

# **Understanding the perception of floor impact sounds in apartment buildings**

Thesis submitted in accordance with the requirements of  
the University of Liverpool for the degree of Master of Philosophy

by

Sang Hee Park

Acoustics Research Unit, School of Architecture  
University of Liverpool

July 2015

## Abstract

This thesis considered the perception of floor impact sounds in apartment buildings and focused on relationships between non-acoustic factors and annoyance caused by floor impact sounds. Firstly, a qualitative study was conducted to investigate exposure to floor impact sounds. Semi-structured interviews were conducted with 14 residents in apartments in South Korea using a grounded theory methodology. These data were analysed using three coding phases; several key themes were identified and grouped into five categories. Two major noise sources (heavy-weight and light-weight impact source) were grouped together with retaliatory noise under the category of ‘noise exposure’. Different ways to manage noise exposure or cope with negative noise perceptions were categorised under ‘coping’. Health issues and concerns were grouped together under ‘health effects’. ‘Intervening conditions’ were identified and non-acoustic variables in this category included attitudes to authorities and neighbours, noise sensitivity, past experience, and dwelling satisfaction. A conceptual model was proposed to give an overview of how residents perceive and react to floor impact sounds. Secondly, a quantitative study was performed to empirically test the findings of the qualitative study. Survey questions were developed based on a literature review of studies on environmental noise and the findings from the qualitative study. A conceptual model was hypothesised and tested using structural equation modelling. Relationships between non-acoustic factors (noise sensitivity, disturbance, health complaints, coping, negative attitudes to authorities, and closeness with neighbours) and annoyance caused by floor impact sounds were tested using path analysis. The impacts of moderators on the perceptions and reactions to floor impact sounds were examined using two different tests. Noise from footsteps increased the direct impact size of noise sensitivity on perceived disturbance. Empathy, past experience, and dwelling satisfaction were also found to have moderation effects on the relationship between negative attitudes to authorities and coping. A positive relationship was found between annoyance and avoidant coping which was influenced by the moderators of negative attitudes to authorities and neighbours. Findings from path analysis and moderation tests supported and extended the previous findings of environmental noise studies and the qualitative study.

## Table of contents

Abstract .....	ii
Table of contents .....	iii
List of tables .....	v
List of figures .....	vi
Acknowledgement.....	viii
<b>1 INTRODUCTION .....</b>	<b>9</b>
1.1 Background and aim of the study.....	9
1.1.1 Noise annoyance .....	9
1.1.2 Acoustic factors related to noise annoyance .....	10
1.1.3 Aim of the study .....	12
1.2 Outline of the thesis.....	13
<b>2 LITERATURE REVIEW .....</b>	<b>16</b>
2.1 Introduction .....	16
2.2 Non-acoustic factors related to noise annoyance .....	16
2.2.1 Non-acoustic factors of environmental noise.....	17
2.2.2 Non-acoustic factors of floor impact sounds .....	25
2.3 Grounded theory.....	26
2.3.1 Theoretical sampling.....	27
2.3.2 Coding .....	28
2.3.2.1 Open coding.....	28
2.3.2.2 Axial coding .....	29
2.3.2.3 Selective coding.....	30
2.3.3 Conducting a literature review in grounded theory.....	30
2.3.4 Criteria for grounded theory.....	31
<b>3 QUALITATIVE STUDY .....</b>	<b>33</b>
3.1 Introduction .....	33
3.2 Methods .....	33
3.2.1 Interviewees .....	34
3.2.2 Interview procedure .....	36
3.2.3 Data analysis .....	37
3.3 Results and discussions .....	38
3.3.1 Noise exposure .....	40
3.3.2 Noise perception.....	42
3.3.3 Coping .....	45

3.3.4	Health effects .....	49
3.3.5	Intervening conditions.....	50
3.3.5.1	Attitude to authorities .....	50
3.3.5.2	Attitude to neighbours .....	52
3.3.5.3	Noise sensitivity .....	55
3.3.5.4	Past experience .....	56
3.3.5.5	Dwelling satisfaction .....	57
3.4	Summary and concluding remarks .....	58
<b>4</b>	<b>QUANTITATIVE STUDY .....</b>	<b>61</b>
4.1	Introduction .....	61
4.2	Hypotheses .....	61
4.3	Methods .....	64
4.3.1	Participants .....	64
4.3.2	Questionnaire development.....	66
4.3.2.1	Annoyance and disturbance.....	66
4.3.2.2	Coping .....	67
4.3.2.3	Health complaints .....	68
4.3.2.4	Attitudinal variables .....	68
4.3.3	Statistical analysis: Structural equation modelling .....	69
4.4	Results .....	72
4.4.1	Reliability and validity .....	72
4.4.2	Results from the path analysis.....	73
4.5	Discussions.....	75
4.5.1	Comparison with previous studies .....	75
4.5.2	Moderation effects .....	77
4.5.2.1	Multiple-group moderation .....	77
4.5.2.2	Interaction moderation.....	79
4.5.3	Type of noise complaints .....	82
4.5.4	Development or change in noise sensitivity.....	83
4.6	Summary .....	83
<b>5</b>	<b>CONCLUSIONS.....</b>	<b>85</b>
5.1	Summary of the present study .....	85
5.2	Recommendations for future research.....	87
	Appendices.....	90
	List of references.....	106

## List of tables

Table 2-1. Personal / attitudinal variables and contextual variables listed by Lercher (1996).....	19
Table 2-2. Non-acoustic factors affecting noise annoyance listed by Laszlo <i>et al.</i> (2012) .....	20
Table 2-3. Basic components of coding paradigm (Corbin and Strauss, 2008) .....	30
Table 2-4. Criteria for grounded theory research (Charmaz, 2006) .....	32
Table 3-1. Demographic characteristics of the interviewees ( $N = 14$ ).....	35
Table 3-2. Interview question items .....	37
Table 3-3. Frequency of final codes describing the key themes and categories .....	39
Table 4-1. Number of the collected, excluded, and analysed survey responses.....	64
Table 4-2. Demographic characteristics of the survey respondents ( $N = 487$ ) .....	65
Table 4-3. Overview of latent variables, observed variables, and question items ....	67
Table 4-4. Results of confirmatory factor analysis.....	73
Table 4-5. Indirect effects of noise sensitivity and disturbance on annoyance, health complaints, and coping.....	75
Table 4-6. Results of multiple-group analyses .....	78
Table A-1. Suggested cut-off values of model fit indices .....	102
Table A-2. T-test results comparing coping between those who reported low noise annoyance ( $N = 244$ ) and high noise annoyance ( $N = 243$ ) .....	103
Table A-3. T-test results comparing health complaints between those who reported low noise annoyance ( $N = 244$ ) and high noise annoyance ( $N = 243$ )..	103
Table A-4. T-test results comparing the participants' noise sensitivity between those who reported their families (or cohabitants) had low noise sensitivity ( $N = 167$ ) and high noise sensitivity ( $N = 320$ ).....	103

## List of figures

Figure 1-1. Outline of the thesis.....	15
Figure 2-1. Noise-health relationship explained by Lercher (1996, right) based on Lazarus' transactional stress model (1984, left).....	21
Figure 2-2. A conceptual model of environmental noise annoyance suggested by Stallen (1999) .....	21
Figure 2-3. A conceptual model of short-term and long-term reactions to environmental noise suggested by Guski (1999) .....	22
Figure 2-4. A causal model of aircraft noise annoyance tested by Kroesen <i>et al.</i> (2008) .....	23
Figure 2-5. A causal model of railway noise annoyance tested by Pennig and Schady (2014).....	24
Figure 3-1. Total length of residency in apartment buildings compared with age ....	36
Figure 3-2. Total length of residency in apartment buildings compared with length of residency in the current building.....	36
Figure 3-3. A conceptual model indicating relationships among the key categories.....	40
Figure 3-4. Lazarus' revised model of stress and coping (2006) .....	55
Figure 3-5. A model summarising the findings of the qualitative study.....	59
Figure 4-1. A hypothesised conceptual model.....	63
Figure 4-2. Major noise sources to which the participants had been exposed.....	66
Figure 4-3. A model for confirmatory factor analysis (CFA).....	71
Figure 4-4. A model for path analysis.....	71
Figure 4-5. Results of the path analysis .....	75
Figure 4-6. A model describing moderation effects of negative attitude to authorities and neighbours on the relationship between annoyance and coping .....	80
Figure 4-7. A model of interaction moderation effects to be tested .....	81
Figure 4-8. Moderation effects of negative attitude to authorities on the relationship between annoyance and coping.....	81
Figure 4-9. Moderation effects of negative attitude to neighbours on the relationship between annoyance and coping.....	81
Figure 4-10. Number of participants who had made noise complaints .....	82

Figure 5-1. Overview of the findings from the present study using both qualitative and quantitative approaches .....	87
Figure A-1. Screen capture of online survey: questions about noise annoyance with floor impact sounds .....	101
Figure A-2. Multiple-group analysis: a causal model of the group who had been exposed to other noises (N = 233).....	104
Figure A-3. Multiple-group analysis: a causal model of the group who had been exposed to footstep noise (N = 254) .....	104
Figure A-4. Multiple-group analysis: a causal model of the group who were satisfied with their apartments (N = 248) .....	105
Figure A-5. Multiple-group analysis: a causal model of the group who were not satisfied with their apartments (N = 239).....	105

## Acknowledgement

This thesis would not have been possible without the help I received from a number of people.

I am immensely grateful to my supervisors, Dr Pyoung-Jik Lee and Professor Carl Hopkins for their invaluable advice, encouragement, and support throughout the duration of my course. I would also like to thank every single person in the Acoustic Research Unit for their warm support.

Specials thanks to all the interviewees and the survey respondents who kindly agreed to give up their time and involve themselves in my study. I would also like to gratefully acknowledge the funding provided by Korea Institute of Civil Engineering and Building Technology.

I also thank to my friends for their warm support and prayer. Last but not least, I would like to thank my beloved family, my in-laws, my parents and brother, and my husband, Seongwon, for their endless support, prayer, and love.



# 1 Introduction

## 1.1 Background and aim of the study

Noise in apartment buildings has emerged as a major social problem over the past years in South Korea where the majority of people live in this type of residence. The number of households that occupy apartments has accounted for more than 70 percent after 2010 (Statistics Korea, 2011; Cha, 2015); this proportion is much greater than that of England and Wales, which was estimated to account for 21.4 percent in 2011 (Office for National Statistics, 2014). As apartment buildings have become more popular, the associated noise problems have grown to be a major issue. In particular, the number of noise complaints made by the residents of apartments in South Korea has rapidly increased and most of them are about floor impact noise (Jeon *et al.*, 2010b; Korea Environment Institute, 2013). The number of complaints about floor impact sounds registered in 2012 was four times greater than those between 2005 and 2011; besides, this number increased twice in 2013 and doubled again in 2014 (Cha, 2015). Disputes between neighbours often make the problem even worse. Some residents use so-called ‘revenge products’, such as a loudspeaker which is designed for passing most of sounds to upstairs, to make retaliatory noise to their upstairs neighbours who have been responsible for the floor impact noise (MBC News, 2014). It was also reported that the constant noise exposure made some people lose their temper so that they killed, or tried to kill, their neighbours (The Korea Herald, 2013). It was recognised that people who have disputes with their neighbours over noise issues are more likely to suffer mental distress when they are exposed to noise (Berry and Flindell, 2009).

