Journal of
Marine Science and Engineering

MDPI

Article

Multi-Faceted Analysis of Airborne Noise Impact in the Port of Split (II)

Gorana Jelić Mrčelić [1], Luka Vukić [1,*] and Kristian Jambrošić [2]

[1] Department for Maritime Management Technologies, Faculty of Maritime Studies, University of Split, Ruđera Boškovića 37, 21000 Split, Croatia; gorana.jelic@pfst.hr
[2] Faculty of Electrical Engineering and Computing, University of Zagreb, Unska 3, 10000 Zagreb, Croatia; kristian.jambrosic@fer.hr
* Correspondence: lvukic@pfst.hr; Tel.: +385-98549849

Abstract: Given the increasing number of citizen complaints about port noise and the lack of relevant studies assessing resident exposure, the effects of port noise are gaining increasing public attention. It is especially significant in ports near residential areas, where excessive noise emissions can seriously impact the urban environment. This paper aimed to investigate the perceptions and attitudes of the population living near the cargo terminals in the Port of Split regarding the impact of port noise in the urban area, focusing on their health and standards of living. The research methodology included a questionnaire distributed in the areas where the residents are most affected by noise. In addition to conventional descriptive survey analysis, the authors used regression analysis and two-way ANOVA with the Tukey post hoc test as a parametric data analysis tool. The survey results showed the harmful effects of port noise on most set parameters, and perceived noise intensity for three different times of the day caused a high level of concern for the urban environment. In addition, the regression analysis results showed a weak and reverse dependency between the distance of the selected residences from the noise sources and the perceived noise intensity. These findings support the validity of the respondents' perceptions and the credibility of the obtained results. The application of parametric data analysis revealed a lack of formal knowledge of residents about the effects of noise and a strong differentiation between groups based on the variables that determine the level of education of residents and their assessments of the noise intensity of the cargo terminal. However, the subjective impressions and the psycho-physical and emotional states of the residents need also to be included in the validation of the results. The obtained results will facilitate the adoption of noise management policies and implementation of noise abatement programs in the Port of Split.

Keywords: airborne noise; local population; questionnaire; parametric data analysis; cargo terminals; Port of Split

check for updates

Citation: Jelić Mrčelić, G.; Vukić, L.; Jambrošić, K. Multi-Faceted Analysis of Airborne Noise Impact in the Port of Split (II). *J. Mar. Sci. Eng.* **2023**, *11*, 1189. https://doi.org/10.3390/jmse11061189

Academic Editor: Mihalis Golias

Received: 11 May 2023
Revised: 2 June 2023
Accepted: 6 June 2023
Published: 7 June 2023

1. Introduction

Noise is a significant environmental stressor that causes serious public health concerns, and unlike other high-pressure ecological factors, noise exposure is increasing in Europe [1]. Noise pollution, marked as one of the most prominent issues of contemporary societies, causes harmful physiological and psychological human health-related problems [2]. As noise pollution is ubiquitous in an urban environment, the noise originating from traffic activities is considered the second highest environmental health risk in Western Europe [3]. More than 40.2 million citizens are exposed to excessive night-time road traffic noise in the EU, a value that rises to 48.8 million when aircraft, rail, and industrial sources are also included [4]. Due to the adverse effects of environmental noise, the European Union finally adopted the Environmental Noise Directive (END) in 2002, which set and prescribed the requirements to create strategic maps of noise for roads, rail, airports, and urban centers [5], while simultaneously excluding port noise from the action plans. These constellations confirm the lack of valid and standardized noise management policy while supporting the premise that port noise is marginalized at the regulatory level [6,7]. Port noise has been neglected for a considerable time [8] and has only recently gained more significant public attention, consequently to the ports' geographical setting in metropolitan centers. Due to the deficiency in current regulation, which classifies port noise under the general category of industrial noise [9], the harmful noise exposure of residents located near ports is often ignored [10]. The ports are usually placed in a complex environment, in proximity to urban areas, which increases the share of citizens' complaints from airborne port noise [11], especially in Mediterranean ports [8]. Murphy and King [12] also indicated the increased awareness among the general population and policymakers considering the relationship between human exposure to environmental noise and public health issues since adoption of the Environmental Noise Directive.

Recently, a list of health concerns as an implication of excessive exposure to environmental noise pollution were established and documented in detail, especially those originating from transportation sources [13]. When considering the effects of airborne noise emissions in ports, particularly those located in urban areas, the most common health-related effects of prolonged exposure to port noise include anxiety, stress, cardiovascular diseases, fatigue, and similar nuisance effects [14], while recent studies also reflected the impacts of noise on house pricing [15]. Various studies indicated adverse noise pollution effects that could be associated with the occurrence of speech disorders [16] and sleep disruptions [17,18], as well as the incidence of heart diseases and hypertension [19]. Detection and classification of individual sources are the central points of the noise abatement program [20]. Vukić et al. [21] indicated a diversity of port noise sources originating from the complex port environment that can be divided into traffic and industrial when a general approach is considered [22]. However, Fredianelli et al. [23] provided a methodology comprising further segmentation of port noise sources by indicating five macro-categories: road, railway, ship, port, and industrial. The quantity and differentiation of specific sources of noise emissions from ports complicate the assessment of total port noise [24]. According to Baldinelli and Marsico [7], direct and indirect noise emissions from ships are primary noise issues in ports, especially due to the low-frequency noise when large vessels are considered [25]. Concerning the relationship between environmental noise exposure and public health issues, low-frequency noise generates even more challenges from the residential exposure standpoint, in contrast to the standard frequency range [13]. However, the topography, individual features of the port area, operations, and the port location are the predictors that determine the level of importance of port noise for specific sites in the long term [26].

Considering the preceding context, the current study investigated residential noise exposure at a shipping port in Split (Croatia), with a particular interest in the perception of noise emissions from cargo terminals. The primary objective of this research was to examine resident attitudes toward the impact of noise generated from cargo terminals and determine the fundamental noise effects in the port area, focusing on health-related issues and the influence of port noise on people's living standards. This survey was conducted on the basis of a methodology that included a newly formulated questionnaire divided among the inhabitants in the exposed area in both physical and digital form. The aim was to examine the general knowledge of noise-affected residents and their perceptions of the impact of airborne noise emissions from the port toward the urban area. The research rationale and the necessity of performing the survey, as described in Fredianelli et al. [23], can be found in the scarcity of relevant studies based on assessments of citizens' exposure to port noise. The authors employed regression analysis and two-way ANOVA with Tukey post hoc analysis as a parametric data analysis technique to assess how members of the local population perceive the effects of noise from cargo terminals. This research followed the findings of Vukić et al. [14], as both papers were determined as outcomes of the project NOIPOS [27], which deals with environmental noise measurement and validation in the Port of Split (cargo terminals). While the previous project activities dealt with port noise source identification and simulations, the current stage involved an examination of the perceptions of the population surrounding the port. The results of these activities will be addressed in the final phase, comparing three individual datasets: theoretical analysis and simulations, noise effects perceived by residents, and on-site measurements. The outcomes of project NOIPOS should be used in creating noise management policies and implementing noise abatement programs in the examined area.

2. Materials and Methods

2.1. Data Collection

The survey on the residents' perceptions of the impact of noise emissions from cargo terminals on their health status and living standards was conducted during the last quarter of 2022. For this research, a questionnaire was created, and the data collection method was divided into the provision of interviews and an online survey disseminated across the relevant and available platforms. The questionnaire was structured in three parts: general data on participants, knowledge of noise pollution, and residents' perceptions of noise impacts from cargo terminals. Additionally, the final part was intended for suggestions for resolving the noise issues that originated from the cargo terminals in the Port of Split. This initial campaign resulted in 148 completed questionnaires. Due to constraints that occurred during its implementation, the authors repeated the survey in January 2023 and collected an additional 54 responses. A total of 202 participants took part in the survey. It represented approximately 5% of the total exposed population in the examined area. This percentage can be deemed as representative, particularly due to the mainly reluctant attitude of inhabitants toward active participation in the survey. The valorization of individual criteria by residents was performed without former knowledge and experience from an acoustics and noise effects standpoint. The sole information on the noise intensity from specific sources (Table A1 from Appendix A) was presented before the questionnaire distribution (Appendix A) or at the start of the interview.

To determine the total number of residents in the local population exposed to excessive noise levels, the authors implemented an on-site field survey, which combined the field investigation in the form of interviews and periodical measurements with low-cost devices during the preparation phase of this research. These measurements were performed periodically, once a week throughout each month (July–September), predominately during the evening-night periods, mainly due to the absence of background noise that facilitated the measurements. Additionally, the measurement site varied between the two examined districts and analyzed streets. The activity was performed by using low-cost equipment: a digital sound level meter with a measuring range of 30 to 13 dB (A), accuracy of $\pm$ 3.5 dB and measuring range resolution 0.1 dB. The rough estimations were already published in the previous paper [14] and based on two separate inhabited areas surrounding the cargo terminals, the northern (Vranjic peninsula) and southern ones (city of Split). The northern area falls within the jurisdiction of Solin town, while the other is under the authority of the city of Split [14]. The measurements revealed occasional, momentarily excessive noise levels. Based on the data collected, this noise type was evaluated as irregular. Furthermore, the activity hat caused the noise to exceed threshold values was cargo handling of various cargo types. The results for the estimated number of local inhabitants exposed to excessive noise levels in the two areas surrounding the cargo terminals are presented in Table 1.

