	126,516	96,913.5	
count	76	338	297	711
r^2/n	11,595,898	47,355,912	31,623,658.19	90,575,469
H-stat				11.05041
H-ties				20.26941
df				2
p-value				3.97×10^{-5}
alpha				0.05
sig				yes

Applying the Kruskal–Wallis test, the results show that the null hypothesis should be rejected, i.e., there is a statistically significant difference between the stakeholders' views on the priority of removing faulty electrical wires (3.1.) ($p = 3.97 \times 10^{-5} < 0.05$; sig: yes).

Thus, after the Kruskal–Wallis test has established a difference between stakeholders' views, the Mann-Whitney test will establish exactly which groups of stakeholders differ. The following three hypotheses are put forward:

H_0. *There is no statistically significant difference in the views of experts and school staff on the priority of removing faulty electrical wires (3.1.).*

H_0. *There is no statistically significant difference in the views of experts and students on the priority of removing faulty electrical wires (3.1.).*

H_0. *There is no statistically significant difference in the views of school staff and students on the priority of removing faulty electrical wires (3.1.).*

The results of the Mann–Whitney test for two independent samples from Real Statistics are shown in Table 5.

Table 5. The Mann–Whitney test for defect 3.1.

Indicator	Experts	School Staff	Experts	Students	School Staff	Students
count	76	338	76	297	338	297
median	5	5	5	5	5	5
rank sum	16,322.5	69,582.5	16,290	53,461	114,224.5	87,705.5
U	12,291.5	13,396.5	9208	13,364	43,452.5	56,933.5
	one tail	two tail	one tail	two tail	one tail	two tail
U	12,291.5		9208		43,452.5	
mean	12,844		11,286		50,193	
std dev	618.5474	ties	662.952	ties	1731.068	ties
z-score	0.893222		3.134465		3.893839	
effect r	0.043899		0.162296		0.154522	
p-value	0.185869	0.371738	0.000861	0.001722	4.93×10^{-5}	9.87×10^{-5}
sig	no	no	yes	yes	yes	yes

The results indicate that in the case of comparing the views of experts and school staff, there is no statistically significant difference; that is, the null hypothesis is not rejected ($p = 0.371738$, sig: no). In the other two cases, there is a statistically significant difference, and the null hypothesis is rejected; that is, there is a statistically significant difference in opinions between experts and students ($p = 0.001722$, sig: yes), and school staff and students ($p = 9.87 \times 10^{-5}$, sig: yes). In other words, experts and school staff agree on the priority rating of removing faulty electrical wires (3.1.), while students from both stakeholder groups disagree.

Hypothesis testing for all defects is shown in Table 6.

Table 6. Testing of statistical hypotheses for individual defects.