### 1.1.1 Noise annoyance

Annoyance is considered as one of the main noise effects (Fyhri and Klæboe, 2006) and it is strongly related to various negative feelings such as mental distress, nuisance, or irritation (Guski, 1999). Noise annoyance is defined as a feeling of resentment, displeasure, discomfort, dissatisfaction, or offence which occurs when noise interferes with someone’s thoughts, feelings, or daily activities (Lindvall and Radford, 1973; WHO, 2004b). It is acknowledged that noise annoyance has adverse

influences on an individual or a group and a chronically strong annoyance was suggested to have a causal chain with health risks (WHO, 2004a).

Noise annoyance can be assessed using direct or indirect measures. Direct measure uses a single question asking respondents to rate their degrees of noise annoyance and indirect measures consist of multiple questions about disturbances caused by the noises and the degree of disturbances. In general, the direct measure is commonly used to assess noise annoyance. In the past, noise annoyance has been assessed by using diverse scales with different adjectives and a number of response options such as 5-point scale and 7-point scale. However, Team 6 of the International Commission on the Biological Effects of Noise (ICBEN) developed two scales for assessing annoyance caused by environmental noises in 2010 and they were adopted by the international standard (ISO/TS 15666). The scales contained a verbal rating scale and a numerical rating scale. The question for both scales is “Thinking about the last (..12 months or so..), when you are here at home, how much does noise from (..noise source..) bother, disturb, or annoy you?”. The verbal scale consists of five adjectives from ‘not at all’ to ‘extremely’ and the numerical scale has 11 options from ‘0’ to ‘10’.

### **1.1.2 Acoustic factors related to noise annoyance**

It is well known that subjective responses to noise are mainly influenced by acoustic features such as noise level, temporal characteristics, and dominant frequency component (Rylander *et al.*, 1980; Björkman, 1991; Bluhm *et al.*, 2004; Miedema, 2004; Yang and Kang, 2005; Jakovljević *et al.*, 2009). Dose-response relationships have been used to describe noise-induced annoyance as a function of exposure (Miedema, 2004; Berry and Flindell, 2009; Jakovljević *et al.*, 2009; Pedersen *et al.*, 2009). The annoyance ratings has been translated into the percentage of a population expressing annoyance; for example, %HA represents the percentage of highly annoyed and %A represents the percentage of annoyed, and they have been used since Schultz (1978) proposed the concept of %HA. The %HA is defined as the percentage of annoyance responses that exceed a defined 72 on a scale from 0 to 100. A number of studies have conducted social surveys to show the relationships between the exposure to environmental noises and annoyance (Rylander *et al.*, 1980; Buchta and Vos, 1998; Miedema, 2004; Pedersen and Waye, 2004; Jakovljević *et al.*,

2009). Most previous studies (Buchta and Vos, 1998; Kurra *et al.*, 1999; Sato *et al.*, 1999; Miedema *et al.*, 2000; Fidell *et al.*, 2002; Miedema, 2004) have focused on transportation noises such as that of road traffic, train, and aircraft but areas of interest have been expanded to non-transportation noise sources such as wind turbines and construction (Pedersen and Waye, 2004; Pedersen and Larsman, 2008; Jeon *et al.*, 2010a; Janssen *et al.*, 2011). For example, Pedersen and Waye (2004) presented the relationship between wind turbine noise annoyance and noise exposure in their survey study. They found that prevalence of noise annoyance due to wind turbines was higher than annoyance caused by transportation noises.

It has been suggested that noise annoyance can be predicted not only by noise level but also by the number of noise events (Öhrström and Rylander, 1990; Rylander and Björkman, 1997; Jakovljević *et al.*, 2009). Björkman (1991) measured equivalent sound pressure level ( $L_{eq}$ ) and maximum sound level ( $L_{max}$ ) outside buildings in different areas and found that increased number of noise events resulted in an increase of noise annoyance level. Rylander and Björkman (1997) reported that the number of aircraft noise events exceeding 70 dBA significantly affected noise annoyance. Jakovljević *et al.* (2009) recently found that noise level at night and the number of noise events induced by heavy vehicles at night had the significant impacts on a high level of noise annoyance.

Vos (2001) reported that annoyance caused by impulse sounds was affected by spectral characteristics and type of noise source (e.g. small, medium, and large firearms). The difference between the C-weighted sound exposure level (CSEL) and the A-weighted sound exposure level (ASEL) was introduced to explain the noise annoyance due to impulse sounds. In addition, temporal and spatial factors extracted from the autocorrelation function (ACF) and the inter-aural cross-correlation function (IACF) were introduced to explain annoyance produced by traffic noise (Fujii *et al.*, 2002).

There have also been many attempts to investigate the effects of acoustic factors on annoyance caused by floor impact noise through laboratory experiments (Jeon *et al.*, 2002; Jeon *et al.*, 2004; Jeon and Sato, 2008; Jeon *et al.*, 2009a; Lee *et al.*, 2009; Kim *et al.*, 2013). Floor impact sounds produced by standard impact sources (bang machine, tapping machine, and impact ball) were compared to an adult's jumping in terms of noisiness as well as loudness (Jeon *et al.*, 2002). Psychoacoustic measures and ACF/IACF parameters were introduced to explain the subjective response to

floor impact sounds. Annoyance caused by floor impact sounds was evaluated in apartment rooms with different sound insulation treatments and it was found that effect of impact sound pressure level on annoyance was the most dominant (Jeon *et al.*, 2004). The ACF parameters and psychoacoustic measures were introduced again to explain annoyance arising from heavy-weight floor impact sounds generated by bang machine and impact ball (Jeon and Sato, 2008). Jeon and Sato reported that loudness and fluctuation strength were related to noise annoyance. More recently, a series of auditory experiments were conducted to investigate the effect of a spatial factor and the magnitude of inter-aural cross-correlation function (IACC) on annoyance caused by impact ball sounds (Jeon *et al.*, 2009a). Just noticeable differences (JND) of impact sound pressure level (SPL) and IACC were found to be 1.5 dB and 0.12-0.13, respectively. In addition, it was shown that the contributions of SPL and IACC to the scale value of annoyance were 79.3% and 20.4%, respectively. Another study (Lee *et al.*, 2009) performed laboratory experiments to find a relationship between annoyance caused by impact ball sounds and psychoacoustic measures, and they confirmed the previous study (Jeon and Sato, 2008) indicating that loudness and fluctuation strength might affect annoyance produced by floor impact sounds. Recent study also found that temporal decay influenced annoyance caused by heavy-weight floor impact sounds (Kim *et al.*, 2013).

### **1.1.3 Aim of the study**

Even though a number of studies have reported the impact of acoustic factors on noise annoyance, there is still an argument that there are variations in annoyance with the same noise level (Berglund *et al.*, 1999; Fyhri and Klæboe, 2006). Previous studies on environmental noise have also insisted that individual's reactions to noise can only be partly explained by acoustic characteristics of noise (Job, 1988; Miedema and Oudshoorn, 2001; Fyhri and Klæboe, 2006). Particularly, noise level can explain only 20% of the variance in each individual's noise annoyance (Job, 1988; Berglund *et al.*, 1999) and non-acoustic factors increase the possibility of explaining the variance. Similar with annoyance caused by environmental noise, annoyance with floor impact noise might also be influenced not only by acoustic factors but by non-acoustic factors; however, only a few studies have been conducted to explore the impact of non-acoustic factors on perception of floor impact noise

(Jeon *et al.*, 2004; Jeon *et al.*, 2010b; Ryu and Jeon, 2011). The present study mainly focused on the impact of non-acoustic factors on people's perceptions and reactions to floor impact sounds in apartment buildings. A qualitative study was carried out to understand how residents in apartment buildings perceive and react to the noise; it was followed by a quantitative study which examined the relationships between noise annoyance and key non-acoustic factors derived from the qualitative study.

Therefore, the present study was designed and conducted to answer the following research questions:

1. How do people living in apartment buildings perceive and react to floor impact sounds coming from their upstairs? How do these experiences vary?
2. Which non-acoustic factors have influences on individuals' different perceptions and reactions to floor impact sounds?
3. How are the non-acoustic factors related to each other and to noise annoyance caused by floor impact sounds?

## **1.2 Outline of the thesis**

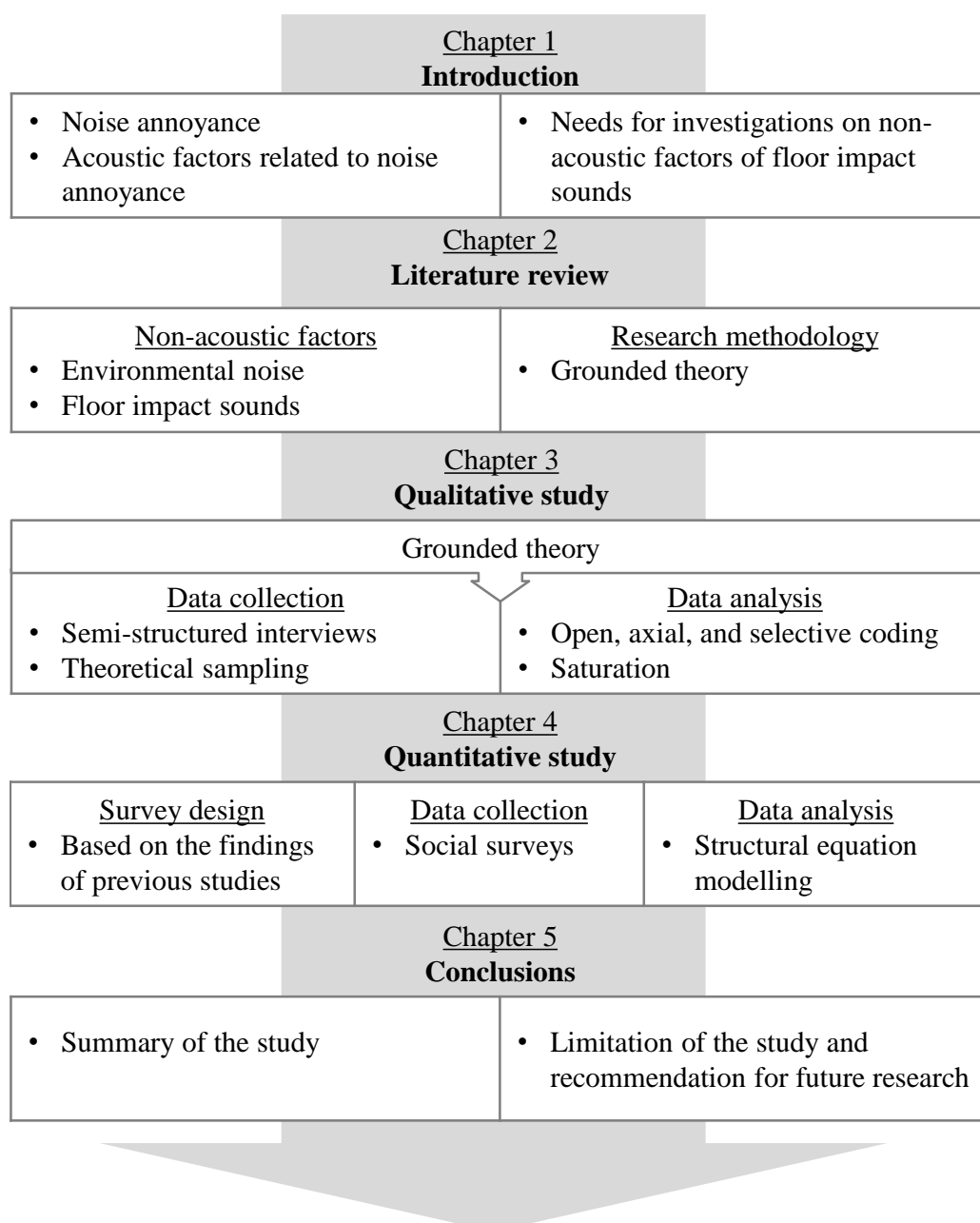
The second chapter explores relevant literature in order to understand and interpret the roles of non-acoustic factors on noise annoyance. The first part of the literature review summarises previous studies on non-acoustic factors and annoyance caused by environmental noise and floor impact sounds. This part also includes the review of previously proposed conceptual models for understanding non-auditory noise effects. The second part of this literature review elaborates grounded theory which was used as a qualitative research method in the present study.

