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# Awaking the awareness of the movida noise on residents: measurements, experiments and modelling

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## ABSTRACT

**Noise is one of the most important pollutant of the modern cities. It affects human health, social relationships and the cognitive sphere. Following the Directive 2002/49/EC, in EU urban agglomerations, noise is assessed by the noise modelling of the main transportation infrastructures and the calculation of noise maps. However, within the historical and pedestrianized centers of cities, night time noise is mostly engendered by the aggregation of people who talk, discuss, drink, listen to music, and have fun together, in a word by the movida, and less by traffic.**

**But the coexistence between movida and the rest's expectations of residents represent a very big issue for lots of historical centers. New initiatives oriented to the social cohesion, need to be introduced in order to smooth existing conflicts.**

**This research extends the preliminary results presented at the Acoustics Society of America meeting, in 2018, on the implementation of a new methodology to awake citizens' awareness on the effects of leisure noise. The paper shows the in situ measurement, the results of subjective assessments administered by a Point of View Questionnaire, and the development of a Neural Net Algorithm to predict the degree of annoyed people.**

**Keywords:** Noise Annoyance, Movida, Modelling
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## 1. INTRODUCTION

Noise is one of the main pollutants of modern cities, it interferes with sleep, and affects negatively on human health and cognitive sphere as well as social relationships [1-3]. In EU, with the Directive 2002/49/EC [4], urban noise is described and managed by Noise Maps and Action Plans. However, many historical city centres and pedestrian areas have changed into vivacious districts where the night time noise is mainly emitted by the aggregation of people who talk, discuss, drink, listen to music and have fun together. This wide social phenomenon is described synthetically with the word *movida* and these districts are known nowadays as *movida districts.*

According to the Italian federation of pubs and restaurants (FIPE) [5], in the 2013, 19 million of Italians attended the movida districts of cities and about 6,4 million of them have under 30 of age. Moreover, there are 15,6 million Italians who go out at least once evening/night per week and 8,5 million who go to the historic centres of their cities or of neighbouring towns. The historic centers are attended more frequently in south Italy (51%) due to the most favourable climatic conditions and in large (54%) and medium (52%) cities.

Unfortunately, *movida* districts are often places of deviant social situations where there is consumption of alcohol and drugs, and where the respect for the public decorum is missing as well as for the quietness of the surrounding environment.

The sleep deprivation caused by the *movida* night noise represents a very big issue for residents, and local Administrators are engaged to monitor the phenomenon and propose new creative and participative strategies to settle existing conflicts.

In the last years several acoustic measurement campaigns to monitor the noise levels at the residents were carried out within Italians' *movida* districts and in several cities. In Turin, ARPA Piemonte created the APP *OpeNoise* for real time noise level monitoring [6]. In the city of Bologna [7] reactive installations "*De De decifra decibel*" were deployed with the intent to raise awareness of people about noise pollution. Low cost acoustic sensors were dislocated in the city centre of Pistoia to detect critical areas and to show the monitoring data by dynamic maps on totem displays located in public areas, and accessible for consultation with smart devices [7]. In Milan the MAAM project (*Monitoraggio Acustico delle Aree della Movida*) has monitored the impact of *movida* on night noise levels and performed survey to understand the effects of noise on residents [8, 9].

Other initiatives were focused on the people's behaviours that engender the noise. In Genoa the owners of pubs and restaurants hired *Silencers* to mitigate the noise of the nightlife, while in Parma and Pistoia was born the figure of the *Urban Steward* to "educate" the people who attend the movida districts to have respectful and aware behaviours.

This paper extends the preliminary results showed at the Acoustics Society of America meeting, in 2017, on the implementation of a new methodology to awake the awareness of citizens on leisure noise [10-11]. Analysing the movida noise within a pedestrian area of the historic centre of Caserta and the reactions of individuals toward some perceptual aspects, we aim to predict Wellness and Noise Annoyance of the population using acoustics/psychoacoustics metrics as input variables of a neural network.

## 2. METHODOLOGY

The research has been organized in three different steps. In the first, a site of the *movida* has been identified and characterized by audio recordings, observations of events and photos. In the second step a questionnaire has been prepared and administered to a sample of people in a test session, to investigate the effects of the *movida* noise on some aspects of Wellness and Annoyance. The results of the test were analysed and used in the third step to build up predictive models based on Artificial Neural Networks.