Table 1. Estimated number of local inhabitants exposed to noise from cargo terminals in the Port of Split [14].

	Total Population	Percentage of Exposed Population	Total Exposed People
Split city district—Brda	6188 *	60%	3713
Solin city district—Vranjic	1066 **	70%	747

* GIS Split, 2022 [28]. ** CBS, 2021 [29].

The process of identification and categorization of noise sources in the Port of Split according to the relevant criteria was already carried out in the previous research phase and published in the work of Vukić et al. [14]. The main conclusions and data from the previous work were an important prerequisite and basis for conducting the current study.

2.2. Methodology and Data Analysis

Several methods were applied to process the data retrieved from the conducted survey. The descriptive statistics were used in the principal part of the questionnaire analysis and set criteria as a pre-phase of data processing. It was relevant to draw initial conclusions and perform valorization of individual parameters used for the selected parametric data analysis application and statistical tools. The authors used Pareto analysis, linear regression, and two-way ANOVA with the Tukey post hoc test for the data processing of individual criteria.

The Pareto analysis is commonly used to illustrate the distribution frequency of descriptive data classified in categories, usually provided in a chart form, showing which ones principally affect the examined problem in descending order (from left to right). In addition, the accumulated percentage of frequencies is shown by a line [30]. As one of the main premises in the use of Pareto graphs related to the identification of organizational deficiencies, this theory can be applied for various purposes [31]. The function of Pareto analysis is prioritization of the parameters having the most influence on the selected problem compared to the remaining factors. The final objective is the improvement of opportunities for identification [32]. Basically, the Pareto principle is based on the premise that 80% of implications are a function of 20% of causes, nominated as the vital few [33], or that the majority of problems (80%) can be resolved by 20% of effort [34]. The advantages of the Pareto chart are thoroughly explained in Joiner Associates Staff [35,36], and its application as a statistical tool to perform case studies in Realyvásquez-Vargas et al. [30]. The Pareto analysis in this study was utilized to determine the location of the noise source from the cargo terminals and identify the most influential port activities generating a nuisance while exceeding the noise threshold levels.

Due to the specific needs and objectives of the research, the authors applied regression analysis for the selected data. Generally, regression analysis is a statistical method that analyzes correlation and mutual relationships between dependent and independent variables. Linear regression models a linear relationship between a dependent variable and one or more independent variables [37]. Determination of the relationship between the independent and dependent variables results in a defined point in the coordinate system. The set of such items determines the correlations of direction, shape, and strength. The linear expression explains the relationship between dependent and independent variables and can be expressed as:

$$y = bx + a \tag{1}$$

where y is the dependent variable (output value), x is the independent variable (input value), and parameter b is the weight of the independent variable (regression coefficient). The expression bx is a variable part, being changed by the regression coefficient, while a is a fixed part.

Regression analysis is also nominated as the method of least squares, and the most significant value is the coefficient of determination or representativeness (R^2), which indicates the strength of the correlation. The coefficient of determination (2) was retrieved from Stat Trek [38] and expressed as follows:

$$R^2 = \left\{ \left(\frac{1}{N}\right) * \sum \frac{\left(xi - \bar{x}\right) * \left(yi - \bar{y}\right)}{(\sigma x * \sigma y)} \right\}^2 \tag{2}$$

where N is the number of observations used to fit the model, xi is the x value for observation i, $\bar{x}$ is the mean x value, yi is the y value for observation i, $\bar{y}$ is the mean y value, σx is the standard deviation of x, and σy is the standard deviation of y.

Generally, the Chaddock scale is used in statistics to qualitatively assess the set criteria evaluating the density of mutual connections [39], with the aim of determining the degree of correlation [40]. The Chaddock scale is used for interpretation of the results, where the value $R^2 = 1$ indicates a complete, functional, or deterministic correlation, while $R^2 < 1$ defines some degree of statistical or stochastic correlation. A positive correlation between variables occurs when the increase in one variable is accompanied by the increase in another one, while a negative correlation can be defined as the disproportionate change in the values of two variables where one variable decreases and another one increases. The interpretation of correlation analysis results according to the Chaddock scale is indicated in Borovskaya et al. [41]. The authors applied a linear regression model in this research to examine the dependence between variables of the distances of selected residences (streets) toward the noise sources and noise intensity from the cargo port, assessed by residents for three different times of the day (day, evening, and night). The reference point of the noise source was set to berth 2 of the cargo terminal, representing the mean distance between the two districts examined and the most frequent berthing place of cargo ships (Figure 1).

Figure 1. Reference point of the noise source (berth 2) and the location of the two residential areas (Google maps—adjusted).

It was to determine whether the results of the estimated noise intensity correlated with the distance, thus whether the assessed noise decreases with the distance from the noise source, and vice versa.

The ANOVA test represents a statistical analysis tool used to evaluate whether two or more datasets have been statistically significant by examining the differences in averages using variance [42]. In addition, ANOVA is a statistical test to perform hypothesis testing among other alternatives, where the independent variable is categorical and the dependent variable scalar, especially if the scale data distribution is parametric [43]. The presumptions of the ANOVA test are summarized in [44]. The application of the ANOVA test procedure starts with the hypothesis that all factor groups have equal mean values. The total sum of squares (TSS) represents the variability in the dataset, which is further divided into two components, the variability (sum of squares) between groups and variability (sum of squares) within the groups. The F-value, determined as the ratio of factor effects to error level, is defined for every available factor. The *p*-value outlines the probability of obtaining the F-value when the factor is not significant and quantifies the risk of incorrectly rejecting the null hypothesis and categorizing an evident effect when it is. The statistical significance threshold for the p-value is commonly set at 5% [45]. The ANOVA is generally used to test if the means of three or more independent groups of continuous data vary significantly concerning a single factor (one-way ANOVA) or two factors (two-way ANOVA). The additional function of the ANOVA is the ability to test the interaction factor, so it examines whether the effects of one factor on the response variable depend on the level of a second factor [46]. For the selected part of this comprehensive research, the authors used two-way ANOVA because more than one independent variable was tested. As the ANOVA test compares the means between groups, it fails to identify which particular pairs of means are significant. As for this deficiency, the ANOVA test is usually applied with multiple comparison techniques, while the most frequently used is the Tukey honestly significant difference (HSD) test. The Tukey test is a post hoc test, meaning the variable comparison is applied after the data have been collected [47]. Two-way ANOVA with Tukey post hoc was used in this paper as a control measure of the selected independent and dependent data. The parametric data analysis was employed to determine whether there was a significant difference between place of residence and level of education, selected as independent variables, and the noise intensity at three different times of the day (day, evening, and night), as a dependent variable. These parameters were selected due to the respondents belonging to different districts examined and the possibility of different results among groups concerning the education status of respondents, primarily for the lack of prior knowledge in determining the noise levels. The purpose was to examine whether the parameters of the place of residence and education level individually and commonly impacted the assessed noise intensity for three different times of the day (day, evening, and night). The significance level was set to 0.05. For this analysis, three null hypotheses were assumed, as follows:

- H_0—The respondents' place of residence has no significant effect on the assessed noise intensity (day, night, evening).
- H_0—The respondents' level of education has no significant effect on the assessed noise intensity (day, night, evening).
- H_0—The interaction between the place of residence and level of education has no significant effect on the assessed noise intensity (day, night, evening).

Finally, the authors used several tools for data calculation: Microsoft Excel for the Pareto and regression analysis, and IBM® SPSS® Statistics for Windows, Version 21.0 for the two-way ANOVA with Tukey post hoc test.

3. Results

The general characteristics of survey respondents necessary for the research are shown in Table 2.

Table 2. General characteristics of residents involved in the survey.

Respondents				
Age (years) %	18–29 22	30–44 38	45–60 23	>60 17
Education level %	Primary 5	Secondary 38	Undergraduate 36	Graduate 21
Gender %	Female 48	Male 52		
Place of residence %	Split 55	Vranjic 45		

The breakdown of the locations of the residences, according to residential street, is indicated in Figure 2. The streets located in the Brda district, Ante Petravića and Vranjički put, and the southern part of the Vranjic peninsula are the areas closest to the cargo terminal.