The third chapter shows how the qualitative study was undertaken using a grounded theory approach. Semi-structured interviews were conducted with adult residents in apartment buildings and key themes were identified and grouped together in higher-order categories. This chapter illustrates a conceptual model which was developed to explore the relationships among the identified categories. Discussions are also presented along with the findings and excerpts from the interview transcripts.

The fourth chapter describes the quantitative study using data obtained from social surveys. Hypothesised paths between non-acoustic factors and annoyance

were presented with a conceptual model. This chapter shows how the survey questionnaire was designed based on the previous studies on environmental noise and the findings from the prior qualitative study. It also describes from whom and how the data was collected. Structural equation modelling was employed to test the hypothesised conceptual model and discussions of the findings were made in relation to previous works on the environmental noises.

The last chapter draws conclusions along with summarising and exploring limitations of the present study. It also makes some recommendations for future research. This chapter is followed by the appendices, which contain additional materials such as the survey questionnaire. Figure 1-1 shows how the present thesis is structured.



**Figure 1-1. Outline of the thesis**

At this point, it is important to clarify the use of expressions in this thesis. The interviewees in the qualitative study (chapter 3) have been referred to as their participant number such as P1 or P2. In addition, this thesis refers to residences with one or more rooms in multifamily housing buildings (e.g., apartments, flats, and townhouses) as ‘apartments’ or ‘apartment buildings’. Those with no separate room (e.g., studio or bedsit) were not regarded as ‘apartments’ in this study.

## **2 Literature review**

### **2.1 Introduction**

A literature review enables researchers to understand how the issue has been studied to date, figure out pertinent gaps to explore, and be confident carrying out a study utilising a specific research methodology. A review of the research literature on environmental noise and floor impact sounds was conducted; thus knowledge of theoretical backgrounds and empirical findings for understanding the associations between noise annoyance and non-acoustic factors were gained. It also gave the rationale for conducting the present research by highlighting the lack of understanding of perception and reactions to the noise using non-acoustic factors. Moreover, a thorough review of literature on grounded theory provided comprehensive awareness of how to design and conduct the qualitative study.

### **2.2 Non-acoustic factors related to noise annoyance**

Given that some people might be highly annoyed when they are exposed to noise with which some others might report low level of noise annoyance, and thus, each individual's diverse reactions to noise cannot be fully explained only by acoustic factors (Job, 1988; Miedema and Oudshoorn, 2001; Fyhri and Klæboe, 2006). Noise annoyance contains a variety of negative feelings caused by noise exposure (Guski, 1999), and it has been the most widely studied noise effect (Fyhri and Klæboe, 2006). Further, noise annoyance is of great importance to be studied since it is closely related to non-auditory effects of noise such as effects on sleep disturbance, performance, or physical and mental health (Stansfeld and Matheson, 2003; Bluhm *et al.*, 2004; WHO, 2004a). Therefore, there is no doubt that more precise understanding about noise annoyance can be made when relevant non-acoustic factors are considered (Job, 1988; Fields, 1993; Berglund *et al.*, 1999).



### 2.2.1 Non-acoustic factors of environmental noise

Arguments of previous researchers have been inconsistent with the significant influences of demographic characteristics on subjective responses to noise; some insisted that they have few impacts on subjective reactions to noise while others suggested significant effects of demographic factors (Job, 1988; NASA, 1992; Fields, 1993; Miedema and Vos, 1999; Yu and Kang, 2008; Paunović *et al.*, 2009; Pierrette *et al.*, 2012). Rather than explaining noise annoyance by demographic characteristics, researchers have made attempts to explore relationships between noise annoyance and other variables such as noise sensitivity and some attitudinal or situational variables (Job, 1988; Fields, 1993; Miedema and Vos, 1999). General noise sensitivity has been emphasised by many researchers to have significant impacts on noise annoyance (Job, 1988; Öhrström *et al.*, 1988; Belojević *et al.*, 1992; Fields, 1993; Stansfeld *et al.*, 1993; Miedema and Vos, 1999; van Kamp *et al.*, 2004). The variation in noise reactions can be more precisely explained when noise exposure is considered along with noise sensitivity (Job, 1988). According to Öhrström *et al.* (1988), not only general neurophysiological sensitivity but also subjectively reported noise sensitivity has significant relationships with noise annoyance. Job (1999) defined noise sensitivity in a broad sense, as an internal state that includes physiological and psychological (including attitudinal) traits and that is related to life style or activities conducted, which increases one's degree of reactions to noise in general. He also suggested noise sensitivity can be considered to include the following components: attitudes to noise in general, beliefs about harmful effects of noise in general, vulnerability caused by stressors other than noise, level of social support, and other available coping mechanisms (Job, 1999). However, many other studies have considered the attitudinal variables as well as coping mechanisms separately from noise sensitivity to explore each variable's impact on noise annoyance (Miedema and Vos, 1999; Botteldooren *et al.*, 2003; Wallenius, 2004; Kroesen *et al.*, 2010a).

Along with one's sensitivity to noise, several attitudinal variables have been taken into account. Fear of danger from noise source has been found to be significantly related to the prevalence of noise annoyance (Job, 1988; Fields, 1993; Miedema and Vos, 1999). Fear of an aircraft crashing or of danger from nearby surface transportation was found to be significantly correlated with annoyance

induced by such noise sources (Fields, 1993). Fields (1993) also highlighted beliefs about prevention of noise exposure; in other words, people's noise annoyance may be affected by how far they believe that noise can be prevented or reduced by relevant authorities. For instance, belief about the aircraft noise reduction led by designers or pilots was suggested to mediate the level of noise annoyance (Fields, 1993). Another kind of belief has also been suggested to be one of the attitudinal variables of importance; previous studies have suggested that belief about the importance of noise source has a significant influence on noise annoyance (Fields, 1993; Pedersen *et al.*, 2009; Janssen *et al.*, 2011). This variable contains economic importance or benefits which individuals or regions can gain from noise sources. For example, owners of wind turbines are more likely to believe that wind turbines, namely the noise source, are important and beneficial so that they may perceive and report relatively low noise annoyance with wind turbine noise (Pedersen *et al.*, 2009).

Furthermore, it has been reported that non-noise impacts of noise source have substantial influences on the prevalence of noise annoyance (Hall *et al.*, 1980; Taylor, 1984; NASA, 1992; Fields, 1993; Pedersen and Waye, 2007). In the case of aircraft noise, air pollution, landing lights, or vibrations could be considered to influence people's noise annoyance (Hall *et al.*, 1980; Taylor, 1984). In addition, previous studies on wind turbine noise have paid special attention to the visual impact of the source. It was found that annoyance induced by wind turbine noise is closely linked to the visibility of wind turbines (Pedersen and Waye, 2004; 2007; Pedersen and Larsman, 2008; Pedersen *et al.*, 2009; Bakker *et al.*, 2012). Moreover, satisfaction with living environment (e.g., neighbourhood or dwelling) has also been suggested as a factor which can explain the variance in subjective reactions to noise (Langdon, 1976; Weinstein, 1980; Fields, 1993; Kroesen *et al.*, 2010b). People who are generally dissatisfied with their neighbourhood perceive or report relatively more negative reactions to noise exposure (Langdon, 1976; Weinstein, 1980). Further, annoyance caused by road traffic noise and neighbour noise was also found to be an important determinant of residential satisfaction. (Kroesen *et al.*, 2010b).

Some non-acoustic factors are related to individuals' personality or attitudes and others are rather associated with their situations or contextual meaning of the situations. For example, noise sensitivity can be referred to as each individual's personal or attitudinal variable because it is a stable personality trait covering attitudes towards a wide range of environmental sounds (Zimmer and Ellermeier,

1999) while neighbourhood satisfaction can be labelled as a contextual or situational variable since it is shaped by one's situation of living in the specific neighbourhood. Lercher (1996) summarised important non-acoustic factors in his paper and grouped them into personal and attitudinal variables, and contextual variables (Table 2-1).

**Table 2-1. Personal / attitudinal variables and contextual variables listed by Lercher (1996)**

Personal / attitudinal variables	Contextual variables
<ul style="list-style-type: none"> <li>▪ Noise sensitivity</li> <li>▪ Critical tendency</li> <li>▪ Negative affectivity</li> <li>▪ Neuroticism, extraversion</li> <li>▪ Locus of control</li> <li>▪ Type A/B pattern</li> <li>▪ Non-complaining attitude</li> <li>▪ Misfeasance, preventability</li> <li>▪ Fear of danger, health effects</li> <li>▪ Importance of noise source, attitude towards source</li> </ul>	<ul style="list-style-type: none"> <li>▪ Interference with activities</li> <li>▪ Neighbourhood satisfaction</li> <li>▪ Change in noise environment</li> <li>▪ Home ownership</li> <li>▪ Previous level of exposure</li> <li>▪ Aesthetic appearance of site</li> <li>▪ Property devaluation</li> <li>▪ Controllability / predictability / adaptability</li> <li>▪ Non-noise impacts (e.g., odour, vibration)</li> <li>▪ Home type and design, rooms facing noise source</li> </ul>

Guski (1999) reported that subjective reactions to noise are moderated by personal and social factors. Personal factors involve individuals' personal traits which are stable over time and situations, and vary between different individuals, while social factors are closely connected with situations and are shared by individuals who belong to the same society (Guski, 1999). He grouped noise sensitivity, personal evaluation of the source, and coping capacity together and referred to them as personal factors, and labelled general attitudes, history of noise exposure, and expectation as social factors.

Recently, Laszlo *et al.* (2012) reviewed previous studies on subjective reactions to environmental noise and classified non-acoustic variables into four groups: demographical, personal, social, and situational factors (Table 2-2). They also presented some important annoyance modifiers (those with asterisks in Table 2-2) based on previous evidences.