### 2.1 Audio-Video material

Audio recordings and photos were collected at Piazza Correra, a small square of 23 m x 35 m located in one of the liveliest movida districts in Caserta (South Italy). The square hosts 8 different commercial activities as pubs, bars and restaurants.

*Figure 1 - Piazza Correra, Caserta (Italy).*

The survey took place on $30^{th}$ November 2018 (between 7 pm and 1 am). During this period, 5 audio recordings sessions, lasting about 30 minutes, were carried out by means of a 4-channel recording/playback system SQobold equipped with a binaural headset BHS II. Contemporary, an operator took some photos, counted the number of occupants in the square and noted the main typologies of activities.

| Time period | Main activities | Intensity of the activity | N. Pax |
|---|---|---|---|
| 19.30 - 20.00 | Speaking<br>Drinking<br>Smoking | Low | < 10 |
| 21.15 - 21.45 | | Low | 15 - 20 |
| 22.30 - 23.00 | | Medium | 40 - 70 |
| 23.30 - 00.00 | | High | 120 - 150 |
| 00.30 - 01.00 | | High | 110 - 100 |

*Table 1 - Movida activity monitoring.*

Two of the previous sessions were selected as representative of two main crowding conditions of the square, Low (L) and High (H). The corresponding audio recordings have been cut in 12 soundtracks and analysed. The main acoustic and psychoacoustic descriptors analysed were: A-weighted and linear sound equivalent levels, L(A) and L; Loudness, N; Sharpness, S; Roughness, R; Fluctuation strength, F; impulsiveness, I and the Specific Prominence Ratio, SPR. A summary of the results analysed by the software Artemis is showed in table 2.

The data collected during the registration campaigns were used for the construction of the experimental session.

| REC ID | L | L(A) | $N_5$ | S | R | F | I | $SPR_5$ |
|---|---|---|---|---|---|---|---|---|
| | dB | dB(A) | soneGF | acum | asper | vacil | iu | dB |
| H1 | 84,5 | 78,1 | 47,0 | 2,46 | 0,0523 | 0,0274 | 0,402 | 1,375 |
| H2 | 84,7 | 78,6 | 48,4 | 2,40 | 0,0533 | 0,0363 | 0,366 | 1,190 |
| H3 | 85,7 | 80,9 | 55,2 | 2,48 | 0,0573 | 0,0369 | 0,381 | 1,360 |
| H4 | 84,3 | 79,4 | 48,6 | 2,44 | 0,0577 | 0,0328 | 0,375 | 1,445 |
| H5 | 87,5 | 79,8 | 51,8 | 2,54 | 0,0544 | 0,0277 | 0,399 | 1,550 |
| H6 | 87,1 | 80,5 | 54,7 | 2,50 | 0,0555 | 0,0316 | 0,371 | 1,355 |
| H7 | 85,3 | 80,9 | 55,2 | 2,43 | 0,0558 | 0,0424 | 0,366 | 1,745 |
| H8 | 88,6 | 79,8 | 52,1 | 2,29 | 0,0539 | 0,0296 | 0,334 | 1,645 |
| H9 | 89,3 | 79,8 | 56,9 | 2,32 | 0,0524 | 0,0292 | 0,342 | 1,450 |
| H10 | 88,8 | 78,8 | 52,3 | 2,40 | 0,0516 | 0,0295 | 0,372 | 1,570 |
| H11 | 83,0 | 78,5 | 47,5 | 2,37 | 0,0539 | 0,0261 | 0,358 | 1,345 |
| H12 | 83,0 | 79,4 | 49,1 | 2,50 | 0,0578 | 0,0299 | 0,378 | 1,455 |
| L1 | 74,6 | 70,1 | 28,9 | 1,99 | 0,0419 | 0,0308 | 0,344 | 1,190 |
| L2 | 76,2 | 72,3 | 34,2 | 2,10 | 0,0452 | 0,0255 | 0,336 | 1,515 |
| L3 | 77,2 | 73,9 | 35,6 | 2,10 | 0,0471 | 0,0399 | 0,358 | 1,740 |
| L4 | 76,9 | 73,4 | 34,4 | 2,04 | 0,0476 | 0,0344 | 0,359 | 1,760 |
| L5 | 76,9 | 73,2 | 33,6 | 2,03 | 0,0478 | 0,0376 | 0,361 | 1,950 |
| L6 | 76,1 | 71,4 | 31,8 | 1,96 | 0,0442 | 0,0282 | 0,328 | 1,190 |
| L7 | 77,4 | 73,4 | 34,8 | 2,07 | 0,0465 | 0,0358 | 0,346 | 2.00 |
| L8 | 77,5 | 73,9 | 34,9 | 2,07 | 0,0486 | 0,0371 | 0,356 | 1,670 |
| L9 | 77,8 | 74,4 | 36,3 | 2,11 | 0,0492 | 0,0356 | 0,373 | 1,335 |
| L10 | 77,7 | 74,4 | 36,7 | 2,11 | 0,0491 | 0,0313 | 0,353 | 1,195 |
| L11 | 78,7 | 75,5 | 38,9 | 2,17 | 0,0509 | 0,0280 | 0,353 | 1,275 |
| L12 | 78,3 | 75,6 | 36,8 | 2,16 | 0,0518 | 0,0253 | 0,344 | 1,300 |

