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Social Inter-Floor Noiseproof Measures According to Experiences of Conflict in Multi-Family Housing

공동주택 거주자의 층간소음 갈등 경험에 따른 사회적 해결방안

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Abstract

This study aims to develop a solution to inter-floor noise complaints by exploring cases of noise complaints between floors and by identifying the demands and needs of the residents. For this purpose, a survey was conducted targeting residents who were sorted into groups depending on their experiences with inter-floor noise. This survey was carried out from June 11, 2014 to June 16, 2014. A total of 100 copies of the questionnaire was distributed to the residents, of which 98 were completed and collected. Data were statistically processed in accordance with SPSS WIN 18.0. The results showed that the leading causes of inter-floor noise complaints were residents' differences in schedules and their inconsideration in behavior. Thus, the solution to this issue is three-fold: first, to take social measures in order to improve communication and understanding between residents so they can be mindful of their noise levels; second, to reinforce noise control regulation; and third, to improve noise reduction design within the building architecture.

Keywords : Social Measures, Inter-floor Noise, Multi-family Housing
주 요 어 : 사회적 해결방안, 층간소음, 공동주택

I. Introduction

1. Background and purpose

According to the 2010 Population and Housing Census, 64.5% of the Korean population is living in multi-family housing (Statistics Korea, 2010). A multi-family housing unit is defined to be a concentrated living space in which the residents share walls, floors and/or ceilings within a building. This design inevitably leads to inter-floor noise issues among other problems. Over the last five years, the number of claims filed with the Inter-floor Noise Between Neighbors Center has increased by over 6700% (Cha & Ko, 2013), from 114 cases in 2005 to 341 cases in 2010, 7,021 cases in 2012 and 15,455 cases in 2013[1,2]. The Korean government has implemented a series of rules and regulations in order to address these issues in recent years. However, these measures have not been effective as the legal criteria are not sufficiently defined to address the noise issues residents are facing, and are also not strict enough to promote noise level reduction.

Noise is defined to be a disorderly, mixed, unpleasant or loud sound[3]. As such, a noise is by definition subjectively named by the one perceiving it, and thus is difficult to objectively quantify. This is primarily because noise, unlike other types of pollution, is not accumulated but instead disappears as quickly as it appears. Furthermore, it is perceived only locally and is caused for many different reasons (Jung, 2009).

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Noise has a strong ability to arouse unpleasant feelings and stress, and both directly and indirectly affects people. Direct impacts include causing hearing impairments or inhibiting conversation. Indirect impacts vary significantly based on the type of noise and the unique characteristics of the people perceiving the noise. Repeated or lasting exposure to noise may disturb sleep or work; lead to mental and physical disorders or result in more serious social problems[4]. Residents of multi-family housing share ceilings, floors and walls, and have different life styles and life cycles, inevitably resulting in a range of disputes between residents The Korean Ministry of Environment defines inter-floor noise to be sound pollution in multi-family housing caused by children, loud footsteps, furniture being moved, toilet flushing, loud music, and so on[5]. Inter-floor noise is largely categorized either as structure-borne sounds which travel through the physical building or as air-borne sound delivered by air[6].

According to Article 14-2 of the Korean Regulations on House Construction Standards Etc., amended in May 2013, concrete slabs must be no thinner than 210 mm (150 mm in the case of Rahmen-structure multi-family housing). Furthermore, light-weight impacts should not be heard between floors at noise levels of greater than 58dB, and heavy-weight sounds no greater than 50dB. In addition, in June 2014, the Korean Rules on Inter-floor Noise[7], jointly enacted by the Ministry of Environment and the Ministry of Land, Infrastructure and Transportation, further detailed the criteria for inter-floor noise as shown in <Table 1>.

However, the legal thresholds defined by <Table 1> are in fact 3dB lower than those recommended by the Environmental Dispute Mediation Committee of Korea, and thus may not deter children from running or jumping in their homes, which is the primary cause of inter-floor noise disputes.