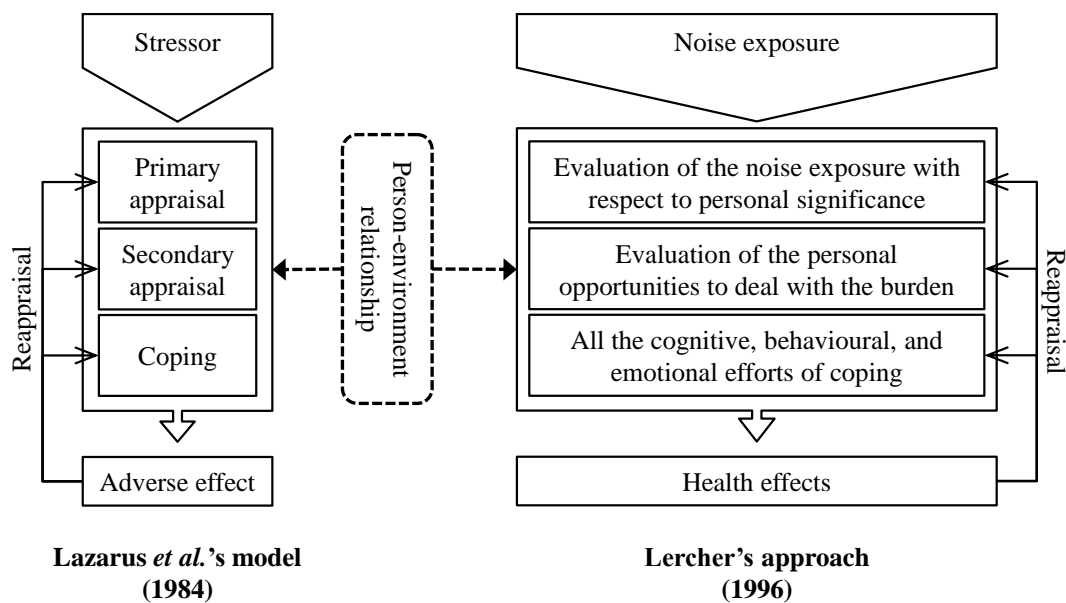
**Table 2-2. Non-acoustic factors affecting noise annoyance listed by Laszlo *et al.* (2012)**

Demographic	Situational
<ul style="list-style-type: none"> <li>▪ Age</li> <li>▪ Gender</li> <li>▪ Type of housing</li> <li>▪ Length of housing</li> <li>▪ Length of residency</li> <li>▪ Education</li> <li>▪ Home ownership</li> <li>▪ Employment</li> <li>▪ Number of people in the household</li> <li>▪ Socioeconomic status</li> <li>▪ Use of mode of transportation*</li> <li>▪ Satisfaction with residence*</li> </ul>	<ul style="list-style-type: none"> <li>▪ Distance from source</li> <li>▪ Spatial factors (type of area, reaction measured indoor or outdoor)</li> <li>▪ Temporal factors (time of the day)</li> <li>▪ Meteorological conditions</li> <li>▪ Previous experience with the area</li> <li>▪ Hours spent at home</li> <li>▪ Sound insulation of the property</li> <li>▪ Media coverage</li> <li>▪ Interviewing mode</li> <li>▪ Dwelling orientation*</li> </ul>
Personal	Social
<ul style="list-style-type: none"> <li>▪ Coping</li> <li>▪ Noise sensitivity*</li> <li>▪ Attitudes to noise source*</li> <li>▪ Feeling that annoyance is preventable*</li> </ul>	<ul style="list-style-type: none"> <li>▪ General evaluation of noise source</li> <li>▪ History of noise exposure</li> <li>▪ Expectations</li> <li>▪ Trust or misfeasance with authorities*</li> </ul>

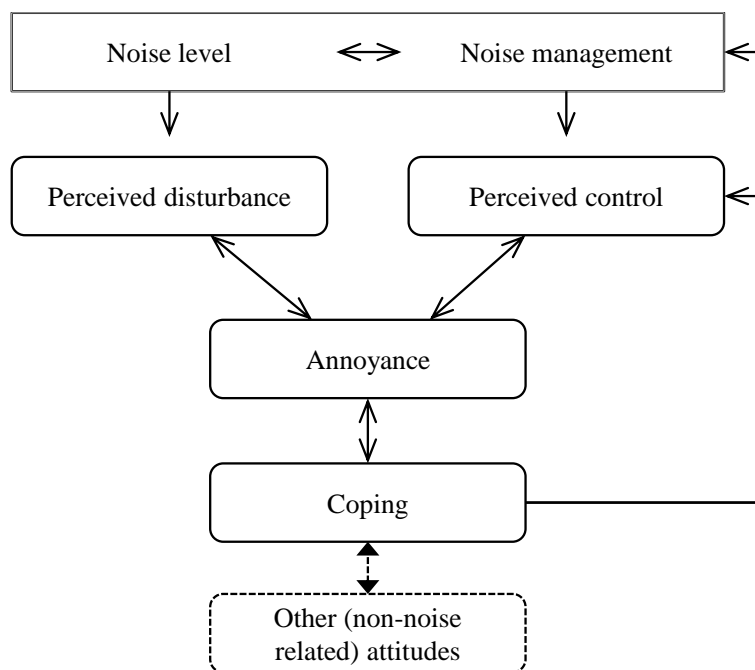
\* Non-acoustic factors which Laszlo *et al.* (2012) suggested to have strong effects on noise annoyance

Several conceptual models have also been developed in theoretical and empirical studies in order to describe how individuals react differently when they are exposed to environmental noise, and which variables have important roles in such mechanisms (Lercher, 1996; Guski, 1999; Stallen, 1999; Kroesen *et al.*, 2008; Pennig and Schady, 2014).

Lercher (1996) explained the relationship between noise and health based on a theoretical stress model (Lazarus, 1966; Lazarus and Folkman, 1984). In his paper, Lercher did not illustrate his own figure of conceptual model but presented the transactional stress model which was developed by Lazarus and Folkman (1984). Evaluation of noise exposure and evaluation of opportunities to deal with the burden were suggested to be referred to as primary and secondary appraisal respectively (Lercher, 1996). These appraisals are tied with coping in a same loop and the processes in this loop are affected by constant reappraisals of the person-environment relationship. Figure 2-1 shows the noise-health relationship which was described as a continuous process of appraisals, coping, and reappraisals based on the transactional stress model (Lercher, 1996).



**Figure 2-1. Noise-health relationship explained by Lercher (1996, right) based on Lazarus' transactional stress model (1984, left)**

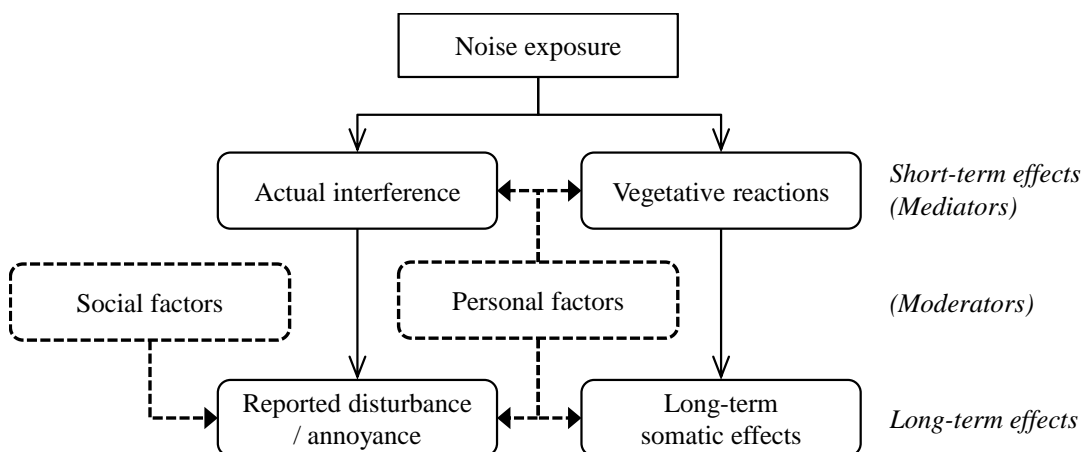


**Figure 2-2. A conceptual model of environmental noise annoyance suggested by Stallen (1999)**

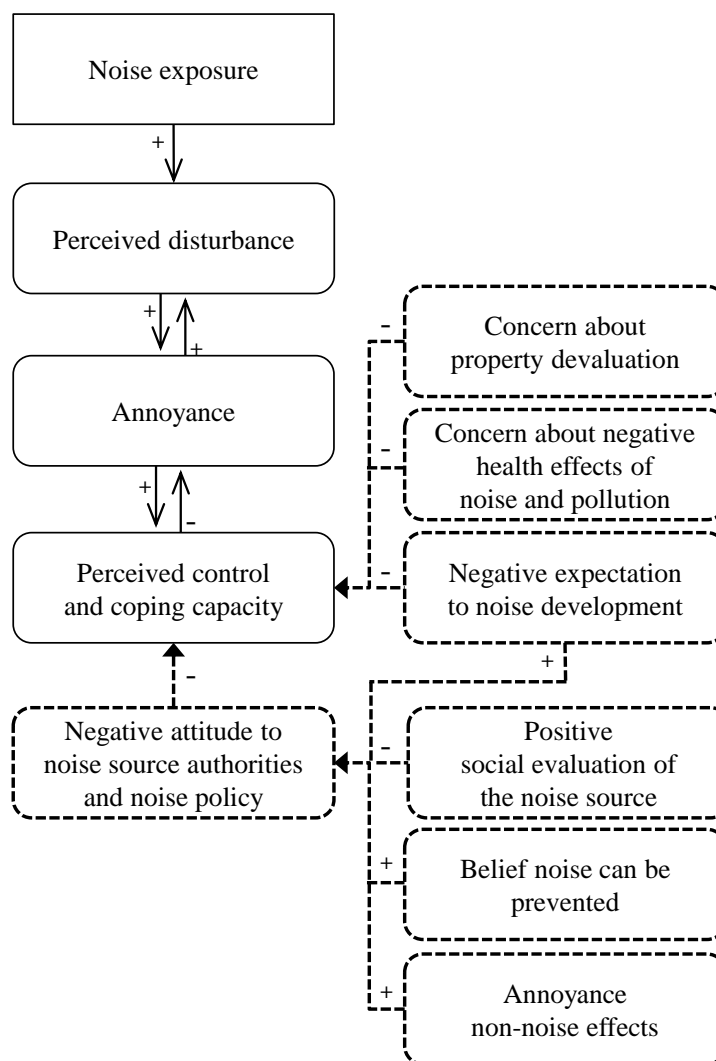
Based on the same stress theory (Lazarus, 1966), Stallen (1999) developed a conceptual model for explaining the underlying process of subjective reactions to environmental noise (Figure 2-2). This model emphasises perceived disturbance (i.e.,

perceived threat) and perceived control as primary and secondary appraisals respectively, in accordance with Lercher (1996). According to this model, noise exposure (i.e., external stimulus) is represented by level of the sounds and noise management by source. Perceived disturbance and perceived control are affected by these two external stimuli and they are associated with annoyance. Both appraisals, perceived disturbance and perceived control, were suggested to have reciprocal relationships with annoyance. Coping is described to have reciprocal relationships with annoyance and other (non-noise related) attitudes. Stallen suggested other (non-noise related) attitudes based on the previous suggestions made by Fields (1993). Additionally, coping is suggested to influence perceived control and noise management.

Guski (1999) developed a conceptual model to account for long-term effects of environmental noise (Figure 2-3). While elaborating his model, Guski employed the idea of mediation and moderation. He regarded short-term noise effects as mediators which are primary reactions, affected by stimuli, and have influences on secondary reactions. Personal and social factors are referred to as moderators which are independent of stimuli but correlated with reactions. In other words, long-term noise effects are regarded to be mediated by short-term effects and moderated by personal and social variables.