*Table 2 - Acoustic/Psychoacoustic descriptors of the 24 soundtracks.*

## 2.2 Two-Point of View Questionnaire (2-POV-Q)

The questionnaire used, is a slight modification of a previous version developed by the authors [10].

It investigates the following aspects:

- *Wellness*: linked to the positive effects that the surrounding environment can have on the interviewee;
- *Place:* connected to the architectural conformation of the site and its usability for recreational or dwelling purposes;
- *Music:* related to the pleasure/displeasure of listening to loud music;
- *Concentration:* correlated to the personal capability of the interviewed person to be able to concentrate in condition of environmental noise;
- *Mood:* linked to the feeling of joy and irritability;
- *Awareness:* of being a possible cause of trouble or being disturbed by *Movida* activities;
- *Noise Annoyance:* related to crowding condition of the site.

For each aspect two different statements that assess two opposite attributes (one positive and one negative) were prepared. Only for the first and the last aspect (Wellness and Noise Annoyance) both the statements had the same direction (both positives, or both negatives). All the positive statements were then grouped in a common aspect called Global Wellness (GW) while all the negative aspects were grouped in a common aspect called Global Annoyance (GA). All the 14 statements presented a grid of 6 possible choices (based on the Likert Scale from 1 to 6) to indicate the disagreement/agreement of experienced GA/GW.

The table 3 shows the statements administered during the listening test. In grey are highlighted the ones related to the GA.

The questionnaire was developed to investigate how the different point of views (POV) of Residents (R) and Frequenters (F) affect the perception of wellness and annoyance of people. Participants were asked to impersonate these roles answering the questionnaire at 2 different degrees of crowding, Low (L) and High (H).

Each scenario was preceded by a brief introduction as detailed below:

- *"You will hear the sounds of a place of aggregation. Imagine that you are a FREQUENTER to this place and that you are there to spend an evening with friends. Listen to them carefully and report the degree of agreement or disagreement with the statements that will be proposed to you."*
- *"You will hear the sounds of a place of aggregation. Imagine you are a RESIDENT of this place and you are facing the balcony of the house. Listen to them carefully and report the degree of agreement or disagreement with the statements that will be proposed to you."*

| | |
|---|---|
| | **FREQUENTER** |
| Wellness | I feel comfortable in this sound environment |
| | It would be pleasant to eat and drink in this area |
| Place | I'd like to spend an evening in this area |
| | I think this area is not suitable for an evening |
| Music | Listening to loud music makes me happy |
| | I think the music should be lower |
| Concentration | I am able to concentrate easily in these conditions |
| | I have difficulty talking with my interlocutor |
| Social/Mood | Being in a place where people have fun makes me happy and in a good mood |
| | In this sound environment I would feel rather nervous |
| Awareness | If I attended this place I would worry about not disturbing the residents |
| | If I attended this place, I would not worry about making noise |
| Noise Annoyance | I think in this place there are too many people who make noise |
| | A place like this seems to be too crowded |
| | **RESIDENT** |
| Wellness | I feel comfortable in this sound environment |
| | It would be nice to sleep in this area |
| Place | It would be nice to live in this area |
| | I think this area is not suitable for living there |
| Music | I love listening to loud music |
| | I think music should be more moderate |
| Concentration | I am able to concentrate easily in these conditions |
| | I have difficulty talking with my interlocutor |
| Social/Mood | I like listening to people having fun |
| | In this sound environment I would feel rather nervous |
| Awareness | If I lived in this place I would be worried about being disturbed by the locals |
| | If I lived in this place, I would not worry about outside noise |
| Noise Annoyance | I think in this place there are too many people who make noise |
| | A place like this seems to be too crowded |