According to Article 44-2 of the Korean Housing Act, residents and/or users of multi-family houses should minimize harmful interactions with other residents and should be mindful of potentially conflict-causing actions. If a resident or user is affected by inter-floor noise, s/he is to inform the building manager (or equivalent), and the manager shall recommend (or demand) that the noise-making resident cease their noise-making actions or take the necessary measures reduce the sound levels. Upon receiving this notice, the resident must fulfill the demands as listed in the notice. If inter-floor noise continues, the affected resident or user may file mediation with a specialized institution, such as the Environmental Dispute Mediation Committee of Korea[8]. However, the Korean Housing Act does not stipulate the penalties that may be incurred in case of violation, and is not strictly binding, leaving the actual efficacy of the act in question.

As the legal measures taken have thus far been ineffective, this study aims to propose a social solution by exploring noise complaints issue between floors and by identifying the demands and needs of the residents.

II. Methods

1. Participants

To understand inter-floor noise thoroughly, it is necessary to explore both the socio-demographic factors of the residents as well as their actual experiences with inter-floor noise. Thus, survey participants were categorized into one of two groups: G1, those who have had experienced a conflict regarding inter-floor noise; and G2, those who have had no experience with noise disputes.

The sample included residents who live in multi-family housing in Busan, South Korea. Table 2 shows the breakdown in residential demographics. The total number of participants was 98, 65 of whom were female and 33 of whom were male. They were further categorized by age group: residents in their

Table 1. *Inter-floor Noise Maximum Permissible Levels*

Types of Inter-floor Noise		Inter-floor Noise Maximum Permissible Level [Unit: dB(A)]	
		Day (06:00~22:00)	Night (22:00~06:00)
Structure-borne Sound	Sound Level Over 1-minute Duration (Leq)	43	38
	Maximum Sound Level (Lmax)	57	52
Air-borne Sound	Sound Level Over 5-minute Duration l (Leq)	45	40

4) The Inter-floor Noise between Neighbors Center. Retrieve date: June 5,2014. http://www.noiseinfo.or.kr/about/stairsreqinfo.jsp?pageNo =1201
5) Ministries lay out new series of noise regulations. (2014. 4. 11.). Dongailbo, http://news.donga.com/3/all/20140411/62455152/1
6) Living Environment Information Center. Retrieve date: June 6, 2014. https://iaqinfo.nier.go.kr/leinfo/noise_between_floors.do
7) Rules on the Scope and Criteria of Inter-floor Noise of Multi-family Houses (Ministry of Environment No. 559, and Ministry of Land, Infrastructure and Transportation No. 97)
8) Article 44-2: Paragraph 4 of Housing Act, Article 21-2: Paragraph 2 of Noise and Vibration Control Act

Table 2. *Participant Demographics* N (%)

Categories		G1		G2		Total		χ^2
Gender	Male	12	(26.1)	21	(40.4)	33	(33.7)	2.234 (n.s) df=1
	Female	34	(73.9)	31	(59.6)	65	(66.3)	
	Total	46	(100.0)	52	(100.0)	98	(100.0)	
Age	20s	24	(52.2)	31	(59.6)	55	(56.1)	1.675 (n.s) df=2
	30s	7	(15.2)	10	(19.2)	17	(17.3)	
	40 and over	15	(32.6)	11	(21.2)	26	(26.5)	
	Total	46	(100.0)	52	(100.0)	98	(100.0)	
Housing type	Apartment	33	(71.7)	35	(67.3)	68	(69.4)	2.032 (n.s) df=2
	Mixed-use housing	7	(15.2)	5	(9.6)	12	(12.2)	
	Multi-household housing	6	(13.0)	12	(23.1)	18	(18.4)	
	Total	46	(100.0)	52	(100.0)	98	(100.0)	
Year of completion	Before 2009	21	(63.6)	22	(62.9)	43	(63.2)	0.004 (n.s) df=1
	2009 and later	12	(36.4)	13	(37.1)	25	(36.8)	
	Total	33	(100.0)	35	(100.0)	68	(100.0)	
Housing size*	Smaller than 30py	12	(26.1)	21	(40.4)	33	(33.7)	3.821 (n.s) df=2
	30-40py	15	(32.6)	9	(17.3)	24	(24.5)	
	Larger than 40py	19	(41.3)	22	(42.3)	41	(41.8)	
	Total	46	(100.0)	52	(100.0)	98	(100.0)	
Space most commonly occupied	Bedroom	21	(45.7)	32	(61.5)	53	(54.1)	5.030 (n.s) df=2
	Living room	22	(47.8)	20	(38.5)	42	(42.9)	
	Kitchen	3	(6.5)	0	(.0)	3	(3.1)	
	Total	46	(100.0)	52	(100.0)	98	(100.0)	
Time frame most spent at home	6~9 am	1	(2.2)	2	(4.1)	3	(3.2)	3.564 (n.s) df=4
	9 am~12 pm	1	(2.2)	2	(4.1)	3	(3.2)	
	12~18 pm	3	(6.7)	1	(2.0)	4	(4.3)	
	18~22 pm	34	(75.6)	32	(65.3)	66	(70.2)	
	After 22 pm	6	(13.3)	12	(24.5)	18	(19.1)	
	Total	45	(100.0)	49	(100.0)	94	(100.0)	