**Figure 2-3. A conceptual model of short-term and long-term reactions to environmental noise suggested by Guski (1999)**

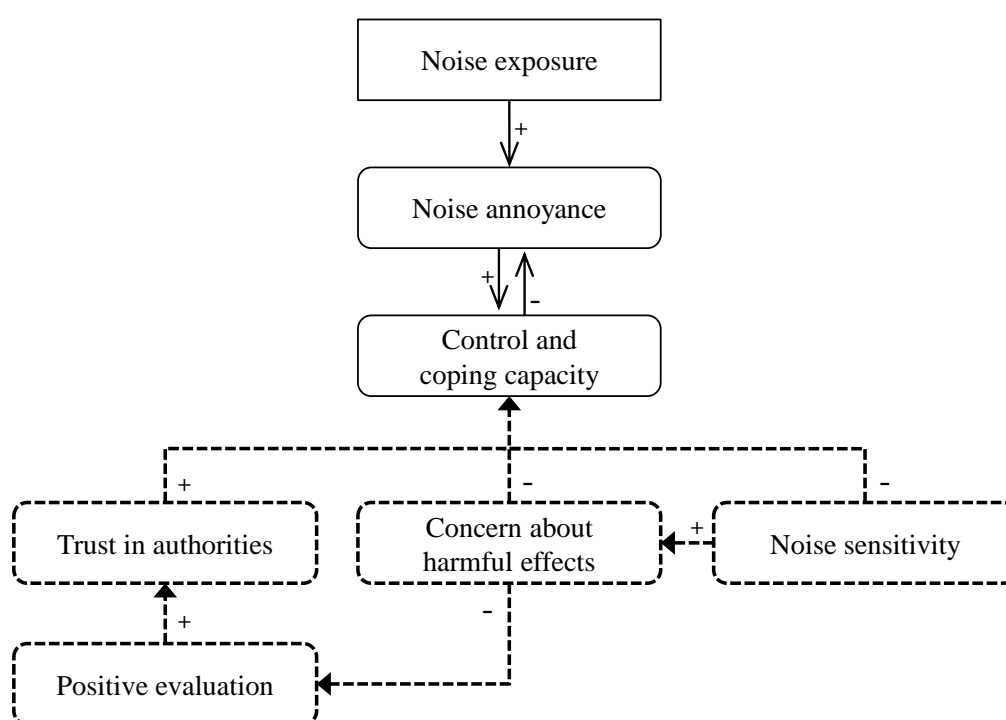


**Figure 2-4. A causal model of aircraft noise annoyance tested by Kroesen *et al.* (2008)**

Kroesen *et al.* (2008) later conducted an empirical study to investigate subjective reactions to aircraft noise. They hypothesised a conceptual model mainly based on the model suggested by Stallen (1999). Survey questions were developed based on earlier studies which reported significant non-acoustic factors (Job, 1988; Fields, 1993; Lercher, 1996; Guski, 1999; Miedema and Vos, 1999; Stallen, 1999) and they collected data from residents in the vicinity of Amsterdam Airport Schiphol. They tested the hypothesised model by applying structural equation modelling and presented the causal model with estimates of each path. Figure 2-4 shows the positive (+) and negative (-) impacts of each variable.

According to their tested model, perceived disturbance and annoyance were found to have reciprocal relationships which were both positively connected.

Annoyance was found to have another reciprocal relationship with perceived control and coping capacity; annoyance positively affected perceived control and coping capacity and was negatively affected by this variable. Kroesen *et al.* tested several attitudinal variables. Perceived control and coping capacity was also negatively affected by concern about property devaluation, concern about negative health effects, negative expectation to noise development, and negative attitude to noise source authorities and noise policy. Negative attitude to noise source authorities and noise policy was found to be influenced by positive social evaluation of the noise source, belief about noise prevention, and annoyance with non-noise effects.



**Figure 2-5. A causal model of railway noise annoyance tested by Pennig and Schady (2014)**

More recently, Pennig and Schady (2014) carried out another empirical study to explain railway noise annoyance. They hypothesised each path of their model based on the findings of previous studies (van Kamp, 1990; Guski, 1999; Stallen, 1999; Kroesen *et al.*, 2008) and collected survey responses from residents living in a vicinity of railway tracks. They also estimated their model by applying structural equation modelling. Figure 2-5 shows positive (+) and negative (-) relationships among the tested variables. They found reciprocal relationship between noise annoyance and control and coping capacity supporting the previous studies (Stallen,



1999; Kroesen *et al.*, 2008). Several non-acoustic variables were found to have influences on control and coping capacity. Control and coping capacity was positively affected by trust in authorities and positive social evaluation of noise source, while was negatively influenced by concern about harmful effects and noise sensitivity.

### **2.2.2 Non-acoustic factors of floor impact sounds**

Jeon *et al.* (2004) suggested that difference in ethnicity may have an impact on subjective responses to floor impact sounds. They performed auditory experiments with Korean and German subjects. Floor impact noises were presented to the subjects via headphones and the subjects were asked to rate the loudness of each noise stimulus. Comparing subjective evaluations of loudness given by the both German and Korean subjects, it was found that Korean subjects were more sensitive to floor impact sounds than German subjects. Jeon *et al.* (2010b) later carried out a survey study to explore people's dissatisfaction with indoor noise environment in residential buildings. They designed a survey questionnaire which included questions about overall dissatisfaction with indoor noise environment, dissatisfaction and annoyance ratings for different noise sources (floor impact sounds, airborne, drainage, and traffic noises). After analysing the collected responses from residents in apartment buildings, they found a close correlation between dissatisfaction with indoor noise environment and annoyance. They also revealed not just that children's jumping and running noises were the most annoying noise source but also that the least satisfactory noise source was floor impact noise.

Maschke and Niemann (2007) insisted that annoyance induced by noise from neighbours has negative effects on both physical and mental health. Their survey study found that people who had perceived severe annoyance caused by neighbour noise had increased health risks such as those in the cardio-vascular system, migraine, or depression. Although they argued significant health risks of neighbour noise annoyance, they did not specify that exposure to floor impact sounds has such health risks. Recent research also revealed an influence of noise sensitivity on annoyance caused by indoor and outdoor noises in residential buildings (Ryu and Jeon, 2011). Ryu and Jeon carried out both an auditory experiment and a survey study; they designed the survey study based on previous studies on noise sensitivity and

annoyance ratings (Weinstein, 1978; Fields *et al.*, 2001; Miedema and Vos, 2003; Ryu *et al.*, 2005). The results showed that noise sensitivity was a significant determinant of annoyance caused by indoor and outdoor noises; moreover, annoyance with indoor noise was found to be more affected by noise sensitivity than annoyance with outdoor noise (Ryu and Jeon, 2011). However, it should be noted that the study included floor impact sounds as one indoor noise but did not examine floor impact sounds separately. In particular, they examined indoor noises in the auditory experiment but this considered only airborne and bathroom drainage noises. They did not examine floor impact noise because the other sounds were assessed using equivalent sound pressure level ( $L_{eq}$ ) but floor impact sounds were evaluated using a different descriptor, the maximum sound level ( $L_{max}$ ). Therefore, it could not be concluded that noise annoyance caused by floor impact noise had negative health effects or was affected by noise sensitivity (Maschke and Niemann, 2007; Ryu and Jeon, 2011).

The literature review of non-acoustic factors related to noise annoyance indicated that there is a lack of research which focuses on non-acoustic factors related to annoyance caused by floor impact sounds. Investigations on noise annoyance with floor impact sounds are needed to confirm the previous findings and to gain insight into subjective reactions to floor impact sounds.

### **2.3 Grounded theory**

Grounded Theory was first introduced by Glaser and Strauss (1967) who had their research backgrounds in nursing field. It is one of the most widely used frameworks in many research fields for undertaking qualitative studies (Bowen, 2008). In particular, research fields on soundscape and environmental noise annoyance have also employed this research methodology (Schulte-Fortkamp and Fiebig, 2006; Pedersen *et al.*, 2007; Smyrnova and Kang, 2010; Jeon *et al.*, 2013). Grounded theory is of use when there is a need for prudent observations in areas with lack of understanding or when a new perspective on a phenomenon is required (Strauss and Corbin, 1990; Pandit, 1996; Corbin and Strauss, 2008; Rechavi, 2009).

This research method is a set of rigorous research procedures to identify conceptual categories. It develops a theory which is grounded in data through repetition of systematic data gathering and analysing, which are called theoretical

sampling and coding (Strauss and Corbin, 1990). Glaser and Strauss (1967) suggested that the phases of theoretical sampling and coding should be carried out interactively and that new data should be constantly compared with previously obtained data and emerged insights. This set of comparative procedures is referred to as a constant comparative analysis. It allows the researcher not only to be fully immersed in the data (Burnard, 1991) and focus on developing key categories but also to be aware of where to find further new data (Charmaz, 2006); this latter part of the research process is known as theoretical sampling.

### **2.3.1 Theoretical sampling**

Theoretical sampling is a process of data collection whereby the researcher jointly collects, codes, and analyses the data, and decides what data to collect next and where to find them (Glaser and Strauss, 1967). In other words, this process of sampling seeks pertinent data based on the previously obtained data; it is carried out with purpose of developing a theory by elaborating and refining the identified themes (otherwise, known as concepts) and categories (Charmaz, 2006). Corbin and Strauss (2008) described this measure of sampling as follows:

*It is a method of data collection based on concepts / themes derived from data. The purpose of theoretical sampling is to collect data from places, people and events that will maximise opportunities to develop concepts in terms of their properties and dimensions, uncover variations, and identify relationships between concepts. (Corbin and Strauss, 2008, p. 143)*

In order to maximise opportunities to uncover variations as Corbin and Strauss (2008) mentioned above, theoretical sampling needs to be carried out continuously until no new insights emerge. The point at which the researcher can obtain no more themes is called saturation. In grounded theory, sampling is driven by the emergence of themes and limited by saturation, not by design (Glaser and Strauss, 1967).

To carry out a grounded theory study, the researcher observes and records the research data (e.g., interview) with no preconceived notions and this initial phase of data collection is followed by another phase in which the data is analysed (Strauss and Corbin, 1998). Each subsequent process of sampling is again compared with previous data and later with any emerged theory (Glaser *et al.*, 1968). Theoretical

sampling is an essential process to allow this set of procedures to be continued until the researcher is confident that saturation of categories has been achieved.

### 2.3.2 Coding

Through several coding phases, collected data is analysed. Data is coded line by line and it allows the researcher to be immersed in the research data and to gain new insights (Burnard, 1991). Also the coded data forms key themes and allows categories to be built based on the key themes. Categories are then compared to each other to develop a theory. This process of data analysis can be achieved by three different coding phases (Stern, 1980; Strauss and Corbin, 1990; Burnard, 1991; Corbin and Strauss, 2008). Data is coded, key themes are identified, and categories are developed during open coding. Axial coding is a stage of relating categories which have been developed. Selective coding selects core categories to explain a theory.

#### 2.3.2.1 Open coding

Initial stage of data analysis in grounded theory contains open coding. It is a phase for identifying, naming, categorising, and describing phenomena which have been found from the research data (Strauss and Corbin, 1998). One of the primary aims of the coding phase is the researcher's immersion in the data (Burnard, 1991). In order to be fully immersed in the data, key questions are kept asking to the researcher:

- *What is at issue here? What phenomenon is being addressed?*
- *What persons or actors are involved? What roles do they play? How do they interact?*
- *What aspects of the phenomenon are addressed (or not addressed)?*
- *How long? Where? How much? How strongly?*
- *What reasons are given or may be deduced?*
- *For what reason? With what intention, and for what purpose?*
- *By what means? What methods, tactics and strategies are used to achieve the goal?*

*(Jenner et al., 2004, p. 271)*

The use of a grounded theory approach in interview studies, transcribed data is examined line by line and the researcher writes memos (Strauss and Corbin, 1990; Corbin and Strauss, 2008). Writing memos is regarded as one of the vital measures of coding and memos are considered as theoretical notes about data and conceptual connections between categories (Glaser and Holton, 2004). The researcher identifies significant themes in the data, gives headings to them, and then groups them into wider categories.

#### 2.3.2.2 Axial coding

Next, categories and subcategories are related to each other based on their themes during axial coding. In other words, emerged categories which have considerable similarities are grouped together under higher-order headings. This phase of coding aims to form complete explanations about the research data (Strauss and Corbin, 1990; Corbin and Strauss, 2008).