*Table 3 - The 2 Point of view Questionnaire.*

### 2.3 Test implementation

The 24 soundtracks, two representative photos and the 2 POV-Q have been implemented in the software PsycoPy [12] and organized in 24 counterbalanced sequences. The playback sound levels at the headphones (Pioneer SE-MJ722T-R) has been calibrated by a Mk1-Cortex manikin, a Symphonie card01dB and a laptop.

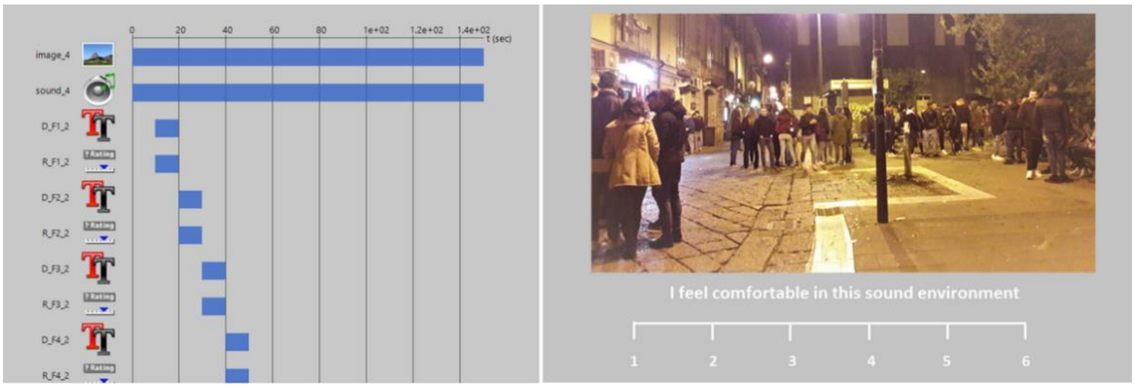


*Figure 2 - Experiment implemented in PsycoPy.*

## 3. TEST SESSION

The 2 POV-Q has been administered in an empty and quiet classroom of the Department of Architecture and Industrial Design of the University of Campania “Luigi Vanvitelli” to 24 persons (13 female); 16 of them aged between 18-24 years and 8 between 25-39 years.

*Figure 3 - Participants at the test session.*

To each interviewee was first asked:

- to sign the Declaration of consent for processing of personal data;
- to fill in a General Information Questionnaire;
- to complete the Weinstein's noise sensitivity scale test.

Then the essential characteristics of the listening test were illustrated to the interviewee and they were asked to participate to a training session. After that each participant completed the test in PsychoPy.

The answers given by the participants were collected, analysed and then organized in a datasheet used for the input of the Artificial Neural Networks.

## 4. RESULTS

The answers were analysed calculating the average values of the scores given by the 24 subjects and then organized distinguishing them in GW and GA. As showed in figure 4, GW of residents and frequenters decreases with increasing noise levels while GA (Fig. 5) increases for residents and frequenters as the *movida* noise levels increase. In all scenarios there are differences between the 2 point of views. The results obtained at the statements n. 8, 11 and 12 were not in line with authors expectations. Statements n. 8 did not discriminate between Resident and Frequenter, while statements n. 11 and n.12 showed counterintuitive results.