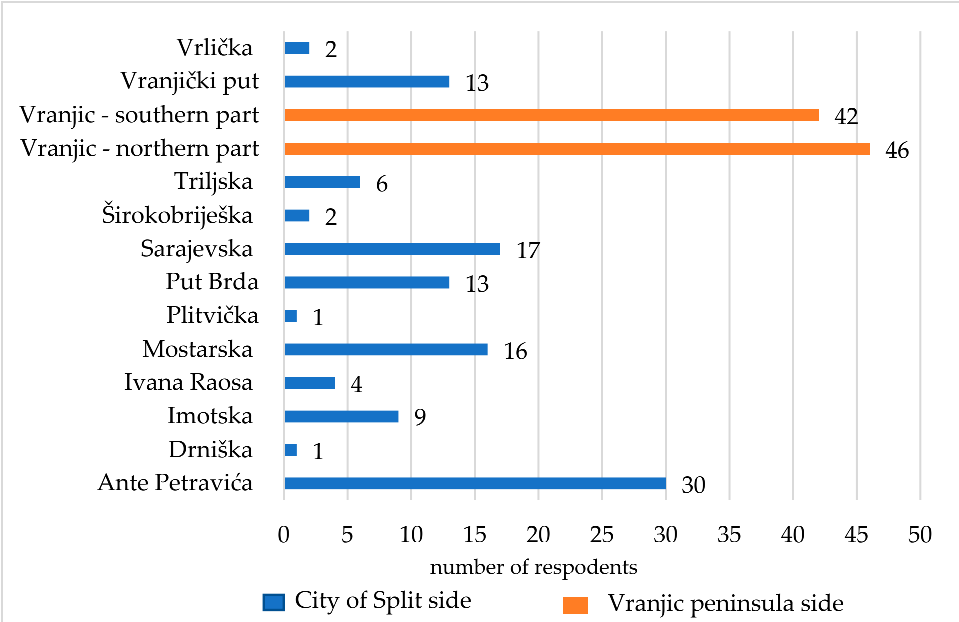

Figure 2. Respondents' places of residence according to residential street.

The respondents' perceptions of port noise are shown in Table 3.

Table 3. Respondents' perceptions of port noise implications from the cargo terminals in the Port of Split.

		Respondents		
Noise pollution %	Significant 83	Insignificant 17		
Noise health hazard %	Aware 83	Not aware 17		
Noise source %	Port 78	Road 11	Rail 4	Indecisive 7
Excessiveness of the noise level %	Day 38	Night 51	N/A 11	
Port noise predominance in total residual noise %	Day 63	Night 65		
Time duration of port noise %	Whole time 51	Several hours 25	Impulsive noise 16	Neutral 8

The majority of respondents indicated that the characteristic of excessive noise pollution was continuous, so it occurred throughout the time the ship was at berth and the handling activities were carried out. In addition, the dominance of excessive noise pollution during night hours was highlighted. Respondents also estimated the type of operation that contributed the most to noise pollution from cargo terminals in the Port of Split, as shown in the Pareto diagram (Figure 3). The analysis showed that cargo handling operations, ship at berth (auxiliary engines, ventilation), and transshipment cargo operations to truck/train had the dominant impact as noise sources, generating a harmful impact on the residents in the vicinity of the cargo terminals.

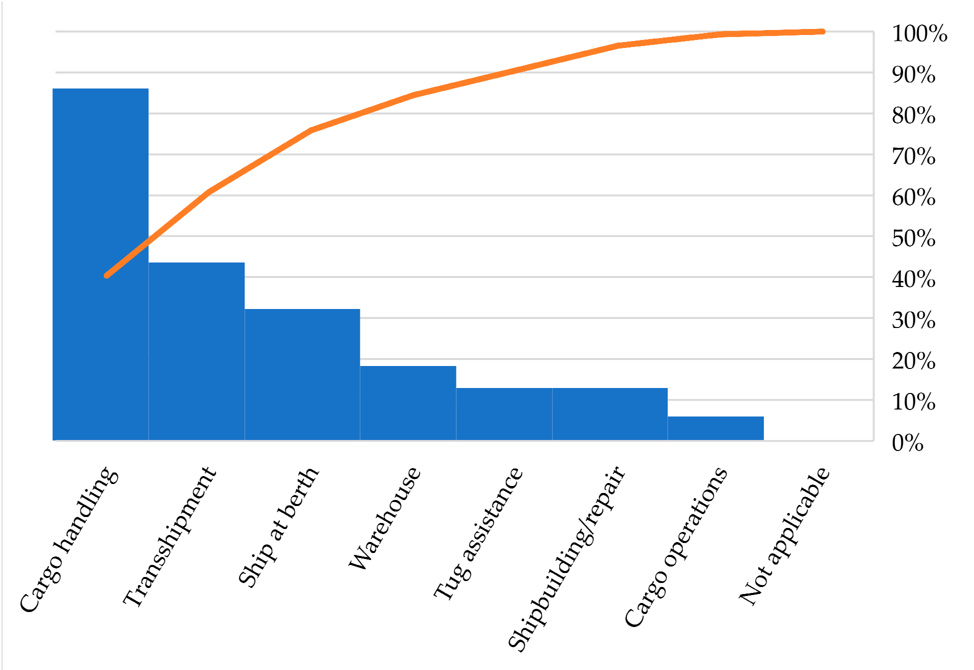

Figure 3. Noise sources at cargo terminals with a dominant contribution to noise pollution.

The share of certain types of cargo in the total increase in noise intensity showed that scrap metal was the cargo type that mainly generated harmful acoustic pollution (75%). The results are indicated in Figure 4.

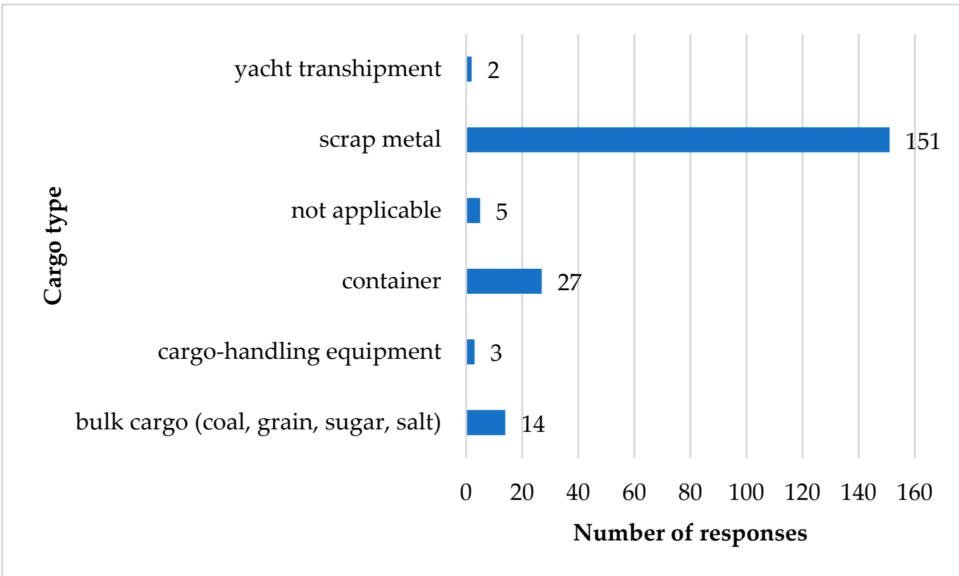

Figure 4. Share of certain types of cargo in the total increase in noise intensity in the Port of Split.

Despite the adverse assessment of noise effects in the Port of Split, more than half (51%) of respondents did not consider changing their residence due to excessive estimated noise levels. On the contrary, 31% replied positively. However, the local inhabitants indicated that the noise nuisances in their places of residence were dominantly annoying (selected by 57%

of respondents), caused stress (50%), or illness (18%). Moreover, the health problems caused by excessive exposure to noise were also assessed in the questionnaire, where the responses varied from a sleep disorder (63%), headaches (30%), and loss of concentration (27%) to depression (21%) and high blood pressure (17%). While some respondents selected more than one health problem, few participants chose none of the proposed parameters (20%). Table 4 indicates the results of the evaluation of the residents' perceptions of the impact of noise on the quality of life at their place of residence and the level of disturbance during rest hours, with predominantly negative perceptions and assessments of both criteria.

Table 4. Evaluation of the residents' perceptions of the impact of noise on the quality of life at their residence and the extent of disturbance during rest hours.

Perception	Positive	Neutral	Negative
Noise impact on quality of life	8%	11%	80%
Disturbance level during rest hours	14%	15%	70%

Two additional criteria were evaluated in the survey, the impact of noise on residential property values (%) and the annual amount (in EUR) residents were willing to spend on noise reduction. When assessing the noise impact on decreases in the value of their apartments, the responses were highly differentiated: 42% of respondents indicated that the value of their apartment would decrease by 15% or more, 23% indicated 10%, and 36% replied that their apartment value would decrease by less than 5%.

In addition, 35% of respondents were willing to spend EUR 1–50 for noise reduction, 28% were unwilling to spend any amount for abatement of excessive noise levels, 23% were prepared to spend amounts in the range of EUR 50 and 100 annually, 8% between EUR 100–150, and only 7% answered that they were willing to spend more than EUR 200 annually to reduce harmful noise pollution.

The core part of the survey concerned the assessment of residents' perceptions of the intensity (dB) of noise from the cargo terminals at their place of resident during the day (7–19 h), evening (19–23 h), and night (23–7 h). The variation of the trend in individual responses is provided in Figure 5.