In order to reveal relationships among the related categories, and to provide explanations about what is going on in the research data, paradigm can be used (Strauss and Corbin, 1990; Corbin and Strauss, 2008). Developing a paradigm is another measure of data analysis, which is carried out during axial coding. It has proved to be of value to explain relationships between categories, which relate to partial features of social action (Jenner *et al.*, 2004). Paradigm consists of three basic components: conditions, actions/interactions, and consequences. Table 2-3 gives some details of them (Corbin and Strauss, 2008). Based on the basic components of the paradigm, the researcher can ask him/herself some key questions during this stage of coding (Jenner *et al.*, 2004). For example, questions such as ‘With what are the actions and interactions in the data actually concerned?’ or ‘What conditions contribute to the occurrence or development of the phenomenon?’ can be asked.

**Table 2-3. Basic components of coding paradigm (Corbin and Strauss, 2008, p. 89)**

Component	Description
Conditions	Conditions allow a conceptual way of grouping answers to the questions about why, where, how and what happens.
Inter/actions	Actions or interactions are the responses made by individuals to situations, problems, happenings and events.
Consequences	Consequences are outcomes of actions or interactions responses to events. These answer the questions about what happened as a result of those actions or interactions or emotional responses.

### 2.3.2.3 Selective coding

Selective coding is reached when core categories become apparent. After the cautious and constant repetition of the whole sets of data analysis, the researcher selects one or more core categories to explain his/her theory. Core categories explain most of the variation that represents the participants' major concern (Jones and Alony, 2011). This stage of coding finally integrates and refines a theory and only the most pertinent codes of transcripts are used. The other phases of coding (e.g., open and axial coding) are ceased when the researcher moves on to selective coding, and the other codes become subservient to the core codes (Strauss and Corbin, 1990; Corbin and Strauss, 2008).

### 2.3.3 Conducting a literature review in grounded theory

There have been arguments for and against an initial literature review when using grounded theory. Along with Glaser and Strauss (1967) who originally introduced this methodology, several researchers have argued against a literature review prior to commencing data collection and analysis since it is likely to prevent the emergent of theory which would be grounded in the data (Stern, 1980; Lincoln and Guba, 1985; Strauss and Corbin, 1994; Hickey, 1997). However, ever since the first introduction of this methodology, concerns have arisen with regard to how students and researchers should approach and use the existing literature relevant to their research topic (Bryant and Charmaz, 2010).

Several researchers have considered it suitable to carry out an early review of relevant literature (Hutchinson, 1993; Coffey and Atkinson, 1996; Strauss and

Corbin, 1998; Denzin, 2002; Chiovitti and Piran, 2003; McCann and Clark, 2004a; b; Coyne and Cowley, 2006; Henwood and Pidgeon, 2006; McMenamin, 2006; McGhee *et al.*, 2007; Urquhart, 2007; Wiener, 2007). The initial literature review has been agreed to be conducted because of following reasons: Finding out how the phenomenon has been studied to date, the researcher can ensure the study has not been carried out previously and highlight pertinent gaps which need to be investigated (Hutchinson, 1993; Creswell, 1998; Denzin, 2002; Chiovitti and Piran, 2003; McMenamin, 2006). Therefore, it provides a cogent rationale for the research, and helps the researcher to avoid potential unhelpful approaches, particularly conceptual or methodological limitations, which previous studies have experienced (McGhee *et al.*, 2007).

Given the contrast perspectives on the initial literature review, reflexivity has been advised for those who utilise a grounded theory method (Cutcliffe, 2000; Robson, 2002; Cutcliffe, 2003; McGhee *et al.*, 2007; Dunne, 2011). Reflexivity must rest on awareness of self and this should also be shared with readers (Cutcliffe, 2003). McGhee *et al.* (2007) argued that the researcher should be aware of the impact of his/her previous life experiences, including previous reading, and turn back on these to appraise their effects. Ultimately, it is advisable to gain some knowledge of the research area to feel confident for carrying out the research (McGhee *et al.*, 2007).

#### **2.3.4 Criteria for grounded theory**

There are some criteria to evaluate the operationalization and conceptualisation of grounded theory (Egan, 2002). Strauss and Corbin (1990) proposed seven criteria to judge the adequacy of the research process; they suggested some questions to be asked such as ‘How was the original sample selected?’, ‘How and why was the core category selected?’, and ‘What major categories emerged?’ To evaluate the conceptualisation of the research, they suggested another seven questions including ‘Are concepts generated?’, ‘Are the concepts systematically related?’, and ‘Do the theoretical findings seem significant and to what extent?’ (Strauss and Corbin, 1990).

In addition, Charmaz (2006) later proposed four criteria for evaluation grounded theory studies as listed in Table 2-4.

**Table 2-4. Criteria for grounded theory research (Charmaz, 2006)**

Credibility
<ul style="list-style-type: none"> <li>▪ Are there strong links between gathered data and argument?</li> <li>▪ Are data sufficient to merit claims?</li> <li>▪ Do categories offer a wide range of empirical observations?</li> <li>▪ Has the research provided enough evidence for the researcher's claim to allow the reader to form an independent assessment?</li> </ul>
Originality
<ul style="list-style-type: none"> <li>▪ Do the categories offer new insights?</li> <li>▪ What is the social and theoretical significance of the work?</li> <li>▪ How does grounded theory challenge, extend, and refine current ideas, concepts / themes, and practices?</li> </ul>
Resonance
<ul style="list-style-type: none"> <li>▪ Do categories portray fullness of the studied experience?</li> <li>▪ Does the grounded theory make sense to the participants?</li> <li>▪ Does analysis offer them deeper insights about their lives and worlds?</li> </ul>
Usefulness
<ul style="list-style-type: none"> <li>▪ Can the analysis spark further research in other substantive areas?</li> <li>▪ How does the work contribute to knowledge?</li> <li>▪ Does the analysis offer interpretations that people can use in their everyday lives or worlds?</li> </ul>



## **3 Qualitative study**

### **3.1 Introduction**

The method of qualitative study focuses on the use of words and phrases rather than emphasising the use of numbers and quantification (Bryman, 2012). Further, it is of use to probe the underlying meanings that individuals themselves ascribe to their behaviours and attitudes (Burnard, 1991; Corbin and Strauss, 2008; Flick, 2011). The present qualitative study aimed to understand how people living in apartment buildings perceive floor impact noise and react to it, and in turn, explore non-acoustic factors of importance that are related to people's perceptions and reactions to floor impact sounds. It utilised a research methodology of grounded theory (Glaser and Strauss, 1967) which focuses on social processes or actions of individuals that are related to the phenomenon (Strauss and Corbin, 1990). Presuming little is known about the phenomenon, grounded theory research begins with open questions (Sbaraini *et al.*, 2011). The following open questions were asked to embark on the present study: What are the circumstances surrounding the experiences of exposure to floor impact sounds? How do apartment building residents feel or behave when they are exposed to floor impact sounds coming from their upstairs? And how do these experiences vary?

### **3.2 Methods**

Semi-structured interviews were undertaken with residents in apartment buildings and some new ways of seeing and understanding the issue were identified (Cohen and Crabtree, 2006). Rich dialogues with the interviewees yielded substantial data which is later developed to key categories and a conceptual model. The transcripts and audio recordings of the interviews were useful to discern each interviewee's nuances of their emotions and experiences.

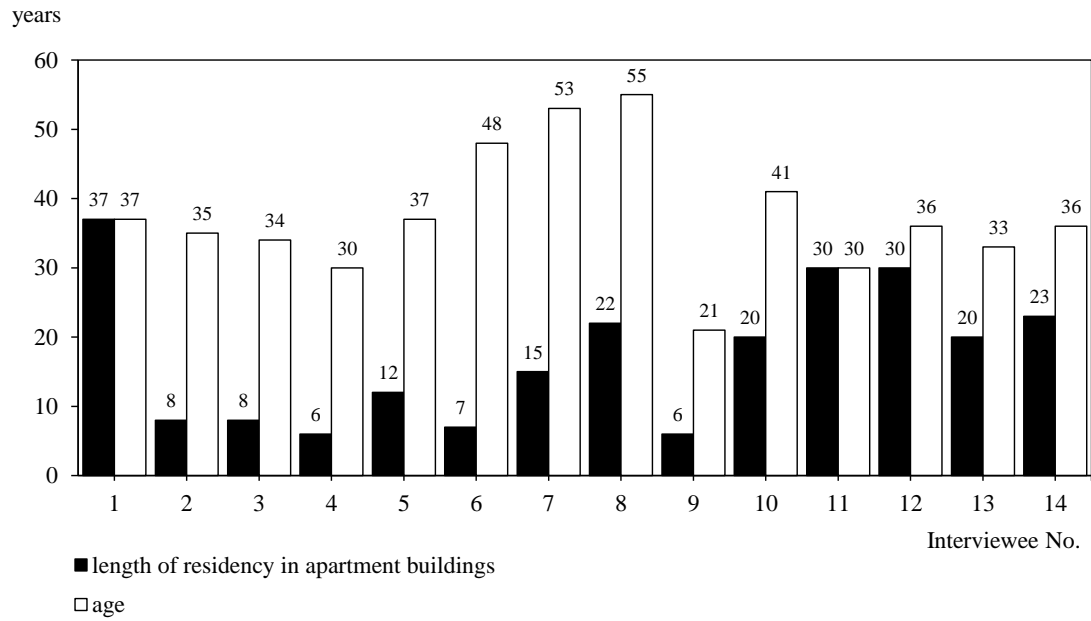
### 3.2.1 Interviewees

As Table 3-1 presents, a heterogeneous group of 14 interviewees (five males and nine females) took part in the study. They had been told that they would be interviewed about their experiences of exposure to floor impact sounds in their current dwellings. All interviewees had normal hearing and no one wore a hearing aid. The average age of the interviewees was 37.6 years old (standard deviation = 9.2, median = 36). Six of them were employed (five full-time and one self-employed) and the other eight were unwaged (one unemployed, six housewives, and one student). Annual household income was asked and four of them answered less than 39.99 million Korean Won which is equivalent to approximately 22,220 British Pound, six answered between 40 and 59.99 million Korean Won (GBP 11,101 to 22,220), and four interviewees answered their annual household income was more than 60 million Korean Won (GBP 33,331). Of the interviewees, nine rented their current apartments while five owned their current properties. The number of bedrooms in the apartments ranged between one and five. Seven interviewees lived in the buildings which had been built for less than 10 years, six were lived in buildings aged 10 to 20 years, and one interviewee lived in a building which had been built for more than 20 years. Nine lived with one or more children aged between 3 and 13 years; five interviewees reported that their upstairs neighbours had one or more children (from 3 to 13 years old). In addition, all interviewees had lived in their current apartments for more than one year, with the exception of one who had lived in her apartment for 10 months. The interviewees spent an average of 14 hours a day (standard deviation = 3.8) in their homes.