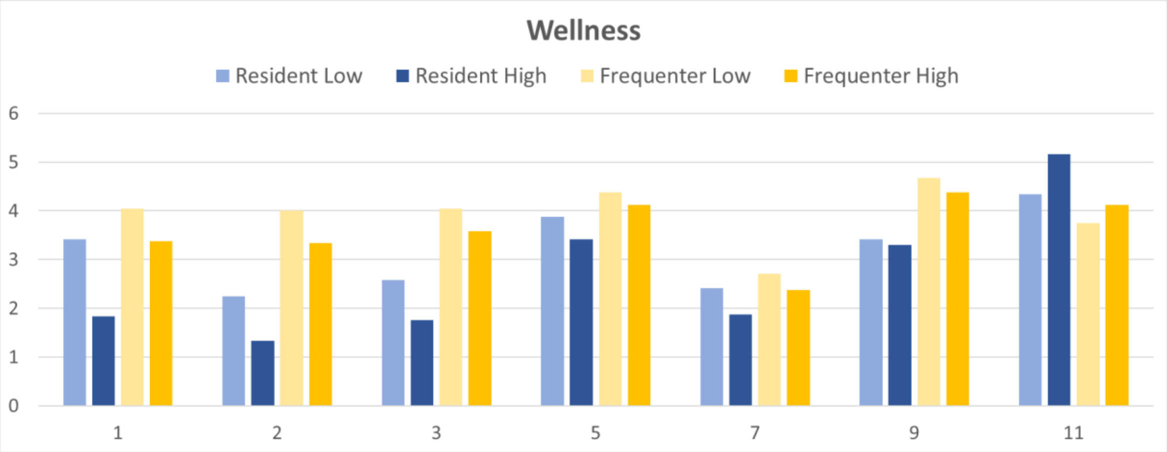


*Figure 4 - Scores of Global Wellness.*

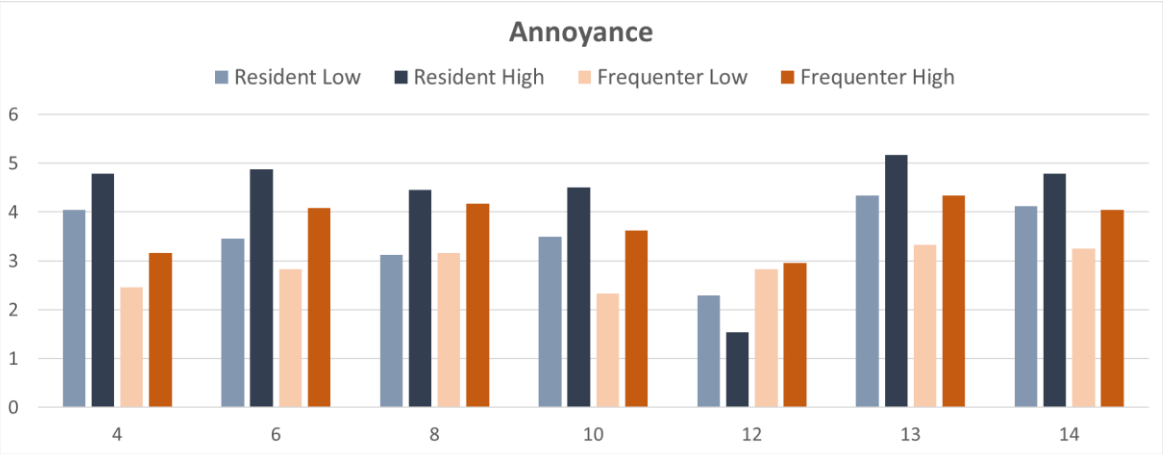


*Figure 5 - Scores of Global Annoyance.*

## 5. ARTIFICIAL NEURAL NETWORKS

All the answers were labeled and grouped in two classes: “0” for scores 1-3 and “1” for scores of 4-6. Then a correlation analysis between the 92 (acoustic and psychoacoustic) input variables and the subjects’ answers has been performed to extract the most correlated variable. In figure 6 the Pearson correlation coefficients are showed for each of the four conditions (GW/GA x R/F). The extraction was carried out using a cut-off value of the Pearson correlation coefficient of r = 0.35.

The variables extracted were: n. 46 for GW/R; n. 30 for GA/R; n. 0 for GW/F; n. 30 for GA/F. Then GW/F scenario was excluded from the next analysis. The table 4 shows the labels of the variables selected for each condition considered.