Defect Number	Kruskal–Wallis Test		Mann–Whitney Test					
			Experts—School Staff		Experts—Students		School Staff—Students	
	p-Value ($p < 0.05$)	H_0 Is Rejected (Yes/No)	*p*-Value ($p < 0.017$)	H_0 Is Rejected (Yes/No)	*p*-Value ($p < 0.017$)	H_0 is Rejected (Yes/No)	*p*-Value ($p < 0.017$)	H_0 Is Rejected (Yes/No)
1. Structural elements								
1.1.	<0.001	yes	0.342	no	<0.001	yes	<0.001	yes
1.2.	<0.001	yes	0.401	no	<0.001	yes	<0.001	yes
1.3.	<0.001	yes	0.988	no	<0.001	yes	<0.001	yes
1.4.	<0.001	yes	0.029	no	0.371	no	<0.001	yes
1.5.	<0.001	yes	0.214	no	<0.001	yes	<0.001	yes
1.6.	<0.001	yes	0.008	yes	<0.001	yes	<0.001	yes
2. Architectural elements								
2.1.	0.001	yes	0.285	no	0.173	no	<0.001	yes
2.2.	0.001	yes	0.188	no	0.259	no	<0.001	yes
2.3.	<0.001	yes	0.324	no	0.072	no	<0.001	yes
2.4.	<0.001	yes	0.002	yes	0.745	no	<0.001	yes
2.5.	<0.001	yes	0.928	no	<0.001	yes	<0.001	yes
2.6.	<0.001	yes	0.043	no	<0.001	yes	<0.001	yes
2.7.	0.004	yes	0.951	no	0.039	no	0.002	yes
2.8.	0.012	yes	0.319	no	0.347	no	0.003	yes
2.9.	0.002	yes	<0.001	yes	<0.001	yes	0.919	no
2.10.	<0.001	yes	0.048	no	0.136	no	<0.001	yes
3. Electrical elements								
3.1.	<0.001	yes	0.372	no	0.001	yes	<0.001	yes
3.2.	<0.001	yes	0.386	no	<0.001	yes	<0.001	yes
3.3.	0.058	no	0.181	no	0.822	no	0.023	no
3.4.	<0.001	yes	0.574	no	0.031	no	<0.001	yes
3.5.	<0.001	yes	0.959	no	0.012	yes	<0.001	yes
3.6.	<0.001	yes	0.720	no	0.006	yes	<0.001	yes
4. Mechanical elements								
4.1.	0.539	no	0.522	no	0.269	no	0.523	no
4.2.	0.177	no	0.636	no	0.479	no	0.064	no
4.3.	<0.001	yes	0.200	no	<0.001	yes	<0.001	yes
4.4.	0.001	yes	0.850	no	0.050	no	<0.001	yes
4.5.	0.841	no	0.747	no	0.539	no	0.750	no
4.6.	0.373	no	0.178	no	0.194	no	0.984	no
4.7.	0.304	no	0.149	no	0.134	no	0.935	no
4.8.	<0.001	yes	0.347	no	<0.001	yes	<0.001	yes
4.9.	<0.001	yes	0.404	no	<0.001	yes	<0.001	yes
4.10.	<0.001	yes	0.013	yes	<0.001	yes	<0.001	yes

There are statistically significant differences between the stakeholders' views tested with the Kruskal–Wallis test. The defects where statistically significant differences between stakeholders were not recognized are faulty lighting fixtures (3.3.), faulty toilets (4.1.), faulty sinks (4.2.), faulty space cooling systems (4.5.), faulty space heating systems (4.6.), and faulty hot water heating systems (4.7.). These defects are a high priority for end users, especially students, so it is important that the stakeholders' views are reconciled here and there are no marked differences of opinion. Regarding all other defects, there are slightly more uneven attitudes.

Observing the comparisons using the Mann–Whitney test, it is evident that experts and school staff agree on certain priorities in most cases, while the differences between experts and students, especially school staff and students, are more prominent.

By looking at the general hypothesis of this work, it was assumed that there are no significant differences between the opinions of experts, school staff, and students. However, it has now been shown that this is incorrect in the case of certain defects.

It is also noticeable that students are the ones who, in most cases, have a slightly different opinion than the other two groups of respondents. This information is very relevant since students are the primary and most numerous end users of school buildings, and looking at their comments can provide valuable feedback to maintenance organizations to increase maintenance efficiency and the satisfaction of the students. To students, defects that, according to them, deserve much attention are critical. Failure to remove such defects negatively affects the functionality and quality of the school and students' comfort in such a space. This involves dissatisfaction with the surrounding area and can ultimately affect work results.

The results of this study are consistent with previous studies [4,8,24–32] in determining the importance of user involvement in building maintenance processes since their requirements differ from what the maintainers currently provide [8,24]. Findings from the literature review [8,24,36,39] indicate that, according to experts, the priority works in building maintenance primarily relate to maintaining the safety and health of users. The studies of [8,34,37,38] that covered users' attitudes indicate that users attach importance to works on electrical installations, plumbing and sewage systems, heating, and air conditioning. The established priorities, although they cover other types of institutions and respondents, are close to the findings of this research.