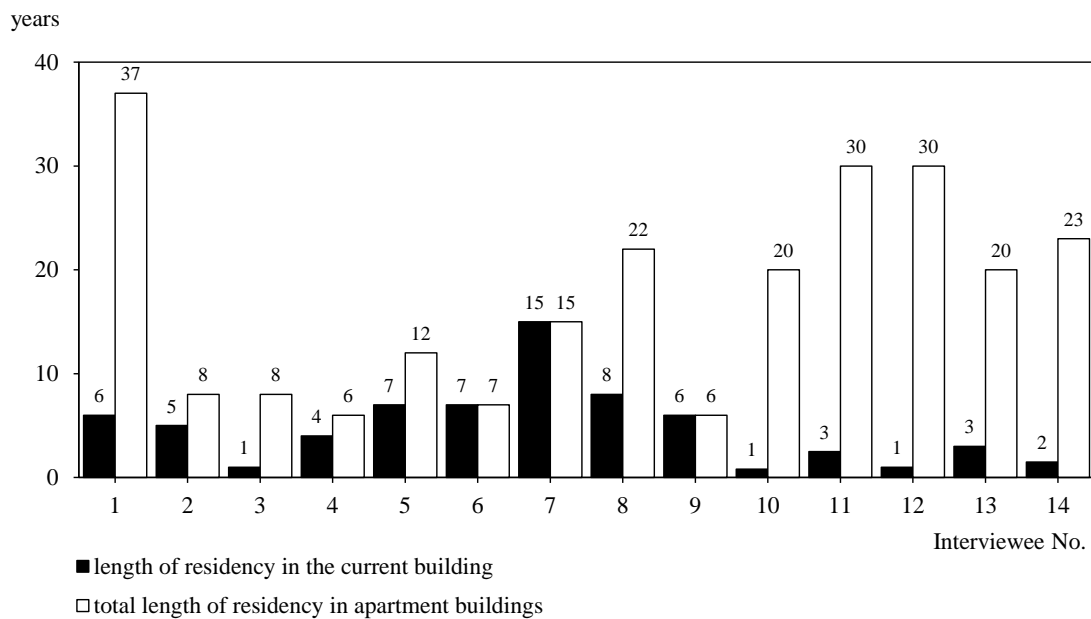
In terms of each interviewee's length of residency in apartment buildings, two questions were asked. First, they were asked how long they had been living in the current apartment, and second, they were asked how long they had lived in this type of, namely, apartment buildings. As Figure 3-1 describes, all interviewees had lived in apartment buildings more than five years, and two of them reported they had only lived in this type of buildings during their lives. Figure 3-2 compares the length of residency in the current apartments with a total length of residency in apartment buildings; three interviewees responded that the current apartments were the only apartment buildings in which they had lived.

**Table 3-1. Demographic characteristics of the interviewees (N = 14)**

Demographic characteristic	Details	N
Gender	Male	5
	Female	9
Age	20s	1
	30s	9
	40s	2
	50s	2
Employment	Full-time employed	5
	Self-employed	1
	Unemployed	1
	Housewife	6
	Student	1
Income (British Pound)	< 11,100	1
	11,101-22,220	3
	22,221-33,330	6
	> 33,331	4
Housing status	Owned	5
	Rented	9
No. of bedroom	One	3
	Two	3
	Three	5
	Four	2
	Five	1
Building age (years)	< 5	3
	5-10	4
	10-15	4
	15-20	2
	> 20	1
Child at home	Yes	9
	No	5
Child upstairs	Yes	5
	No	9
Length of residency (years)	< 2	4
	3-5	4
	6-10	5
	> 10	1
Amount of time at home a day (hours)	< 10	3
	10-15	7
	15-20	3
	> 20	1



**Figure 3-1. Total length of residency in apartment buildings compared with age**



**Figure 3-2. Total length of residency in apartment buildings compared with length of residency in the current building**

### 3.2.2 Interview procedure

Semi-structured interviews, ranging from 30 to 90 minutes in duration, were conducted. Each interview started by the interviewee voluntarily signing their consent to involvement, audio recording, confidentiality, and anonymity. The

interviewees were asked to fill in a pre-interview questionnaire before the interviews. The pre-interview questionnaire was developed for asking their demographic characteristics and housing situations (Appendix 1). The interview questions were also developed as guidance (Table 3-2); the question items were developed based on the findings of the previous studies that identified non-acoustic factors which affect individuals' perceptions and reactions to environmental noise (Job, 1988; Fields, 1993; Lercher, 1996; Guski, 1999; Miedema and Vos, 1999; Stallen, 1999; Paunović *et al.*, 2009; Laszlo *et al.*, 2012). The questions were open-ended allowing the interviewees to choose their own terms when answering the questions (Turner, 2010) and the interviews were carried out depend upon the responses of the interviewees. The interviewees were encouraged to freely express their own thoughts and experiences of exposure to floor impact sounds.

**Table 3-2. Interview question items**

Question category	Question item
Current dwelling	<ul style="list-style-type: none"> <li>▪ Reasons for choosing the current apartment</li> <li>▪ Satisfaction (or dissatisfaction) with the current apartment</li> <li>▪ Satisfaction (or dissatisfaction) with the neighbourhood</li> </ul>
Floor impact sounds	<ul style="list-style-type: none"> <li>▪ Major noise sources</li> <li>▪ Place and time of noise exposure</li> <li>▪ Disturbed activities</li> </ul>
Past experience	<ul style="list-style-type: none"> <li>▪ Noise exposure from previous neighbours</li> <li>▪ Noise exposure in previous apartments</li> </ul>
Other noise	<ul style="list-style-type: none"> <li>▪ Inside the building (e.g., airborne noise)</li> <li>▪ Outside noise (e.g., traffic)</li> </ul>
Reactions to noise	<ul style="list-style-type: none"> <li>▪ Emotional or cognitive coping</li> <li>▪ Behavioural coping</li> <li>▪ Health effects</li> </ul>
Attitudes	<ul style="list-style-type: none"> <li>▪ to noise problems</li> <li>▪ to authorities</li> <li>▪ to upstairs neighbours</li> </ul>

### 3.2.3 Data analysis

Each interview was manually coded line by line using the interviewees' own words and immediate expressions. The codes were classified into several themes, and those with considerable relations and similarities were grouped together in higher-

order categories. The emerging themes and categories were again compared with the raw data (i.e., the original transcripts and audio recordings), memos, and later theoretical ideas (Glaser *et al.*, 1968). This set of manual coding procedures was repeated several times. No more new insight appeared after interviewing the 13th interviewee, and theoretical saturation was thus considered to have been reached after conducting one additional interview. The final re-coding phase was carried out using the qualitative data analysis software, NVivo 10. The numerous processes of the manual and computerised re-coding enabled comprehensive analysis of the research data and identification of the core themes and categories. In order to meet the requirements of transparency, following parts of this chapter presents excerpts from the interview transcripts from which the readers can themselves interpret each interviewee's emotions and experiences, and discern the findings of the study (Wilson and Hutchinson, 1996; Yardley, 2000; Bringer *et al.*, 2004).

### **3.3 Results and discussions**

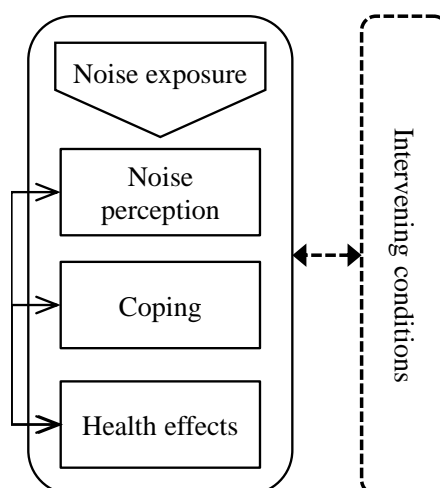
Through the data analysis, 15 themes were identified. Table 3-3 gives the counted frequency of the final codes. The key themes were categorised into five groups. The characteristics of the noise sources to which the interviewees had been exposed were classified into three themes under the category of 'noise exposure'. Annoyance and disturbance were grouped as 'noise perception'. The adopted coping strategies were classified into vigilant, avoidant, and cognitive coping and they were grouped together as 'coping' (Folkman and Lazarus, 1988); the related health issues and concerns were grouped as 'health effects'. The last category, 'intervening conditions' included the underlying psychological factors that were observed to interact with the other categories (Corbin and Strauss, 2008).

A conceptual model (Figure 3-3) was developed to illustrate the relationships among the five categories. The development of this model was mainly based on previously suggested models of people's perceptions and reactions to environmental noise (Lercher, 1996; Guski, 1999; Stallen, 1999). Figure 3-3 shows the reciprocal relationships among noise perception, coping, and health effects. The path between noise perception (i.e., annoyance and disturbance) and coping was theoretically suggested by Stallen (1999) and empirically tested by studies on annoyance caused by aircraft and railway noises (Kroesen *et al.*, 2008; Pennig and Schady, 2014).

Negative health effects are the crucial long-term noise effects coming after people's perceptions and reactions to noise, in other words, health effects follow annoyance, disturbance, and coping (Lercher, 1996; Guski, 1999). The reciprocal relationships among noise perception, coping, and adverse health effects in Figure 3-3 extend the earlier suggestion of Lercher (1996). In addition, the intervening conditions are described to be related to the other variables (Figure 3-3). Lercher (1996) earlier suggested the 'person-environment relationship' which affects stress appraisals and coping process and Guski (1999) suggested moderating effects of personal and social factors on noise annoyance. Similarly, the intervening conditions are illustrated to influence people's noise perception, coping, and health consequences. What is different from the previous studies (Lercher, 1996; Guski, 1999; Stallen, 1999; Kroesen *et al.*, 2008; Pennig and Schady, 2014) is that the noise exposure is also located in the same loop along with noise perception, coping, and health effects. It shows that the intervening conditions might have influences on noise exposure as well. The relationship between noise exposure and intervening conditions was proposed since it was found that having relationship problems with upstairs neighbours may change the characteristics of the noise source; it may cause the noise source to be retaliatory noise. That is why retaliatory noise was also included in the category 'noise exposure' (Table 3-3).

**Table 3-3. Frequency of final codes describing the key themes and categories**

Category	Theme	Frequency
Noise exposure	Heavy-weight impact noise	86
	Light-weight impact noise	61
	Retaliatory noise	33
Noise perception	Annoyance	128
	Disturbance	117
Coping	Vigilant coping	114
	Avoidant coping	93
	Cognitive coping	23
Health effects	Health issues	51
	Health concerns	43
Intervening conditions	Attitude to neighbours	131
	Attitude to authorities	95
	Dwelling satisfaction	82
	Noise sensitivity	66
	Past experience	42



**Figure 3-3. A conceptual model indicating relationships among the key categories**

### 3.3.1 Noise exposure

Floor impact noise sources are classified into light-weight and heavy-weight based on their physical characteristics such as the impact force and mechanical impedance (Scholl, 2001; Jeon *et al.*, 2006). The most common light-weight impact noise sources are walking with high-heeled shoes and the dropping of light-weight objects, which produce high-frequency floor impact noise. Heavy-weight impact noise is mainly caused by running or jumping children. Furthermore, light-weight impact noise is dominated by high-frequency components, whereas heavy-weight impact noise has a dominant sound energy at frequencies below 100 Hz (Jeon *et al.*, 2009a). The noises produced by different impact sources have varied physical and psycho-acoustical characteristics. Consequently, the subjective response of an individual to floor impact noise is affected by the type of source (Jeon *et al.*, 2009a; Lee *et al.*, 2009).

The various noise sources collated from the interviewees of the present study were classified into light-weight or heavy-weight impact sources. The majority of the interviewees had frequently been exposed to heavy-weight impact sources; for example, walking adults and jumping and running children. This was mainly because Koreans do not wear shoes in their homes and barefoot walking on the floor often causes heavy-weight impact noise. Among the 14 interviewees, 10 mentioned footsteps, which agreed with the findings of previous studies that footsteps were the



most frequent noise sources in apartment buildings (Jeon *et al.*, 2006; Maschke and Niemann, 2007; Jeon *et al.*, 2010b).