Based on the criterion of residential location or distance (on streets adjacent to or distant from the cargo terminals), filtered and selected noise levels for individual districts from the respondents' perceptions for three different times of day (day, evening, and night) could be analyzed and compared. The closest streets located south of the cargo terminals and the most exposed to noise emissions were Ante Petravića street and Vranjički put. The southern part of the Vranjic peninsula was the most exposed area to the north of the terminal. Conversely, Mostarska street and the northern part of Vranjic were geographically distant from the noise source evaluated. The comparison of the nearest and more distant streets in the examined area in terms of noise exposure from the cargo terminals and regarding the average noise intensities for three different times of day (day, evening, and night) is provided in Table 5.

Table 5. Comparison of residents' perceptions of noise exposure from the cargo terminals on the nearest and more distant streets in the examined area and regarding the average noise intensities (dB) in the day (D), evening (E), and night (N).

Split (Brda) Streets						Solin (Vranjic)					
Closest			Distant			Closest			Distant		
D	E	N	D	E	N	D	E	N	D	E	N
75	61	56	73	60	54	74	60	56	73	60	56

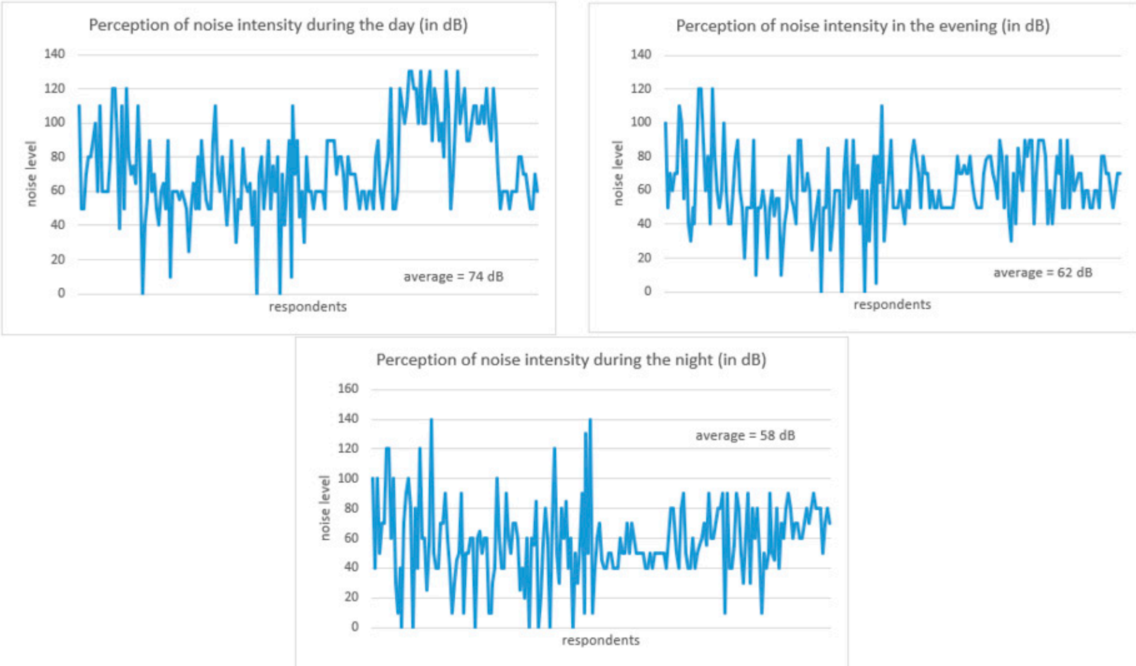

Figure 5. Assessment of residents' perceptions of the intensity of noise pollution from the cargo terminals at their places of residence during the day, evening, and night (in dB).

In addition, the authors used linear regression to examine the dependence between the variables of the distance of individual residences and the assessed noise intensity for three different times of the day (day, evening, and night).

The most common berthing practice considers berthing the vessel alongside, with the port side to the quay wall. In addition, the distances in the considered populated areas were defined as the nearest points between each road and berth 2. The results are shown in Figure 6.

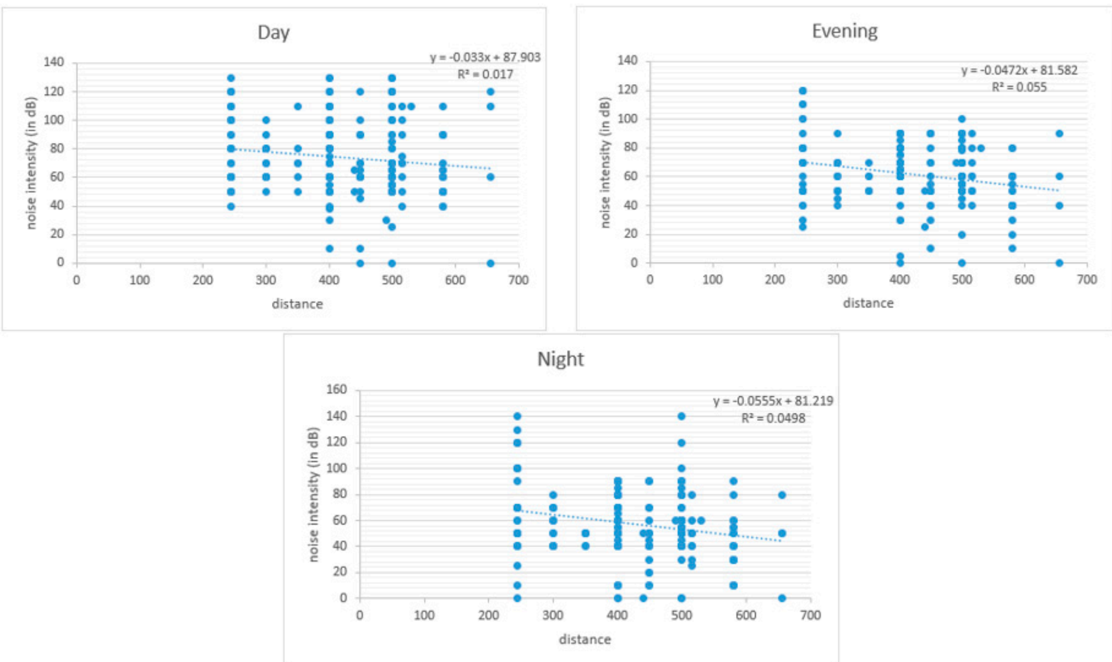

Figure 6. Dependence of the assessed noise intensity (dB) on the distance of individual residences, for three different times of the day (day, evening, and night).

The linear regression results showed weak and reverse dependency between distance and perceived noise intensity.

As an additional control measure, the authors employed two-way ANOVA with Tukey post hoc to evaluate whether there was a significant difference between two independent variables, place of residence and level of education, in relation to the perceived noise intensity, for three different times of day (day, evening, and night) assessed as a dependent variable. The results of the two-way ANOVA test are provided in Tables 6–8.

Table 6. Results of the two-way ANOVA test for perceived noise intensity during the day.

Source of Variation	Sum of Squares (SS)	Degree of Freedom (df)	Mean Square (MS)	F	*p*-Value
Place of residence	3085	1	3085	0.005	0.946
Level of education	11,336,753	3	3,778,918	5694	<0.001
Interaction	1,958,744	3	652,915	0.984	0.401
Error	128,750,856	194	663,664		
Total	1,247,269,000	202			

Table 7. Results of the two-way ANOVA test for perceived noise intensity in the evening.

Source of Variation	Sum of Squares (SS)	Degree of Freedom (df)	Mean Square (MS)	F	*p*-Value
Place of residence	720,374	1	720,374	1646	0.201
Level of education	4,498,968	3	1,499,656	3428	0.018
Interaction	498,666	3	166,222	0.380	0.768
Error	84,880,195	194	437,527		
Total	90,732,520	202			

Table 8. Results of the two-way ANOVA test for perceived noise intensity during the night.

Source of Variation	Sum of Squares (SS)	Degree of Freedom (df)	Mean Square (MS)	F	*p*-Value
Place of residence	2,138,840	1	2,138,840	3142	0.078
Level of education	2,088,435	3	696,145	1022	0.384
Interaction	746,349	3	248,783	0.365	0.778
Error	123,080,750	194	680,829		
Total	811,275,000	202			

The results of the two-way ANOVA test revealed a statistically significant difference in respondents' levels of education for the assessed noise intensity for the day [$F(3, 194) = 5694$, $p = < 0.001$] and evening periods [$F(3, 194) = 3428$, $p = 0.018$]. Thus, the second hypothesis (the respondents' level of education has no significant effect on the assessed noise intensity) for day and evening times of the day was rejected. Based on the evaluation of the remaining hypotheses (the respondents' place of residence has no significant effect on the assessed noise intensity (day, night, evening), and the interaction between the place of residence and level of education has no significant effect on the assessed noise intensity (day, night, evening)), the authors were unable to reject the hypotheses regarding the significance of the place of residence for the assessed noise intensity for three different times of the day (day, evening, and night).