*30pys: between 99-132 m^2, 40py: approx. 132 m^2

20s (56.1%, N=55), residents in their 30s (17.3%, N=17) and residents aged 40 or over (26.5%, N=26). Regarding housing type, 69.4% of the residents lived in an apartment, 12.2% in mixed-use housing, and 18.4% in multi-family housing. At the time of completing the survey, 63.2% of the total respondents lived in a building built before 2009, and 36.8% in 2009 or later. With regard to housing size, 33.7% of the residents lived in space smaller than 30py, 24.5% in a space of 30-40pys and 41.8% in a space larger than 40py. Regarding space most commonly occupied, 54.1% of residents reported that they spent most of their time in the bedroom while 42.9% reported that they spent most of their time in the living rom. 70.2% of residents spent the greatest amount of time in the home during the evenings.

Differences in the two groups were as follows. G1 respondents were typically female, aged 40 years or older, lived in an apartment, lived in 30-40pys housing units, and spent the majority of their time in the living room. G2 had a higher proportion of males, typically in their 20s and 30s, who tended to live in multi-family housing, had spaces of less than 30py and mostly spent their time in their bedroom.

2. Scope

This study analyzes apartments, multi-family housing (multiplex housing) and mixed-use housing (commercial & residential housing) where inter-floor noise issues frequently arise, and defines these types of housing as multi-family houses[9].

9) The Ministry of Environment and the Ministry of Land, Infrastructure and Transportation announced the Rules on Inter-floor Noise in Multi-family Housing, which details matters discussed in the amended Noise and Vibration Control Act and Housing Act. The Rule aims to establish the definitions and regulations regarding inter-floor noise which has recently been the main culprit behind neighborhood disputes in multi-family houses, and also includes noises in apartments, row houses and multi-household houses.

Table 3. *Organization of Questionnaire*

Demographics	Gender, Age
Residence	Housing Type, Year of Completion, Housing Size, Space Most Commonly Occupied, Time Frame Most Spent at Home
Inter-floor Noise	Times of Conflict, Duration, and Location of Noise
Assessment of Inter-floor Noise	Awareness of Inter-floor Noise, Satisfaction, Knowledge Regarding Inter-floor Noise, Improvement Measures

3. Survey

This study conducted a survey on multi-family housing residents. The structured survey was utilized in order to collect data on inter-floor noise and resident demographics. The survey consisted of questions regarding noise disputes, including whether disputes had arisen because of inter-floor noise, and if so, what the causes, time and duration, and location of the noise were. It also included other questions such as those measuring resident perception of inter-floor noise, their satisfaction with relevant conditions, their knowledge regarding inter-floor noise, and improvement measures <Table 3>.

4. Procedure

The study was carried out from June 11, 2014 to June 16, 2014. A total of 98 copies of the questionnaire were ultimately collected and analyzed. The data was processed statistically using SPSS WIN 18.0.

III. Results

1. Inter-floor noise

The subjects were asked to respond regarding the current state of inter-floor noise within their housing. The results show that there was no statistically significant difference between the two groups' experiences with floor noise disputes <Table 4>.