According to our knowledge, no extensive research has been conducted on the maintenance priorities of elementary and secondary school buildings. Within this study, a database was created and processed, which includes three main groups of stakeholders in the maintenance of school buildings (experts, school staff, and students). The database includes the views of the mentioned stakeholders on the maintenance priorities of school buildings, about which there was no information until now. A model of school building defects was developed. The data thus collected were statistically processed. First, descriptive statistics related to respondents' profiles and data on ranking and prioritization of maintenance, which is important for achieving the goals of this research, were conducted. Inferential statistics were conducted on the data for further valuable and insightful interpretations to provide research findings of strong significance. Through data processing, insights were gained into stakeholders' views on maintenance priorities and certain differences were recognized, and the aforementioned provide input for creating a school maintenance process that meets the needs of all critical stakeholders. The presented conclusions are the result of the study of the existing literature, the creation and analysis of questionnaires for the collection of available data, the processing of the obtained data and the presentation of the results. This research has contributed to the knowledge and theory of school buildings' maintenance and maintenance priorities. Therefore, this study's findings can serve as a benchmark for future similar studies.

Deciding on maintenance priorities is the basis of effective building management [22], and all essential stakeholders should be included in that process, some to a greater and some to a lesser extent. This work fulfilled its goal and contributed to identifying the requirements of experts and the needs of two groups of end users in the maintenance segment of school institutions. Traditionally, the determination of maintenance priorities is carried out without considering the opinions of end users, which contradicts the fact that they are the ones who spend the most time in schools. The condition and damage of schools have the most physical and psychological impact on them. Although several criteria and limitations should be considered when making decisions about the maintenance of buildings, especially in the amount of available finance, one of the criteria should be the impact of the building on the end users. Instead of possibly seeing users as a means of feedback, they should be considered one of the drivers in providing maintenance services. Consultations with end users should be a means of establishing a proactive management process. It is, therefore, desirable to further develop a school maintenance priority system that will incorporate the opinions of different stakeholders, who, as this study has shown, may have different perspectives on maintenance criteria and priority preferences.

However, it should be noted that expert opinion should be used to a large extent when determining priorities in maintaining all types of buildings. Experts have professional knowledge and experience and can best assess which building defects threaten, for example, the technical resistance and stability of the building and, ultimately, the safety of users. In a situation where only the user's opinion would be considered, some maintenance works may be underestimated, such as works on structural elements, as also shown by the results of this research. Users do not have professional knowledge, so their contribution to developing the priority system should be carefully conceived and evaluated.

Since the problems of deciding on maintenance priorities are based on several groups of stakeholders and different decision criteria, multi-criteria decision-making methods can be crucial in developing a priority school maintenance system. Such studies will undoubtedly contribute to the current management process, primarily in planning maintenance works and the organization and execution of works. They will also increase user satisfaction with the maintenance and condition of the building. Also, the current maintenance system is characterized by limited financial resources; therefore, building maintenance should be programmed in such a way as to achieve optimal redistribution of available funds to priority operations. Priorities should be established to ensure the execution of the most critical and necessary works at the beginning of the plans [4]. An appropriate maintenance prioritization system would help to achieve an optimal maintenance outcome for all parties involved. The priority system is an integral part of effective maintenance management. Effective management of school maintenance implies planned, organized, and high-quality implementation of maintenance activities with optimal consumption of resources, primarily financial resources. It also entails avoiding work interruptions and increasing the satisfaction of staff and students by creating conditions that ensure their health and safety and facilitate teaching and learning. All of the above can ultimately improve students' academic results [10].

4. Conclusions

This work examines and compares the views of construction experts, school staff, and students on the priority of removing certain defects in school buildings. The general hypothesis of the work assumed that there would be no significant differences between the views of the selected stakeholders, which, based on the collected database and the conducted statistical tests, proved untrue in certain cases.

A model was developed to divide the building into structural, architectural, electrical, and mechanical elements. The main part of the model is a list of defects that can appear within the mentioned elements. The necessary data were collected using the questionnaire method.