Although the results of the two-way ANOVA test highlighted the significance of respondents' level of education on estimated noise intensity for day and evening periods, a limitation occurred as the analysis failed to identify the effect of differences between the educational levels of the respondents and their perceived noise intensity values (dB). Therefore, to detect the differences in the respondents' levels of education, the Tukey post hoc test was applied. The input data used in the Tukey post hoc test were based on the two-way ANOVA dataset. The comparison between education levels at four study points was analyzed considering a significance level set to $p < 0.05$. The results are provided in Table 9.

Table 9. Application of Tukey post hoc test to identify the effect of differences in educational level of respondents and their perceived noise intensity values for day and evening periods.

		Day	Evening
Study Level	**Level of Education**	**Std Err/Sig**	**Std Err/Sig**
Graduate	Primary	9065/0.840	7360/0.268
	Secondary	4942/<0.001	4012/0.006
	Undergraduate	4989/0.006	4051/0.129
Primary	Graduate	9065/0.840	7360/0.268
	Secondary	8659/0.995	7031/1000
	Undergraduate	8687/0.940	7053/0.920
Secondary	Graduate	4942/<0.001	4012/0.006
	Primary	8659/0.995	7031/1.000
	Undergraduate	4208/0.900	3417/0.552
Undergraduate	Graduate	4989/0.006	4051/0.129
	Primary	8687/0.940	7053/0.920
	Secondary	4208/0.900	3417/0.552

The pair-wise comparisons of the means using the Tukey post hoc test revealed significant differences between the respondents' levels of education and perceived noise intensity from cargo terminals during the day for graduate–secondary and graduate–undergraduate pairs ($p < 0.05$). In addition, a significant difference was also identified for the graduate–secondary level of education of the local population when validating the port noise emitted during the evening period.

4. Discussion

The residents' assessments of noise intensity from cargo terminals for three different times of the day (day, evening, and night) showed high average values: 74 dB for the day, 62 dB for the evening, and 58 dB for the night period. Assuming the relevance and credibility of the perceived values and comparing them with the threshold levels indicated in the Ordinance on the highest permissible noise levels by type of noise source, time, and place of occurrence [48], there was a significant concern considering the deviation from the prescribed levels. However, the respondents evaluated the noise intensity for three different times of the day (day, evening, and night) without formal education and prior knowledge, having only the informative table of noise levels available (Appendix A). This limitation significantly compromised the objectivity and relevance of the perceived values. Nevertheless, public opinion and impressions are always significant and should be considered.

The results for the perceived noise levels (for the day, evening, and night periods), when filtered based on the distance criterion for the residential location (streets adjacent to or distant from the cargo terminal), showed noticeable differences in terms of assessed noise levels but were not statistically significant. These values still support the credibility of the survey conducted. The outcomes of regression analysis showed weak and reverse dependency between distance and perceived noise intensity. This means that the relationship between the selected variables was unreliable, which was primarily due to the inconsistency of the noise pollution assessed by the local population as a result of the subjective perceptions of noise emissions from cargo terminals. These findings validated the respondents' perceptions of noise intensity from the cargo terminals because, by increasing the distance from the noise source, perceived noise intensity (dB) gradually decreased. Furthermore, by conducting the two-way ANOVA with Tukey post hoc, the authors highlighted the effect of significant differences in respondents' levels of education on assessed noise intensity for the day and evening periods. According to these outcomes, the authors partially rejected the second null hypothesis, as the respondents' levels of education showed a significant effect on the assessed noise intensity (for the day and evening periods). The remaining null hypotheses (the first and the third) were accepted, due to the fact that the variable concerning the participants' places of residence did not show any significant differences in effect on perceived noise intensity. Due to the limitations of the two-way ANOVA, which failed to identify the impact of educational level on the noise intensity perceived from different standpoints, and the need for additional segmentation of the education levels, the Tukey post hoc test was performed. This test showed significant differences in the graduate–secondary and graduate–undergraduate pairs during the day and graduate–secondary ones in the evening. These parametric data analyses enabled the authors to identify the significance between set criteria and detect the differences among sub-criteria while underlining the residents' levels of education as a referent variable. The results revealed a considerable differentiation in response among residents according to educational level. The reason could be that some residents lacked knowledge and understanding of noise fundamentals and their effects.

The analysis of the questionnaire distributed to the residents situated adjacent to the cargo terminals in the Port of Split revealed a high level of awareness concerning the harmful effects of noise on health-related problems and the general significance of noise as an environmental issue. Despite knowing about noise effects, more than half of the respondents were not ready to spend even a small amount to compensate for the excessive noise levels in order to reduce harmful noise pollution. The same share was found among residents who, despite facing excessive noise levels and significant health-related issues in their residential locations, had never considered moving. However, when assessing the impact of noise on the reduction in the value of their homes, about two-thirds of the respondents estimated the impact on the value of their properties to be significant. This high differentiation and inconsistency in the attitudes of, and perceived noise effects by, the local population on the one hand and their level of readiness to relocate, invest in noise mitigation, or assess the decrease in their home value due to the port noise impacts on the other, could be related to a lack of general understanding of the implications of noise pollution for the environment and social and cultural differences among people. This argument follows the contribution of the paper by Cerniglia et al. [49], who declared that depending on the individual state of the listener, acoustic phenomena can be perceived differently, while the subjective perception of sound follows the nature of the current psycho-physical and emotional states of the subject. The subjectivity of noise assessment considers personality traits, expectations, and situational factors within exposure levels [50,51]. The dominance of port noise is perceived predominantly at night while underlining the cargo-handling activities as the principal source of port noise, followed by noise generated from berthed ships and transshipment cargo operations to trucks/trains, as a result of a Pareto analysis. These results follow the findings obtained by Murphy and King [13], which indicate the harmful and significant impacts of cargo-handling activity during the night period on the local sound environment. As the port handling activity is associated with low-frequency noise, it represents a concern from a public health perspective. It implies the necessity of proper noise management strategies, especially for port activities operating adjacent to residential neighborhoods. These data should be used in the formulation of remediation activities.

Examples of efficient noise management strategies can be found in Baldinelli and Marsico [7] and van Breeman [22]. The duration of the noise was found to be continuous, with the noise emissions occurring for the entire time from the berthed ship performing cargo-handling operations. The measurement campaign was intended to approximate the total population affected by the excessive port noise resulting from the irregular nature of the acoustic activity. Ohrstrom and Rylander [52] analyzed the effects of recorded intermittent and continuous traffic noise on human subjects. Measurement campaigns demonstrated more disturbances in humans from intermittent than from continuous noise.

However, due to the complex geography of the cargo terminal in the Port of Split and the presence of traffic, industrial, logistical, and other facilities in the port area, the provision of effective noise-abatement strategies depends on the identification of the dominant port noise sources [20] and measurement campaigns that should highlight the noise sources violating the threshold levels. The first activity, related to the classification of port noise sources, has already been carried out by Vukić et al. [14], while the second is planned in the future phases of the NOIPOS project. In addition, the complexity of identifying a single noise source in total residual noise refers to the setting of a permanent and continuous noise measurement system. It would enable us to analyze the real-time values and extract the time sequences when the noise levels exceed valid prescribed limitations. As for the inconsistency of the research findings, the project's final activity should eliminate the challenges that occurred and the high differentiation between the assessed and empirically generated values.

Scrap metal was assessed as a referent cargo type that mainly contributes to the increase in noise intensity when providing port handling activities. The physical features of this cargo type, especially metal-on-metal scraping procedures, produce a high-pitched sound [53]. Although the analysis of strategic noise maps [14] identified road and rail noise as the principal activities for the day (Lday), evening (Levening), and night (Lnight) periods, port noise was assessed by residents as the predominant source in total residual noise, during all analyzed periods. The preparation of noise maps for the microsite (port area) is of utmost importance, especially since they are an effective tool for determining the noise exposure of citizens [54]. The residents indicated that harmful noise affects their general health and causes great annoyance and stress. High variability was found considering the health problems attributed as a direct effect of excessive noise exposure, with sleep disorder as the dominant health-related consequence. These results follow the findings of Murphy and King [55], which indicated annoyance and sleep disturbance as the primary health issues associated with excessive exposure to environmental noise pollution. Besides the sleep disturbances reported in numerous studies [23,56–60] as the primary effect of acute exposure to environmental noise, secondary effects include fatigue, low work capacity, reduced cognitive performance, and changes in daytime behavior as well as mood changes and associated negative emotions [13]. Residents who live in the vicinity of the cargo terminals stated that the noise has a negative impact on the general quality of life in their places of residence and that they are unable to take advantage of the rest hours due to the high noise level of acoustic pollution from the port. Apart from the negative impact of port noise on human health and the whole environment, it reduces the quality of life and endangers some sectors of the economy [61]. The complaints from residents living in urban areas in the vicinity of the port are rising [62], while the disturbances have already been reported in several port areas, such as Dublin [2], Athens [13], La Spezia and Nice [63], and other French and Italian ports [64].