In regards to the time of noise occurrence, 64.4% of the subjects answered that noises frequently occurred in the evening (18:00-22:00). In regards to the location of noise occurrence, 52.2% of those surveyed responded that the living room was one of the noisiest spaces. G1 felt more strongly than G2 that floor noise often occurred in the living room. In regards to duration of noise, G1 responded that noise usually lasted for 10 to 30 minutes while G2 answered that floor noise continued for less than 10 minutes.

Respondents within G1 typically complained about upper

Table 4. *Inter-floor Noise Status* N (%)

Categories		G1		G2		Total		χ^2
Time of noise	6-9 am	0	(0.0)	1	(2.2)	1	(1.1)	2.693 (n.s) df=4
	9 am-12 pm	4	(9.1)	2	(4.3)	6	(6.7)	
	12-18 pm	6	(13.6)	4	(8.7)	10	(11.1)	
	18-22 pm	28	(63.6)	30	(65.2)	58	(64.4)	
	After 22 pm	6	(13.6)	9	(19.6)	15	(16.7)	
	Total	44	(100.0)	46	(100.0)	90	(100.0)	
Location of noise	Bedroom	14	(31.8)	14	(29.2)	28	(30.4)	7.161 (n.s) df=3
	Living room	27	(61.4)	21	(43.8)	48	(52.2)	
	Bathroom	3	(6.8)	11	(22.9)	14	(15.2)	
	Utility room	0	(0.0)	2	(4.2)	2	(2.2)	
	Total	44	(100.0)	48	(100.0)	92	(100.0)	
Duration of noise	Less than 5 minutes	7	(15.6)	18	(37.5)	25	(26.9)	12.698 (n.s) df=4
	5-10 minutes	10	(22.2)	17	(35.4)	27	(29.0)	
	10-30 minutes	19	(42.2)	10	(20.8)	29	(31.2)	
	30-60 minutes	5	(11.1)	1	(2.1)	6	(6.5)	
	Greater than 60 minutes	4	(8.9)	2	(4.2)	6	(6.5)	
	Total	45	(100.0)	48	(100.0)	93	(100.0)	

floor neighbors indirectly, often 'through an administration or a security office,' when inter-floor noise was occurred. However, when addressing noise from lower floor neighbors, they often complained directly by visiting the neighbors personally <Table 5>.

Table 5. *Inter-floor Noise Dispute* N (%)

Total	Occurrence of noise			
	Complaint made		Complaint Received	
Personal visitation	7	(20.6)	13	(56.5)
Phone Call	9	(26.5)	5	(21.7)
Administration or security office	18	(52.9)	5	(21.7)
Total	34	(100.0)	23	(100.0)

2. Assessment of Inter-floor Noise

1) Resident awareness of inter-floor noise

The mean values of each item were compared between the two groups through two independent samples of the T-test <Table 6>. The subjects evaluated the inter-floor noise they experienced in their home through 10 items on the survey. Each item consisted of a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree).

For participants in G1, the mean value of 'I refrain from using home appliances (washing machines, vacuum cleaners, etc.) and exercise equipment after 10 pm' (M=4.0, SD=1.1) was the highest, while the mean value of 'I am acquainted with my neighbors' (M=2.2, SD=0.9) was the lowest. For those in G2, the mean value of 'I refrain from using home appliances (washing machines, vacuum cleaners, etc.) and exercise equipment after 10 pm' (M=3.8, SD=1.0) was the highest, while the mean value of 'I want to move out because of the inter-floor noise' (M=1.7, SD=0.9) was the lowest.

Five items out of ten, 'I am usually sensitive to noise,' 'I feel uncomfortable because of the level of inter-floor noise in the building,' 'I want to move out because of the inter-floor noise,' 'My neighbors have a weak sense of community responsibility,' and 'Periodic announcements by the administration office will reduce the occurrence of inter-floor noise' showed significant differences between responses by G1 and G2. In regards to those in G1, respondents were found to be sensitive to noise than those in G2. As such, those in G1 felt more uncomfortable with inter-floor noise, were more likely to want to move out, and typically thought that their neighbors had a weak sense of community responsibility. For those in G2, the mean value of 'Periodic announcements by the administration office will reduce the occurrence of inter-floor noise' was higher than for those in G1.

Both groups were not acquainted with their neighbors, but they both made attempts to minimize their creation of inter-floor noise.