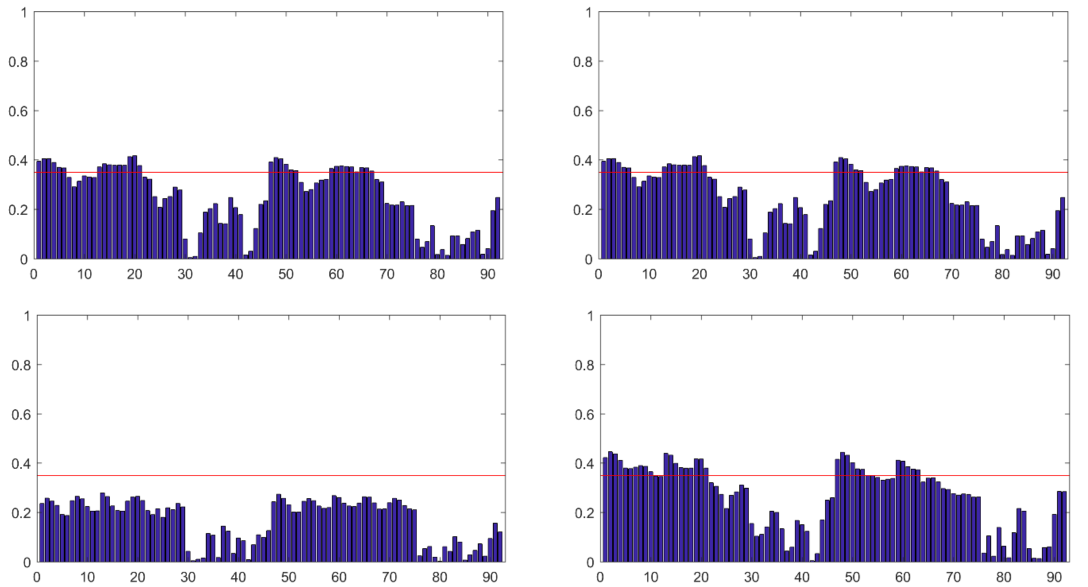

*Figure 6 - Pearson correlation coefficients for the 4 scenarios (GW/R, GA/R, GW/F, GA/F).*

| | |
|---|---|
| Global Wellness / Resident | RL5, RL10, LL10, LS10, LL5, RS5, RS10, RL, LL, LS5, RN10, RN50, LN50, RL50, LL50, LN10, RN90, RS50, LN95, LN90, RN95, RN5, RS, LS50, LS, LL90, RL90, LL95, LN5, RL95, RS90, LL50A, LL95A, RL95A, LL90A, RS95, RL90A, LS90, LLA, RLA, LS95, RL50A, LL10A, LSPR95, RL10A, LR90 |
| Global Annoyance / Resident | LS10, LS5, RL5, LL10, LL5, RL10, LL, RL, LL50, LN10, RL50, LN50, LN95, LN90, LS, LS50, RN50, RN10, RN90, RN95, LN5, LL90, RS5, RS10, LL95, RN5, RL90, RL95, RS50, RS |
| Global Annoyance / Frequenter | LL5, RL5, LN5, LL10, LN10, RL10, LL, LS5, LS10, RL, RN5, LL50, RN10, RL50, LN50, LL5A, LL10A, RN50, LLA, LN90, LL90, LS50, LS, LN95, LL95, RL90, RN90, RL95, RN95, LL50A |

*Table 4 - Variables labels. First letter indicates the recording channel: left, L and right, R.*

The developed classification model is based on the construction of feed-forward multilevel artificial neural networks, with 1 hidden layer and 1 binary output (0,1) representative of the two classes (0, 1). The learning paradigm used is “supervised”.

In the training phase the input data and the respective binary outputs were randomly selected. During this phase the data sets were submitted to the networks for weights adjustment and errors minimization using a Scaled Conjugate Gradient Backpropagation (SCBP) algorithm. In the last row of table 5 are shown the accuracy percentage of the proposed networks.

| | | Global Wellness / Resident | | Global Annoyance / Resident | | Global Annoyance / Frequenter | |
|---|---|---|---|---|---|---|---|
| | | Predicted | | Predicted | | Predicted | |
| | **Class** | 0 | 1 | **0** | 1 | **0** | 1 |
| Actual | 0 | **64.6 %** | 10.4 % | **8.3 %** | 4.2 % | **27.1 %** | 6.3 % |
| | 1 | 8.3 % | **16.7 %** | 8.3 % | **79.2 %** | 14.6 % | **52.1 %** |
| Accuracy | | **81.3 %** | | **87.5 %** | | **79.2 %** | |