The uncertainty of noise perceptions, the share of the area exposed to noise pollution, and the occurrence of disturbances caused by noise emissions were indicated in the paper by Vukić et al. [21]. These are especially significant in the port area, containing a complex mix of various activities and thus the propagation of noise from numerous sources. These effects contribute to the subjective assessment of noise emissions, especially for the perceived detrimental effects of noise on the local population.

5. Conclusions

The application of parametric data analysis revealed a lack of formal knowledge of noise effects and thus, high differentiation between groups based on the variable determining residents' levels of education and their assessments of noise levels from the cargo terminal. These data should be utilized by the port management body to implement popularization campaigns, external communications policies, and public events to increase the knowledge level on noise and thus improve their public image. Due to the lack of standardization in regulating port noise and deficiencies in the provision of noise management guidelines, citizens' complaints prompted by port noise are commonly handled at a local level. These issues are managed by applying diverse approaches that tend only to respond to the problems that arise from the severe effects of port noise [11]. These conclusions should be exploited to strengthen the role of the port managing body and its responsibility for environmental and social protection by introducing green port governance and, finally, implementing noise abatement policies. Due to the addressed limitations that occurred in residents' estimations of the noise levels, the installation of a permanent noise measurement system in the port area should help verify the questionable results and eliminate the uncertainties. However, as for the difficulties in identifying a singular noise source from the total residual noise, these noise levels are usually addressed as cumulative port noise. The final activity of the NOIPOS project should address the noise levels generated by the simulations provided, the noise assessed by residents living near the port area, and the results obtained through regular measurements at selected sites in the port and surrounding populated areas.

Author Contributions: Conceptualization, L.V.; methodology, L.V.; validation, G.J.M. and K.J.; formal analysis, L.V.; resources, G.J.M. and L.V.; data curation, K.J.; writing—original draft preparation, L.V.; writing—review and editing, L.V. and K.J.; visualization, G.J.M.; supervision, G.J.M. and K.J. All authors have read and agreed to the published version of the manuscript.

Funding: Research activities presented in this paper were conducted under the scientific research project "Measurement and validation of external airborne noise from ships in the port of Split (01/2021)" supported by the University of Split Faculty of Maritime Studies, Croatia (Class: 641-02/21-01/0001).

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the Faculty of Maritime Studies, University of Split (2181-197-01-06-0003).

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

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Acknowledgments: The authors gratefully acknowledge the interviewed inhabitants from the two examined areas for participating in the research.

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

Appendix A. Questionnaire

General perceptions and attitudes of the local population on the influence of noise emissions from the cargo terminals of the Port of Split on health and the standard of life (population on the outside parts of the terminal)

Noise is one of the biggest public health problems today. More than 20% of the inhabitants of the European Union are exposed to noise. Health problems caused by noise pollution range from disturbances and anxiety to impaired concentration, sleep disorders and hearing loss, to high blood pressure and heart attacks. Noise pollution causes anxiety in at least 13% of people. Traffic is the main cause of noise in the environment. Noise above 50 dB (the intensity of a normal conversation in your home) is harmful to health, and above 65 dB (the intensity of a loud conversation in a café/restaurant) should not be tolerated. A noise intensity of 65 dB is 15 times higher than a noise intensity of 50 dB. The individual methods used to retrofit noise-reducing elements are extremely expensive; they reduce the intensity by a maximum of 10 dB, but usually by 2–3 dB. Use the attached table to make it easier to estimate the intensity of the noise you are exposed to (Table A1).

Table A1. Display of decibel level comparison.

Examples	Sound Pressure Level L_p dB SPL
Jet plane, 50 m distance	140
Pain threshold	130
Discomfort threshold	120
Chainsaw, 1 m distance	110
Disco club, 1m distance from the speakers	100
Truck, 10 m distance	90
Rush hour road, 5 m distance	80
Vacuum cleaner, 1 m distance	70
Normal conversation, 1 m	60
Average house noise	50
Silent library	40
Bedroom at night	30
TV studio noise	20
Falling leaf	10
Hearing threshold	0

Table A2. GENERAL DATA.

1. GENDER:						
☐ M			☐ F			
2. AGE:						
☐ 18–30	☐ 30–45		☐ 45–60		☐ >60	
3. EDUCATION LEVEL:						
☐ primary	☐ secondary		☐ undergraduate		☐ graduate	
4. PLACE OF RESIDENCE:						
☐ Vranjic			☐ Split—Brda			
5. PLACE OF RESIDENCE ACCORDING TO THE RESIDENTIAL STREET:						
☐ Vranjic—southern part	☐ Vranjic—northern part	☐ Ante Petravića	☐ Vranjički put	☐ Triljska	☐ Vrlička	☐ Drniška
☐ Put Brda	☐ Plitvička	☐ Mostarska	☐ Sarajevska	☐Imotska	☐Širokobriješka	☐ Ivana Raosa

Table A3. GENERAL KNOWLEDGE OF NOISE POLLUTION.

1. DO YOU CONSIDER NOISE A SIGNIFICANT ENVIRONMENTAL PROBLEM?					
☐ yes			☐ no		
2. ARE YOU AWARE OF THE HARMFUL EFFECTS OF NOISE ON HEALTH?					
☐ yes	☐ no		☐ not applicable		
3. WHAT AMOUNT (IN EUR) WOULD YOU BE WILLING TO SPEND ANNUALLY ON NOISE REDUCTION TO PROTECT YOUR HEALTH?					
☐ 0	☐ EUR 1–50	☐ EUR 50–100	☐ EUR 100–150	☐ EUR 150–300	☐ >EUR 300

Table A4. THE IMPACT OF NOISE FROM CARGO TERMINALS.

1. USING THE ATTACHED TABLE SHOWING THE INTENSITY OF VARIOUS NOISE SOURCES, ESTIMATE HOW MUCH NOISE FROM CARGO TERMINALS (IN dB) YOU ARE EXPOSED TO IN YOUR HOUSEHOLD:				
(a) During **day** ___________ dB (the day is categorized as the time from 7–19 h)				
(b) In the **evening** ______________ dB (the evening is categorized as the time from 19–23 h)				
(c) During the **night** ______________ dB (night is categorized as the time from 23–7 h)				
2. CAN YOU ASSESS THE SOURCE OF THE NOISE FROM THE CARGO TERMINALS OF SPLIT PORT?				
☐ cargo handling	☐ ship at berth (auxiliary engines, ventilation, etc.)	☐ tug assistance	☐ warehouse operations	
☐ cargo operations (refining/finishing)	☐ shipbuilding/repair	☐ transshipment operations (cargo transfer to truck/train)	☐ other:	
3. IS THE NOISE MORE PRONOUNCED AT NIGHT OR DURING DAY?				
☐ at night		☐ during day	☐ not applicable	
4. IS THE NOISE CONTINUOUS, AND WHAT IS THE TIME DURATION OF EXCESSIVE NOISE POLLUTION?				
☐ during the entire time that the vessel is at the terminal performing cargo handling operations	☐ a few hours	☐ impulsive noise	☐ not applicable	
5. CAN YOU ESTIMATE WHICH TYPE OF CARGO CONTRIBUTES MOST TO THE INCREASE IN NOISE INTENSITY?				
☐ scrap metal	☐ bulk cargo (coal, grain, salt, sugar)	☐ container	☐ yacht transshipment	☐ other: ______________
6. CAN YOU DISTINGUISH THE NOISE OF THE PORT/SHIP FROM THAT OF OTHER NOISE SOURCES (ROAD, RAILROAD), AND IS IT DOMINANT DURING THE DAY?				
☐ port/ship noise is dominant	☐ port/ship noise is not dominant	☐ I can't determine	☐ not applicable	
7. CAN YOU DISTINGUISH THE NOISE OF THE PORT/SHIP FROM THAT OF OTHER NOISE SOURCES (ROAD, RAILROAD), AND IS IT DOMINANT DURING THE EVENING/DURING THE NIGHT?				
☐ port/ship noise is dominant	☐ port/ship noise is not dominant	☐ I can't determine	☐ not applicable	
8. HIGHER NOISE INTENSITY COMES FROM (CHOOSE):				
☐ road	☐ port	☐ railroad	other:______________	☐ not applicable