Table 6. *Resident's Awareness of Inter-floor Noise* M (SD)

Statement	G1		G2		Total		t-value	
① I am usually sensitive to noise	3.5	(1.0)	3.1	(1.0)	3.3	(1.0)	2.1	*
② I am acquainted with my neighbors	2.2	(0.9)	2.1	(1.0)	2.1	(1.0)	0.8	(n.s)
③ I feel uncomfortable because of the level of inter-floor noise in the building	3.2	(1.2)	2.3	(0.9)	2.7	(1.1)	4.2	***
④ I want to move out because of the inter-floor noise	2.4	(1.3)	1.7	(0.9)	2.0	(1.1)	3.0	**
⑤ My neighbors have a weak sense of community responsibility	3.3	(1.0)	2.8	(0.8)	3.1	(0.9)	2.5	*
⑥ I think that residents in the upper floor make a lot of noise	3.3	(1.4)	2.8	(1.2)	3.0	(1.3)	1.8	(n.s)
⑦ I don't care about noise pollution I cause	2.6	(1.1)	2.6	(1.1)	2.6	(1.1)	0.0	(n.s)
⑧ I refrain from using home appliances (washing machines, vacuum cleaners, etc.) and exercise equipment after 10 pm.	4.0	(1.1)	3.8	(1.0)	3.9	(1.0)	0.9	(n.s)
⑨ Periodic announcements by the administration office will reduce the occurrence of floor noise	3.0	(1.0)	3.5	(0.8)	3.3	(0.9)	-3.1	**
⑩ I will pay to install soundproofing materials	2.9	(1.0)	2.6	(0.9)	2.8	(0.9)	1.4	(n.s)

*p< .05, **p< .01, ***p< .001

Table 7. *Resident Satisfaction* M (SD)

Category	G1		G2		Total		t-value	
Satisfaction with inter-floor noise	2.8	(1.1)	3.5	(0.9)	3.2	(1.0)	-3.2	**
Satisfaction with residential environment	3.3	(0.9)	3.7	(0.7)	3.5	(0.8)	-2.5	*

Table 8. *Correlation between Satisfaction with Inter-floor Noise and Residential Environment*

	1	2
Satisfaction with inter-floor noise	1	
Satisfaction with residential environment	.647**	1

2) Resident satisfaction

In regards to resident satisfaction with inter-floor noise and satisfaction with residential environment, <Table 7> shows that significant differences were observed between the two groups. For those in G1, the mean value of satisfaction with inter-floor noise was 2.8 (SD=1.1) and residential environment satisfaction was 3.3 (SD=0.9). For those in G2, the mean value of satisfaction with inter-floor noise was 3.5 (SD=0.9) and satisfaction with residential environment was 3.7 (SD=0.7). The group who had experienced inter-floor noise conflicts was relatively more unsatisfied with inter-floor noise and residential environment than the other group.

Regarding correlations between satisfaction with inter-floor noise and satisfaction with residential environment, inter-floor noise satisfaction showed a high positive (+) correlation (of greater than 0.6) with residential environment satisfaction <Table 8>, implying that increased satisfaction with inter-floor noise may improve satisfaction with residential environment.

3) Knowledge regarding inter-floor noise

In regards to inter-floor noise knowledge, there were not significant differences between the two groups <Table 9>. Both groups were unfamiliar with regulations and authorities related to inter-floor noise. Those in G1 had relatively higher levels of knowledge on inter-floor noise than the subjects in G2 but participants in both groups were equally aware of the rules established by the apartment management.

4) Improvement to inter-floor noise

Participants were asked to categorize the different potential solutions to inter-floor noise based on importance <Table 10>. In improvement of inter-floor noise, 58.1% of all respondents chose to “establish legal repercussions for faulty construction” and 51.6% of the subjects answered that it was important to “Increase sense of community responsibility between residents.”

In regards to the experience of inter-floor noise conflicts, there were no significant differences between the two groups. However, those in G1 responded that it was important to “establish legal repercussions for faulty construction” while those in G2 chose more social solutions, such as to “increase awareness through broadcasting and educational institutions.”

Thus, it is necessary for residents in multi-family housing to expand their sense of community responsibility through understanding and reinforcement of noise control regulations.