*Table 5 - Accuracy levels of the neural models.*

## 6. CONCLUSIONS

In this research a questionnaire has been used to predict the degree of Global Wellness and Global Annoyance of Frequenters and Residents within a *movida* district. Except some statements (n. 8,11,12) which were excluded by the predictive neural models, the results showed differences between the scores obtained by Frequenters and Residents. As regard the Global Annoyance, Frequenters were always less disturbed than the Residents and for both GA decreases as the *movida* noise levels decrease. An opposite behaviour emerges for GW scores that decrease with increasing of the noise levels. Correlation analysis showed that the measure of Global Wellbeing is weakly linked with the acoustic context in which people are immersed. The neural models, at least for the Global Annoyance, looks to be very promising with success rates of 79,2% for the Frequenters and 87,5% for the Residents.

The study has showed the potential of this kind of approach that uses measurements, questionnaires and predictive models to reveal the expected Global Annoyance of two categories of citizens: Residents and Frequenters.

Although good accuracy levels were already obtained, some aspects need further improvements. The most important are the dimension and the typology of input and output datasets: number and typologies of acoustics scenarios and number and age of participants interviewed.

## 7. REFERENCES

1. W. Passchier-Vermeer and W.F. Passchier, "*Noise Exposure and Public Health*", Environmental Health Perspectives, 108 (1), 123-131 (2000)

2. W. Babisch, "*The noise/stress concept, risk assessment and research needs*", Noise Health, 4, 1-11 (2002)

3. M. Basner, W. Babisch, A. Davis, M. Brink, C. Clark, S. Janssen, S. Stansfeld, "*Auditory and non-auditory effects of noise on health*", The Lancet, 383(9925), 1325-1332 (2014)

4. European Union (UE), "*Directive 2002/49/EC"* of the European Parliament and of the Council of 25 June 2002 Relating to the Assessment and Management of Environmental Noise; European Commission: Brussels, Belgium (2002)

5. Federazione Italiana Pubblici Esercizi (FIPE), "*Le Opportunità della Movida. Andare oltre la deriva circense di centri e luoghi storici delle città italiane. Rapporto Finale"*, Indagine Fipe **-** Censis (2013)

6. E. Gallo, E. Ciarlo, M. Santa, E. Sposato, B. Vincent, Y. Halbwachs, "*Analysis of leisure noise levels and assessment of policies impact in San Salvario district, Torino (Italy), by low-cost IoT noise monitoring network*", In Proc. of Euronoise, 27-31 May, Crete, Greece (2018).

7. F. Fimiani and S. Luzzi, "*Monitoring and Reducing Noise Related to Movida: Real Cases and Smart Solutions*", In Proc. of the 22nd International Congress on Sound and Vibration, 12-16 July, Florence, Italy (2015)

8. E. Ottoz, L. Rizzi, F. Nastasi, "*Recreational Noise in Turin and Milan: Impact and Costs of for Disturbed Residents*", In Proc. of the 22nd International Congress on Sound and Vibration, 12-16 July, Florence, Italy (2015)

9. M.G. Piuri, S. Ferrari, M. Gravelloni, D. Pavesi, M.R. Barone, S. Zerbo, F. Antognazza, A. Cati, F. Olivieri, "*The Movida in Milan: A Year of Noise Monitoring Noise monitoring*", In Proc. of AIA-DAGA, 18-21 March, Merano (2013).

10. L. Maffei, M. Masullo, G. Ciaburro, L. D'Onofrio, "*Methodology to awake citizens' awareness on the effects of leisure noise*", The Journal of the Acoustical Society of America, 141 (5), 3563 (2017)

11. M. Masullo, L. Maffei, “*Movida, una questione di punti di vista: analisi, modellazione e sensibilizzazione della popolazione”*, In Proc. of 45° Convegno Nazionale, 20-22 giugno, Aosta (2018).
12. J. Peirce, J.R. Gray, S. Simpson, M.R. MacAskill, R. Höchenberger, H. Sogo, E. Kastman, J. Lindeløv, *“PsychoPy2: experiments in behavior made easy”*, Behavior Research Methods. 10.3758/s13428-018-01193-y (2019)