Table A4. *Cont.*

9. HAVE YOU EVER CONSIDERED CHANGING YOUR PLACE OF RESIDENCE BECAUSE OF THE HARMFUL NOISE POLLUTION?						
☐ yes		☐ no		☐ not applicable		
10. WHICH OF THE LISTED NOISE NUISANCES HAVE YOU EXPERIENCED AT YOUR PLACE OF RESIDENCE?						
☐ annoyance		☐ stress		☐ illness	other:______________	☐ not applicable
11. WHICH OF THE LISTED HEALTH PROBLEMS HAVE YOU EXPERIENCED DUE TO EXCESSIVE NOISE EXPOSURE?						
☐ depression	☐ sleep disorder	☐ loss of concentration	☐ high blood pressure	☐ headaches	☐ diabetes	☐ not applicable
12. CAN YOU DETERMINE HOW MUCH THE NOISE FROM CARGO TERMINALS AFFECTS THE QUALITY OF LIFE, LIVING, RAISING CHILDREN IN THE PLACE OF RESIDENCE?						
☐ huge problem		☐ significant		☐ neutral	☐ negligible	☐ not applicable
13. HOW MUCH DO YOU THINK NOISE COULD REDUCE THE VALUE OF YOUR HOME (IN PERCENT %)?						
☐ 1%		☐ 5%		☐ 10%	☐ 15%	☐ >15%
14. HOW MUCH DOES NOISE DISTURB YOU DURING REST PERIODS, AND HOW DOES IT AFFECT YOUR DAILY LIFE?						
☐ very much	☐ a lot	☐ slightly		☐ very slightly	☐ not at all	☐ not applicable
15. SUGGESTIONS AND PROPOSALS FOR SOLVING THE NOISE PROBLEM OF CARGO TERMINALS:						
____						

References

1. World Health Organization-Regional Office for Europe. Burden of Disease from Environmental Noise: Quantification of Healthy Life Years Lost in Europe. Available online: https://apps.who.int/iris/handle/10665/326424 (accessed on 10 January 2023).
2. Paschalidou, A.K.; Kassomenos, P.; Chonianaki, F. Strategic Noise Maps and Action Plans for the Reduction of Population Exposure in a Mediterranean Port City. *Sci. Total Environ.* **2019**, *654*, 144–153. [CrossRef] [PubMed]
3. Hänninen, O.; Knol, A.B.; Jantunen, M.; Lim, T.A.; Conrad, A.; Rappolder, M.; Carrer, P.; Fanetti, A.C.; Kim, R.; Buekers, J.; et al. Environmental Burden of Disease in Europe: Assessing Nine Risk Factors in Six Countries. *Environ. Health Perspect.* **2014**, *122*, 439–446. [CrossRef] [PubMed]
4. Guarinoni, M.; Ganzleben, C.; Murphy, E.; Jurkiewicz, K. Towards A Comprehensive Noise Strategy. Brussels: European Union. Available online: https://www.europarl.europa.eu/RegData/etudes/etudes/join/2012/492459/IPOL-ENVI_ET(2012)492459_EN.pdf (accessed on 26 January 2023).
5. European Union Directive 2002/49/EC of the European Parliament and the Council of 25 June 2002 Relating to the Assessment and Management of Environmental Noise. *Off. J. Eur. Communities* **2002**, *L189/12*. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002L0049&from=DE (accessed on 20 January 2023).
6. Puig, M.; Wooldridge, C.; Casal Fàbrega, J.; Darbra Roman, R.M. Environmental Reporting and Communication—"Show Me the Evidence"! In Proceedings of the 2013 GreenPort Congress, Antwerp, Belgium, 9–11 October 2013; pp. 168–177. Available online: https://upcommons.upc.edu/handle/2117/21489 (accessed on 20 January 2023).
7. Baldinelli, G.; Marsico, G. State of the Art of Best Practices for Port Noise Management. Deliverable Number A1 Dissemination Level Internal-External LIFE Programme. Available online: http://anchorlife.eu/wp-content/uploads/2021/01/deliverable_A1_State_of_the_art.pdf (accessed on 26 February 2023).
8. Fredianelli, L.; Gaggero, T.; Bolognese, M.; Borelli, D.; Fidecaro, F.; Schenone, C.; Licitra, G. Source Characterization Guidelines for Noise Mapping of Port Areas. *Heliyon* **2022**, *8*, e09021. [CrossRef]
9. The Maritime Executive. Industry-First Airborne Noise Notation for Ships in Port Launched. Available online: https://maritime-executive.com/article/industry-first-airborne-noise-notation-for-ships-in-port-launched (accessed on 3 March 2023).
10. Peris, E. (Ed.) *Environmental Noise in Europe—2020*; EEA Report No 22/2019; EEA: Copenhagen, Denmark, 2020; Available online: https://www.eea.europa.eu/publications/environmental-noise-in-europe/at_download/file (accessed on 1 February 2023).
11. Schiavoni, S.; D'Alessandro, F.; Borelli, D.; Fredianelli, L.; Gaggero, T.; Schenone, C.; Baldinelli, G. Airborne Sound Power Levels and Spectra of Noise Sources in Port Areas. *Int. J. Environ. Res. Public Health* **2022**, *19*, 10996. [CrossRef]
12. Murphy, E.; King, E.A. Strategic Environmental Noise Mapping: Methodological Issues Concerning the Implementation of the EU Environmental Noise Directive and Their Policy Implications. *Environ. Int.* **2010**, *36*, 290–298. [CrossRef]
13. Murphy, E.; King, E.A. An Assessment of Residential Exposure to Environmental Noise at a Shipping Port. *Environ. Int.* **2014**, *63*, 207–215. [CrossRef]
14. Vukić, L.; Peronja, I.; Glavinović, R. Multi-Faceted Analysis of Airborne Noise Impact in the Port of Split (I). *J. Mar. Sci. Eng.* **2022**, *10*, 1564. [CrossRef]
15. Trojanek, R.; Tanas, J.; Raslanas, S.; Banaitis, A. The Impact of Aircraft Noise on Housing Prices in Poznan. *Sustainability* **2017**, *9*, 2088. [CrossRef]
16. Jin, S.-H.; Nelson, P.B. Interrupted Speech Perception: The Effects of Hearing Sensitivity and Frequency Resolution. *J. Acoust. Soc. Am.* **2010**, *128*, 881–889. [CrossRef]
17. Elmenhorst, E.M.; Griefahn, B.; Rolny, V.; Basner, M. Comparing the Effects of Road, Railway, and Aircraft Noise on Sleep: Exposure–Response Relationships from Pooled Data of Three Laboratory Studies. *Int. J. Environ. Res. Public Health* **2019**, *16*, 1073. [CrossRef] [PubMed]
18. Kim, M.; Chang, S.I.; Seong, J.C.; Holt, J.B.; Park, T.H.; Ko, J.H.; Croft, J.B. Road Traffic Noise: Annoyance, Sleep Disturbance, and Public Health Implications. *Am. J. Prev. Med.* **2012**, *43*, 5-1–5-32. [CrossRef] [PubMed]
19. Münzel, T.; Gori, T.; Babisch, W.; Basner, M. Cardiovascular Effects of Environmental Noise Exposure. *Eur. Heart J.* **2014**, *35*, 829–836. [CrossRef] [PubMed]
20. Čurović, L.; Jeram, S.; Murovec, J.; Novaković, T.; Rupnik, K.; Prezelj, J. Impact of COVID-19 on Environmental Noise Emitted from the Port. *Sci. Total Environ.* **2021**, *756*, 144147. [CrossRef] [PubMed]
21. Vukić, L.; Mihanović, V.; Fredianelli, L.; Plazibat, V. Seafarers' Perception and Attitudes towards Noise Emission on Board Ships. *Int. J. Environ. Res. Public Health* **2021**, *18*, 6671. [CrossRef]
22. Van Breemen, T.; Popp, C.; Witte, R.; Wolfkenfelt, F.; Wooldridge, C. Noise Management in European Ports, LIFE05 ENV/NL/000018, Good Practice Guide on Port Area Noise Mapping and Management, Technical Annex, Brussels, Belgium. 2008. Available online: https://www.ecoports.com/assets/files/common/publications/good_practice_guide.pdf (accessed on 20 January 2023).
23. Fredianelli, L.; Bolognese, M.; Fidecaro, F.; Licitra, G. Classification of Noise Sources for Port Area Noise Mapping. *Environments* **2021**, *8*, 12. [CrossRef]
24. Fredianelli, L.; Nastasi, M.; Bernardini, M.; Fidecaro, F.; Licitra, G. Pass-by Characterization of Noise Emitted by Different Categories of Seagoing Ships in Ports. *Sustainability* **2020**, *12*, 1740. [CrossRef]