The processing and analysis of the collected data showed that the priority order of element groups was the same for all three groups of respondents. However, the order of individual defects within them was not the same. Established priorities are as follows: (1) electrical elements, (2) mechanical elements, (3) structural elements, and (4) architectural elements. Observing individual defects within groups of elements, according to experts, the highest priority maintenance works include the removal of faulty electrical wires and the faulty switchboard. School staff believe the priority is faulty sewage installations, and students believe it is faulty toilets. Experts believe that damage to the external environment is the lowest priority, while school staff and students say a damaged facade is the lowest priority. The Kruskal–Wallis and Mann–Whitney statistical tests showed statistically significant differences among the stakeholders' views in most of the observed defects. Nevertheless, there are defects in which statistically significant differences were not detected, namely: faulty lighting fixtures, faulty toilets, faulty sinks, faulty space cooling systems, faulty space heating systems, and faulty hot water heating systems.

The results of this study can be helpful to founders when adopting effective strategies for optimizing maintenance activities and increasing end user satisfaction with the condition and maintenance of the school building.

The results also provide a basis for developing a priority system for maintaining school institutions. Making decisions about maintenance priorities is a demanding activity that should be based on the main stakeholders, considering different decision criteria. Usually, these decisions are made by maintenance service providers (founders) without interaction with end users, which, according to this research, is not justified. By collecting and comparing the views of key stakeholders in the maintenance of school buildings in this paper, insight into the different perceptions of end users and experts was provided, which gives a more comprehensive view of the issues of school building maintenance. The identified differences in attitudes can be used in future research to develop a new, balanced priority-based maintenance system based on multi-criteria decision-making methods.

The limitation of this research is reflected primarily in the restriction of respondents to the territory of the Republic of Croatia, as well as in their number and the number of collected data. Due to the differences between elementary and secondary schools, they could also be considered separately. Also, a limited number of building defects were used to examine stakeholders' views. The list provided here was created with the intended audience in mind without considering the more complex methods of treating defects. The mentioned shortcomings of the research can be overcome by continuing and expanding the study.

Author Contributions: Conceptualization, K.T.Š.; methodology, K.T.Š., D.C.-P. and S.M.; software, K.T.Š.; validation, K.T.Š.; formal analysis, K.T.Š.; investigation, K.T.Š.; resources K.T.Š. and D.C.-P.; data curation, K.T.Š.; writing—original draft preparation, K.T.Š.; writing—review and editing, K.T.Š., D.C.-P. and S.M.; visualization, K.T.Š.; supervision, D.C.-P. and S.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data supporting the published results are available upon request from the corresponding author.

Acknowledgments: This research has been fully supported by the University of Rijeka under projects: "Analysis of measures to reduce energy and maintenance costs of the public educational facilities through the performance system" (uniri-tehnic-18-125) and "Increasing the efficiency of school institutions' maintenance through the maintenance cost estimation model development" (uniri-mladi-tehnic-22-66).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Xaba, M.I. A qualitative analysis of facilities maintenance—A school governance function in South Africa. *S. Afr. J. Educ.* **2012**, *32*, 215–226. [CrossRef]
2. Yong, C.Y.; Sulieman, M.Z. Assessment of building maintenance management practice and occupant satisfaction of school buildings in Perak, Malaysia. *J. Teknol.* **2015**, *75*, 57–61. [CrossRef]
3. Teixeira, J.; Amoroso, J.; Gresham, J. Why Education Infrastructure Matters for Learning. Available online: https://blogs.worldbank.org/education/why-education-infrastructure-matters-learning (accessed on 5 June 2023).
4. Tijanić Štrok, K. Development of the Model for Efficient Maintenance Management of Public Educational Buildings. Ph.D. Thesis, Josip Juraj Strossmayer University of Osijek, Faculty of Civil Engineering and Architecture Osijek, Osijek, Croatia, October 2021. (In Croatian)
5. Fertika, D.Y.; Sowiyah, S.; Hariri, H. Procurement and maintenance of facilities and infrastructure in inclusive schools. *Int. J. Educ. Stud. Soc. Sci.* **2022**, *2*, 79–87. [CrossRef]
6. Herath, N.; Duffield, C.; Zhang, L. Public-school infrastructure ageing and current challenges in maintenance. *J. Qual. Maint. Eng.* **2023**, *29*, 401–419. [CrossRef]