Table 9. *Knowledge Regarding Inter-floor Noise* N (%)

Statement	Response	G1		G2		Total		χ^2
① I know the regulation standards about inter-floor noise well	YES	10	(21.7)	8	(15.4)	18	(18.4)	0.657
	NO	36	(78.3)	44	(84.6)	80	(81.6)	(n.s) df=1
② I know the rules established by the apartment management regarding inter-floor noise	YES	13	(28.3)	15	(28.8)	28	(28.6)	0.004
	NO	33	(71.7)	37	(71.2)	70	(71.4)	(n.s) df=1
③ I have heard of the Environmental Dispute Resolution Commission	YES	21	(45.7)	16	(30.8)	37	(37.8)	2.301
	NO	25	(54.3)	36	(69.2)	61	(62.2)	(n.s) df=1
④ I have heard of the Inter-floor Noise between Neighbors Center	YES	13	(28.3)	10	(19.2)	23	(23.5)	1.108
	NO	33	(71.7)	42	(80.8)	75	(76.5)	(n.s) df=1

Table 10. *Improvement to Inter-floor Noise* Multiple responses: N (%)

		G1		G2		Total	
①	Increase sense of community responsibility between residents	23	(52.3)	25	(51.0)	48	(51.6)
②	Establish legal repercussions for residents who cause inter-floor noise	19	(43.2)	19	(38.8)	38	(40.9)
③	Increase awareness through broadcasting and educational institutions	11	(25.0)	19	(38.8)	30	(32.3)
④	Establish legal repercussions for faulty construction	27	(61.4)	27	(55.1)	54	(58.1)
⑤	Reinforce intervention by the administration office	8	(18.2)	8	(16.3)	16	(17.2)
Total	Responses	88	(200.0)	98	(200.0)	186	(200.0)
	Respondents	44	(100.0)	49	(100.0)	93	(100.0)

IV. Conclusion

The purpose of this study is to propose a social solution to issues caused by inter-floor noise by analyzing inter-floor noise disputes in multi-family housing and by identifying resident needs and demands. To understand inter-floor noise practically, the participants were categorized into one of two groups based on whether they had experienced inter-floor noise disputes. The results and conclusions are as follows:

First, of the two categories of respondents, those who had experienced inter-floor noise conflicts responded that noise frequently occurred in the evening and that it lasted for a significant amount of time. Therefore, residents who live in multi-family houses should be mindful of creating inter-floor noise after a certain hour.

Second, in terms of resident awareness of inter-floor noise, there were significant differences in five items. Subjects in G1 were more sensitive to noise than those in G2, and so those in G1 felt more uncomfortable with inter-floor noise, wanted to move out, and tended to think that their neighbors had a weak sense of community responsibility. However, both groups were equally unacquainted with their neighbors and both responded that they were making effort to minimize their noisy activities.

In regards to resident satisfaction with inter-floor noise and satisfaction with residential environment, significant differences were observed in both categories. Residents who had experienced inter-floor noise conflicts were more unsatisfied with inter-floor noise and residential environment than those in the other group. Regarding correlation between satisfaction with inter-floor noise and satisfaction with residential environment, inter-floor noise satisfaction showed a high positive (+) correlation with residential environment satisfaction, which indicates that if satisfaction with inter-floor noise increases, so will satisfaction with residential environment.

Lastly, in regards to possible solutions to the issue of inter-floor noise, participants thought that establishment of legal repercussions was the most important means to ensure peace. They also identified a need for the community to resolve noise disputes well and to live in harmony with neighbors in multi-family housing.

The results of this study demonstrate that there are differences between the two groups based on their experiences with inter-floor noise dispute. Those who had experienced such disputes had a negative attitude about their neighbors and lower satisfaction with inter-floor noise and residential environment.

The leading causes of noise complaints are differences in resident schedules and their general inconsideration in behavior. Because these are avoidable, man-made causes, it is essential to seek social measures in order to improve community responsibility and mindfulness. This can be done by taking greater steps to facilitate understanding and by better enforcing noise control regulations and noise reduction technology.

This study was conducted based on Korean multi-family housing. Therefore, the perception of ‘inter-floor noise’ may vary, depending on local and cultural characteristics.

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