25. Ryan, J.P.; Joseph, J.E.; Margolina, T.; Hatch, L.T.; Azzara, A.; Reyes, A.; Southall, B.L.; DeVogelaere, A.; Peavey Reeves, L.E.; Zhang, Y.; et al. Reduction of Low-Frequency Vessel Noise in Monterey Bay National Marine Sanctuary during the COVID-19 Pandemic. *Front. Mar. Sci.* **2021**, *8*, 587. [CrossRef]
26. Dragan, D.; Mulej, M. Deterioration of the Life Quality of the Koper's Inhabitants as a Result of the Port's Ships' Activities: The SEM Modeling Study of Social Irresponsibility. In Proceedings of the 13th IRDO International Scientific Conference Social Responsibility and Current Challenges 2018: Social Responsibility and Sustainable Development in Science, Education and Business, Maribor, Slovenia, 27 September 2018; Available online: https://www.researchgate.net/publication/327931765_Deterioration_of_the_life_quality_of_the_Koper\T1\textquoterights_inhabitants_as_a_result_of_the_Port\T1\textquoterights_ships\T1\textquoteright_activities_The_SEM_Modeling_Study_Of_Social_Irresponsibility (accessed on 10 January 2023).
27. Faculty of Maritime Studies. Project List. Available online: https://www.pfst.unist.hr/en/research/projects/project-list (accessed on 11 January 2023).
28. GIS Split. Records of Settlements, Streets and House Numbers of the City of Split. Available online: https://web.archive.org/web/20120313234009/http://clgis.split.hr/gis_splita/geo_data/pdf/GradskiKotari.pdf (accessed on 19 January 2022).
29. Croatian Bureau of Statistics (CBS). Census of Population, Households and Apartments 2021-First Results. Available online: https://web.dzs.hr/default.htm (accessed on 19 January 2022).
30. Realyvásquez-Vargas, A.; Arredondo-Soto, K.C.; Carrillo-Gutiérrez, T.; Ravelo, G. Applying the Plan-Do-Check-Act (PDCA) Cycle to Reduce the Defects in the Manufacturing Industry. A Case Study. *Appl. Sci.* **2018**, *8*, 2181. [CrossRef]
31. Ivančić, V. Improving the decision making process trough the Pareto principle application. *Econ. Thought Pract.* **2014**, *2*, 633–656.
32. Webber, L.; Wallace, M. *Quality Control for Dummies*; John Wiley & Sons: Indianapolis, IN, USA, 2011.
33. Lestyánszka Škůrková, K.; Fidlerová, H.; Niciejewska, M.; Idzikowski, A. Quality Improvement of the Forging Process Using Pareto Analysis and 8D Methodology in Automotive Manufacturing: A Case Study. *Standards* **2023**, *3*, 84–94. [CrossRef]
34. Brooks, C. What is a pareto analysis? *Bus. News Dly. Sr.* **2014**, *29*, 1–5.
35. Joiner Associates Staff. *Pareto Charts: Plain & Simple*; Oriel Incorporated: Madison, WI, USA, 1995.
36. Joiner Associates Staff. *Introduction to the Tools: Plain & Simple: Learning and Application Guide*; Oriel Incorporated: Madison, WI, USA, 1995.
37. Kim, S.J.; Bae, S.J.; Jang, M.W. Linear Regression Machine Learning Algorithms for Estimating Reference Evapotranspiration Using Limited Climate Data. *Sustainability* **2022**, *14*, 11674. [CrossRef]
38. Stat Trek. Linear Regression. Available online: https://stattrek.com/regression/linear-regression?utm_content=cmp-true (accessed on 2 March 2023).
39. Ramazanovna, K.N. Customs Fees and Revenues Factors of Formation. *J. Posit. Sch. Psychol.* **2022**, *6*, 975–979.
40. 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]
41. Borovskaya, R.; Krivoguz, D.; Chernyi, S.; Kozhurin, E.; Khorosheltseva, V.; Zinchenko, E. Surface Water Salinity Evaluation and Identification for Using Remote Sensing Data and Machine Learning Approach. *J. Mar. Sci. Eng.* **2022**, *10*, 257. [CrossRef]
42. Thango, B.A. Application of the Analysis of Variance (ANOVA) in the Interpretation of Power Transformer Faults. *Energies* **2022**, *15*, 7224. [CrossRef]
43. Ahammed, F.; Smith, E. Prediction of Students' Performances Using Course Analytics Data: A Case of Water Engineering Course at the University of South Australia. *Educ. Sci.* **2019**, *9*, 245. [CrossRef]
44. Laverty, W.; Kelly, I. Using Excel to Explore the Effects of Assumption Violations on One-Way Analysis of Variance (ANOVA) Statistical Procedures. *Open J. Stat.* **2019**, *9*, 458–469. [CrossRef]
45. Strobl, P.; Schermer, E.; Groetsch, D.; Pointner-Gabriel, L.; Voelkel, K.; Pflaum, H.; Stahl, K. Identification and Validation of Linear Friction Models Using ANOVA and Stepwise Regression. *Lubricants* **2022**, *10*, 286. [CrossRef]
46. Henson, R.N. Analysis of Variance (ANOVA). *Brain Mapp. Encycl. Ref.* **2015**, *1*, 477–481. [CrossRef]
47. Nanda, A.; Bhusan Mohapatra, B.; Prasada Kumar Mahapatra, A.; Prasad Kumar Mahapatra BALVIKAS, A.; Prasad Kumar Mahapatra, A.; Prasad Kumar Mahapatra, A. Multiple Comparison Test by Tukey's Honestly Significant Difference (HSD): Do the Confident Level Control Type I Error. *Int. J. Stat. Appl. Math.* **2021**, *6*, 59–65. [CrossRef]
48. Ministry of Health. Ordinance on Maximum Permitted Noise Levels with Regard to the Type of Noise Source, Time and Place of Origin. Available online: https://narodne-novine.nn.hr/clanci/sluzbeni/2021_12_143_2454.html (accessed on 4 February 2023).
49. Cerniglia, A.; Chiarella, D.; Cutugno, P.; Marconi, L.; Magrini, A.; Di Feo, G.; Ferretti, M. Questionnaire Analysis to Define the Most Suitable Survey for Port-Noise Investigation. *arXiv* **2020**. [CrossRef]
50. Health Canada. Guidance for Evaluating Human Health Impacts in Environmental Assessment: NOISE. Available online: https://publications.gc.ca/collections/collection_2017/sc-hc/H129-54-3-2017-eng.pdf (accessed on 12 February 2023).
51. Civil Aviation Authority. Aircraft Noise and Annoyance: Recent Findings, No CAP 1588, Environmental Research and Consultancy Department. Available online: https://publicapps.caa.co.uk/docs/33/CAP1588_FEB18.pdf (accessed on 10 February 2023).
52. Öhrström, E.; Rylander, R. Sleep Disturbance Effects of Traffic Noise—A Laboratory Study on after Effects. *J. Sound Vib.* **1982**, *84*, 87–103. [CrossRef]
53. Holusha, J. Tech Notes; Trains That Don't Screech. *New York Times* **1992**. Available online: https://www.nytimes.com/1992/02/23/business/tech-notes-trains-that-don-t-screech.html (accessed on 19 January 2023).

54. Fredianelli, L.; Carpita, S.; Bernardini, M.; Del Pizzo, L.G.; Brocchi, F.; Bianco, F.; Licitra, G. Traffic Flow Detection Using Camera Images and Machine Learning Methods in ITS for Noise Map and Action Plan Optimization. *Sensors* **2022**, *22*, 1929. [CrossRef] [PubMed]
55. Murphy, E.; King, E.A. Scenario Analysis and Noise Action Planning: Modelling the Impact of Mitigation Measures on Population Exposure. *Appl. Acoust.* **2011**, *72*, 487–494. [CrossRef]
56. Babisch, W. Noise and Health. *Environ. Health Perspect* **2005**, *113*, 1–2. [CrossRef]
57. Carter, N.L. Transportation Noise, Sleep, and Possible after-Effects. *Environ. Int.* **1996**, *22*, 105–116. [CrossRef]
58. Vallet, M.; Gagneux, J.M.; Blanchet, V.; Favre, B.; Labiale, G. Long Term Sleep Disturbance Due to Traffic Noise. *J. Sound Vib.* **1983**, *90*, 173–191. [CrossRef]
59. Petri, D.; Licitra, G.; Vigotti, M.A.; Fredianelli, L. Effects of Exposure to Road, Railway, Airport and Recreational Noise on Blood Pressure and Hypertension. *Int. J. Environ. Res. Public Health* **2021**, *18*, 9145. [CrossRef] [PubMed]
60. Basner, M.; McGuire, S. WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Effects on Sleep. *Int. J. Environ. Res. Public Health* **2018**, *15*, 519. [CrossRef] [PubMed]
61. Vukić, L.; Peronja, I.; Mandić, N. Significance and Current Regulations of External Airborne Noise from Ships. *WIT Trans. Built Environ.* **2022**, *212*, 139–148. [CrossRef]
62. Borelli, D.; Gaggero, T.; Pallavidino, E.; Schenone, C.; Waffo Kamdem, E.L.; Yousseu Njiotang, C.A. Possible Solutions for Port Noise Monitoring. In Proceedings of the 26th International Congress on Sound and Vibration, Montréal, QC, Canada, 7–11 July 2019; Available online: http://toc.proceedings.com/50377webtoc.pdf (accessed on 20 January 2023).
63. Bolognese, M.; Fidecaro, F.; Palazzuoli, D.; Licitra, G. Port Noise and Complaints in the North Tyrrhenian Sea and Framework for Remediation. *Environments* **2020**, *7*, 17. [CrossRef]
64. Licitra, G.; Bolognese, M.; Palazzuoli, D.; Fredianelli, L.; Fidecaro, F. Port noise impact and citizens' complaints evaluation in rumble and mon acumen Interreg projects. In Proceedings of the 26th International Congress on Sound and Vibration, ICSV 2019, Montreal, QC, Canada, 7–11 July 2019.