7. Izobo-Martins, O.O.; Ekhaese, E.N.; Ayo-Vaghan, E.O.; Olotuah, A.O. Assessing Users' Perceptions of the Current Maintenance Disorder of Public Secondary School in Ogun, Nigeria. *J. Build. Constr. Plan. Res.* **2018**, *6*, 90–101. [CrossRef]
8. Olanrewaju, A.L.; Abdul-Aziz, A.R. *Building Maintenance Processes and Practices: The Case of a Fast Developing Country*; Springer: New York, NY, USA, 2014.
9. Besiktepe, D.; Ozbek, M.E.; Atadero, R.A. Identification of the criteria for building maintenance decisions in facility management: First step to developing a multi-criteria decision-making approach. *Buildings* **2020**, *10*, 166. [CrossRef]
10. Tijanić Štrok, K.; Marenjak, S.; Car-Pušić, D. Analysis of the Current Maintenance Management Process in School Buildings: Study Area of Primorje-Gorski Kotar County, Republic of Croatia. *Front. Built Environ.* **2022**, *84*, 912326. [CrossRef]
11. ElSamadony, A.; Hossny, O.; ElHakeem, A.; Hussein, D. An Asset Management System for Maintenance and Repair of Educational Buildings. *Int. J. Sci. Eng. Res.* **2013**, *4*, 2053–2064.
12. Izobo-Martins, O.O. Maintenance Strategies and Condition of Public Secondary School Buildings in Ado-Odo/Ota Local Government Area Ogun State, Nigeria. Ph.D. Thesis, Covenant University, Ota, Nigeria, November 2014.
13. Alzaben, H. Development of a Maintenance Management Framework to Facilitate the Delivery of Healthcare Provisions in the Kingdom of Saudia Arabia. Ph.D. Thesis, Nottingham Trent University, Nottingham, UK, 2015.
14. Mong, S.G.; Mohamed, S.F.; Misnan, M.S. Maintenance management model: An identification of key elements for value-based maintenance management by local authority. *Int. J. Eng. Technol.* **2018**, *7*, 35. [CrossRef]
15. Olanrewaju, A.L.; Fang, W.W.; Tan, Y.S. Hospital building maintenance management model. *Int. J. Eng. Technol.* **2018**, *2*, 747–753. [CrossRef]
16. Le, A.T.H.; Domingo, N.; Rasheed, E.; Park, K. Maturity model of building maintenance management for New Zealand's state schools. *Build. Res. Inf.* **2022**, *50*, 438–451. [CrossRef]
17. Wang, K.C.; Almassy, R.; Wei, H.H.; Shohet, I.M. Integrated Building Maintenance and Safety Framework: Educational and Public Facilities Case Study. *Buildings* **2022**, *12*, 770. [CrossRef]
18. Saraiva, T.; De Almeida, M.; Bragança, L.; Barbosa, M. Environmental Comfort Indicators for School Buildings in Sustainability Assessment Tools. *Sustainability* **2018**, *10*, 1849. [CrossRef]
19. Katić, D.; Krstić, H.; Marenjak, S. Energy performance of school buildings by construction periods in federation of Bosnia and Herzegovina. *Buildings* **2021**, *11*, 42. [CrossRef]
20. Vandiver, B. The Impact of School Facilities on the Learning Environment. Ph.D. Thesis, Capella University, Minneapolis, MN, USA, January 2011.
21. Barrett, P.; Davies, F.; Zhang, Y.; Barrett, L. The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis. *Build. Environ.* **2015**, *89*, 118–133. [CrossRef]
22. Cerić, A.; Katavić, M. Building maintenance management. *Građevinar* **2000**, *53*, 83–89. (In Croatian)
23. Cavalcante, C.A.V.; Alencar, M.H.; Lopes, R.S. Multicriteria model to support maintenance planning in residential complexes under warranty. *J. Constr. Eng. Manag.* **2017**, *143*, 04016110. [CrossRef]
24. Nik-Mat, N.E.M.; Kamaruzzaman, S.N.; Pitt, M. Assessing the maintenance aspect of facilities management through a performance measurement system: A Malaysian case study. *Procedia Eng.* **2011**, *20*, 329–338. [CrossRef]
25. Olanrewaju, A.L. Revealing the service gaps in building maintenance service delivery: Balancing providers' perspectives with users' perspectives. *Int. J. Built Environ. Asset Manag.* **2013**, *1*, 121–138. [CrossRef]
26. Abisuga, A.O.; Oshodi, S. Stakeholders' Participation in University Campus Facilities Maintenance: An e-Maintenance Approach. In Proceedings of the 2014 IAJCISAM International Conference, Orlando, FL, USA, 25–27 September 2014.
27. Lavy, S.; Bilbo, D.L. Facilities maintenance management practices in large public schools, Texas. *Facilities* **2009**, *27*, 5–20. [CrossRef]
28. Tam, V.W.; Fung, I.W.; Choi, R.C. Maintenance priority setting for private residential buildings in Hong Kong. *J. Perform. Constr. Facil.* **2017**, *31*, 04016115. [CrossRef]
29. Wing, A.C.K.; bin Mohammed, A.H.; bin Abdullah, M.N. A literature review on maintenance priority-conceptual framework and directions. *MATEC Web Conf.* **2016**, *66*, 00004. [CrossRef]
30. Osaro, N.G.; Wokekoro, E. Stakeholders roles in improving the current state of public secondary schools infrastructure in Rivers State, Nigeria. *Int. J. Soc. Sci. Humanit. Invent.* **2018**, *5*, 4503–4508. [CrossRef]
31. Ampofo, J.A.; Nassè, T.B.; Amoah, S.T.; Peprah, K. Stakeholders responsibilities in public SHS buildings maintenance practices in the Wa Municipality. *Int. J. Manag. Entrep. Res.* **2020**, *2*, 109–138. [CrossRef]
32. Olanrewaju, A.L.; Tan, W.X. An artificial neural network analysis of the satisfaction of hospital building maintenance services. In Proceedings of the IOP Conference Series: Materials Science and Engineering, Budapest, Hungary, 28–30 June 2022.
33. Lavy, S.; Garcia, J.A.; Dixit, M.K. KPIs for facility's performance assessment, Part I: Identification and categorization of core indicators. *Facilities* **2014**, *32*, 256–274. [CrossRef]
34. Yusof, N.A.; Abdullah, S.; Zubedy, S.; Najib, N.U.M. Residents' maintenance priorities preference: The case of public housing in Malaysia. *Procedia Soc. Behav. Sci.* **2012**, *62*, 508–513. [CrossRef]
35. Au-Yong, C.P.; Chua, S.J.L.; Ali, A.S.; Tucker, M. Optimising maintenance cost by prioritising maintenance of facilities services in residential buildings. *Eng. Constr. Archit. Manag.* **2019**, *26*, 1593–1607. [CrossRef]
36. Noaman, M.A.A.A.A.; Mohammed, S.R. Application Innovation Strategy for Digital Maintenance Management of School Building in Iraq. *J. Posit. Sch. Psychol.* **2022**, *6*, 2023–2035.
37. Preiser, W.F.E.; Vischer, J.C. *Assessing Building Performance*; Edition Butterworth-Heinemann: Great Britain, UK, 2005.

38. Mossel, H.J.V.; Jansen, S.J.T. Maintenance services in social housing: What do residents find important? *Struct. Surv.* **2010**, *28*, 215–229. [CrossRef]
39. Primorsko-Goranska Županija. Decision on the Criteria, Benchmarks and Method of Financing the Minimum Financial Standard for Decentralized Functions of Elementary and Secondary Education in 2022. 2022. Available online: http://www.sn.pgz.hr/default.asp?Link=odluke&id=44623 (accessed on 29 May 2023). (In Croatian).
40. Bakri, N.N.O.; Mydin, M.A.O. General building defects: Causes, symptoms and remedial work. *Eur. J. Technol. Des.* **2014**, *3*, 4–17.
41. Mydin, M.O.; Salim, N.A.; Tan, S.W.; Tawil, N.M.; Ulang, N.M. Assessment of significant causes to school building defects. *E3S Web Conf.* **2014**, *3*, 01002. [CrossRef]
42. Ismail, I.; Ani, A.I.C.; Razak, M.Z.A.; Tawil, N.M.; Johar, S. Common building defects in new terrace houses. *J. Teknol.* **2015**, *75*, 83–88. [CrossRef]
43. Bedru, M.A. Study of Construction Defects in Public Building Projects in Addis Ababa (A Case study of Federal Government Office Building Projects). Master's Thesis, Addis Ababa Institute of Technology, School of Civil & Environmental Engineering, Addis Ababa, Ethiopia, 2016.
44. Linggar, S.; Aminullah, A.; Triwiyono, A. Analysis of building and its components condition assessment case study of dormitory buildings. *MATEC Web Conf.* **2019**, *258*, 03003. [CrossRef]
45. Paton-Cole, V.P.; Aibinu, A.A. Construction defects and disputes in low-rise residential buildings. *J. Leg. Aff. Disput. Resolut. Eng. Constr.* **2021**, *13*, 05020016. [CrossRef]
46. Awasho, T.T.; Alemu, S.K. Assessment of public building defects and maintenance practices: Cases in Mettu town, Ethiopia. *Heliyon* **2023**, *9*, e15052. [CrossRef] [PubMed]
47. Adebayo, O.O.; Osmond, I.C. A search for an acceptable margin of valuation error: A case study of valuers and their clients in Nigeria. *Sri Lankan J. Estate* **2010**, *4*, 54–73.
48. Ali, A.S.; Chua, S.J.L.; Ali, D.B.A. Issues and challenges faced by government office buildings in performing maintenance work. *J. Teknol.* **2016**, *78*, 11–23. [CrossRef]
49. Kušljić, D. Determination of Criteria for Evaluating the Success of Public-Private Partnership Construction Projects. Ph.D. Thesis, Josip Juraj Strossmayer University of Osijek, Faculty of Civil Engineering Osijek, Osijek, Croatia, July 2012. (In Croatian)
50. Wackerly, D.D.; Mendenhall, W.; Scheaffer, R.L. *Mathematical Statistics with Applications*, 7th ed.; Cengage Learning: Belmont, MA, USA, 2008.
51. Šopić, M.; Car-Pušić, D. Statistical Data Analysis of Weather Conditions Aiming at Determining the Mathematical Expectation of Construction Site Delays in Rijeka Within a Monthly Period. *Zb. Rad.* **2018**, *21*, 67–85. (In Croatian) [CrossRef]
52. Krstić, H.; Marenjak, S. Analysis of buildings operation and maintenance costs. *Građevinar* **2012**, *64*, 293–303.
53. Krstić, H.; Marenjak, S. Maintenance and operation costs model for university buildings. *Teh. Vjesn.* **2017**, *24* (Suppl. S1), 193–200.
54. Tijanić Štrok, K.; Car-Pušić, D.; Marenjak, S. Elementary School Buildings Condition Assessment: Case of Primorje-Gorski Kotar County (Croatia). *Adv. Civ. Archit. Eng.* **2023**, *14*, 95–117. [CrossRef]