*P6: A child keeps running. And I can hear people's footsteps. I suppose it would be less noisy if they wore shoes (indoor shoes) or put a mat on the floor, but they don't do anything.*

*P7: There are three adults living upstairs, husband and wife in their late 50s and their son. I can clearly imagine their movements because I can clearly hear their footsteps. Usually from 10:10 at night, until late 11 p.m. or midnight, I get so annoyed by their footsteps.*

*P14: A boy (living upstairs) makes noise a lot. His footsteps are very noisy. He makes noise even after midnight.*

Light-weight impact noise sources were also mentioned by the interviewees, although less frequently compared to heavy-weight sources. This was because, unlike heavy-weight impact noise, the dominant sound energy produced by light-weight impact noise sources can be easily reduced by acoustical treatments such as floor coverings and resilient isolators (Jeon *et al.*, 2009b; Yoo *et al.*, 2010). The sources of light-weight impact noise observed in this study included the scraping of furniture or vacuum cleaners against the floor, the scratching of the floor by dogs, and the dropping of light-weight items.

*P2: There's something like the noise of furniture scraping at 11 or 12 at night. Or hitting or dropping noise; it sounds like they (upstairs neighbours) are hitting their floor or dropping something to disturb us.*

*P4: A dog scratches the floor all the time. I have seen the dog once, it was a big schnauzer.*

Most environmental noise sources such as road traffic and wind turbines continuously produce sounds with high pressure levels, which can be measured over 24 hours to determine the day-night noise level ( $L_{dn}$ ) and day-evening-night noise level ( $L_{den}$ ). In contrast, floor impact noises are intermittent and occur irregularly

because the noise events and their frequencies are significantly dependent on the behaviours of the upstairs neighbours. As a recent study on combined industrial and road traffic noise reported that the noise was less tolerable in the early morning and evening (Pierrette *et al.*, 2012), most interviewees of the present study reported that they had heard floor impact noises at night or in the morning. The significantly lower level of ambient noise at those times could explain the relatively high frequency of complaints about night and morning noises.

*P2: Normally at night, when we (my family) are about to go to bed (I can hear the noise.*

*P3: Before I go to sleep, when I'm lying on my bed at night (I can hear the noise) ... sometimes early in the morning as well.*

*P14: I can hear the noise at night, but also at 7 to 8 in the morning ... the noise disturbs my sleeping ... it wakes my baby up, he cries, it's hard to get him to sleep again.*

### **3.3.2 Noise perception**

Perception and health effects of noise can be explained by stress theories (Lercher, 1996; Guski, 1999; Stallen, 1999). One means of doing this is applying a transactional stress model (Lazarus, 1966), by which Lercher (1996) described the noise-health relationship as a continuous process of appraisals, coping, and reappraisals. Using the transactional stress model (Lazarus, 1966), perception of noise (i.e., annoyance and disturbance) can be described as a phase of primary appraisals (Lercher, 1996; Guski, 1999; Stallen, 1999). In the present study, most of the interviewees reported their negative perceptions of floor impact noise, which they described in terms of annoyance and disturbance caused. This is unsurprising given that noise coming from neighbours is the second major cause of noise annoyance in living environments (Maschke and Niemann, 2007), and floor impact noise has been found to be the most annoying source in apartment buildings (Jeon *et al.*, 2010b). Some of the interviewees reported relatively low noise annoyance and that they had rarely made noise complaints.

*P1: The kid (upstairs) makes noise at night and it seems they (upstairs neighbours, parents of the kid) don't control him (the kid) ... it is true that I'm annoyed sometimes, but I just try not to mind too much ... I've made (a noise complaint) once but I just don't want to complain about it again, to them or anywhere else (to authorities).*

*P3: I haven't complained about it. Sometimes I think about moving house, maybe to the top floor because it'll be quieter. Anyway, I can understand why they (upstairs neighbours) make noise, and try to be sympathetic.*

Conversely, some interviewees addressed high noise annoyance. In most cases, they expressed their negative emotions at the noise exposure itself and their upstairs neighbours who had been responsible for the noise. They also complained about their current apartment buildings or expressed concerns about the health risks. Moreover, it was observed that those who had experienced high levels of noise-induced annoyance had coped very actively with the noise problems. They had contacted or visited their upstairs neighbours, called security officers to complain about the noise, or made official complaints to relevant authorities. This indicates that annoyance caused by floor impact noise is closely associated with the adoption of coping strategies, as revealed by previous studies on environmental noise (Lercher, 1996; Guski, 1999; Stallen, 1999).

*P6: They (upstairs neighbours) make noise wherever, in the living room, in the bedroom, and even in the bathroom ... now I can understand those who killed their neighbours. It's very stressful ... it (the continuous noise) stresses us so much and I think it's harmful to health physically and mentally ... I once asked the officer (building manager) to move (my apartment) to another floor, or to another block.*

*P8: I've tried everything to solve this (noise) problem ... of course I've called everywhere (related authorities) to make complaints ... I called the police at first ... I've recorded the noise to make the evidence, I thought they couldn't deny, but they did ... they continued*

*making that noise ... I started to hit the ceiling of my bedroom to disturb them. There's a hole in my ceiling, you can imagine how strongly and continuously I've been doing that.*

*P14: They even make noise after midnight ... it's very noisy ... it's stressful and annoying ... they say they don't (make noise) but we (my husband and I) can hear it ... we've suffered so much and my eye problem is getting worse ... I really don't want to live in my apartment anymore.*

The different levels of noise annoyance among the interviewees can be explained by both acoustic and non-acoustics factors. Noise annoyance in buildings is affected by physical attributes such as floor thickness and dynamic properties of the floor (Jeon *et al.*, 2004; Lee *et al.*, 2009; Lee *et al.*, 2013). Non-acoustic factors such as noise sensitivity, attitudes to the noise source, demographic characteristics, and situational factors such as the time spent at home also contribute to subjective responses to floor impact noise (Job, 1988; Fields, 1993; Miedema and Vos, 1999; Laszlo *et al.*, 2012). Unlike the case of environmental noise, the effects of non-acoustic factors on the perception of floor impact noise have not been empirically investigated. Further study is therefore required to validate conceptual models that consider non-acoustic factors using empirical data on the perception of floor impact noise.

Another major negative consequence of noise exposure is related to the disturbance caused. It has been reported that exposure to environmental noise disturbs various activities such as speech, watching TV, listening to the radio, and sleep (Fields, 1998; Öhrström, 2004; Bakker *et al.*, 2012). The interviewees of the present study also reported disturbance caused by floor impact noise such as studying, reading, and watching TV. Interestingly, the descriptions of their disturbance experiences usually included noise annoyance. This shows that noise disturbance is closely associated with annoyance confirming the conceptual model that suggests a reciprocal relationship between disturbance and annoyance (Stallen, 1999).

*P8: It (floor impact noise) is very annoying ... my daughter's private tutors come every weekend because she's now in her third year (of*

*high school, preparing for university entrance exams) ... they (private tutors) say they can't concentrate on studying and have the class properly (because of the noise from upstairs).*

*P12: When reading some books in my living room, or when concentrating on something, I'm disturbed by noises from upstairs; it easily makes me lose my concentration.*

Given that the majority of the interviewees complained of noise exposure at night or in the morning, it can be deduced that sleep disturbance might be the most prevalent disturbed aspect of home lives. As expected, most of the interviewees reported that their sleeping had been disturbed because of floor impact sounds. Among the 14 interviewees, eight mainly complained about sleep disturbance. It can be discussed by that noise sensitivity at night is significantly higher compared to noise sensitivity during the rest of the day, and the higher night-time noise sensitivity can be explained by the close link between sleep and quieter ambient noise (Ouis, 1999; Hume *et al.*, 2002; Marks and Griefahn, 2007; Muzet, 2007).

*P1: Of course, I can understand it (noise from upstairs) during the afternoon, but I'm very annoyed with it at night because it's quieter, so I can hear it (noise from upstairs) far more at night ... when we (my family) are about to go to bed, after 9 or 10 p.m.? I can hear it.*

*P6: The noise disturbs our (my family's) sleep and rest. We don't have to wake up at 5 in the morning but, that short and strong noise always wakes us up. I get angry and can't get back to sleep ... we can't take proper rest because of the noise; it's very difficult for us.*

### **3.3.3 Coping**

Coping includes all the cognitive and behavioural efforts involved in managing stress, and in this case, negative noise perception such as noise annoyance (Lazarus, 1966; Folkman and Lazarus, 1988; Lercher, 1996; Guski, 1999). In describing coping in his transactional stress model, Lazarus (1966) distinguished emotional coping from problem-focused coping. Accordingly, Guski (1999) also categorised

coping into indirect and direct strategies, which can be referred to as cognitive control and behavioural strategies respectively. Indirect strategies include cognitive processes such as denial, repression, and suppression, while direct strategies involve problem-solving behaviours that reduce or manage the distressing emotions (Folkman and Lazarus, 1988). The majority of the coping strategies identified in the narratives of the interviewees were behavioural coping; only four interviewees mentioned cognitive coping strategies.

*P1: Of course, I can hear it (noise from upstairs) but I try not to mind too much.*

*P2: We (husband and I) just try not to hear it ... sometimes I'm scared, you know, there have been some murder cases these days.*

Relatively small number of interviewees described their cognitive coping and two forms of discussions can be considered. Firstly, in the case of exposure floor impact sounds, people easily recognise the type of noise source and the location of noise events, so that more behavioural coping strategies can be used than cognitive ones. Secondly, even though the interviewees might have used cognitive coping several times, they were unlikely to report verbally on cognitive coping strategies during the interviews since cognitive coping is a mental strategy, namely 'self-talk', whereas behavioural coping is a mechanism of 'taking action or doing something' (Latack and Havlovic, 1992). Thus it might be easier for the interviewees to report what they had taken action.

A number of behavioural coping strategies were reported by the interviewees, and these were classified into avoidant and vigilant coping behaviours (Folkman and Lazarus, 1988). Avoidant coping is aimed at diverting one's attention from stress to get away from it, whereas vigilant coping involve the direction of attention to the source of the stress in order to prevent or control it (Folkman and Lazarus, 1988). The measures that were used by the interviewees to avoid exposure to floor impact sounds were labelled as avoidant coping behaviours, while making noise complaints was referred to as vigilant coping behaviours. It was found that most of the interviewees employed avoidant coping strategies when they first heard the floor impact noise. Although the number of codes listed in Table 3-3 shows that the

frequency of final codes representing vigilant coping was higher than that of avoidant coping, actual number of interviewees who reported that they had employed avoidant coping behaviours was higher than those who had used vigilant coping behaviours. Frequently used avoidant coping strategies were going out, using earplugs, turning up the volume of the TV or music, and trying to concentrate on other activities.

*P5: I suppose that it's better to go out not to hear the noise, if possible, rather than visiting them (upstairs neighbours to complain).*

*P12: My wife turns up the volume of the TV (not to hear the noise).*

*P14: I've used earplugs and I could hear less noise but it was not comfortable, so I stopped using them.*

Hume and Thomas (1993) reported that people rarely complained about aircraft noise because they assumed that their complaints would yield no effective or satisfactory results from the relevant authorities (e.g., airport). Another study on annoyance caused by aircraft noise found that the low success expectation caused disparity between incidences of annoyance and the corresponding complaints (van Wiechen *et al.*, 2002). However, most of the interviewees of the present study reported that they had made noise complaints, which is one of the means to manage noise and to cope with noise annoyance (Maziul *et al.*, 2005). Indeed, making complaints might be one of the most common vigilant coping behaviours to deal with noise exposure in residential buildings because neighbours are the main noise sources, unlike the cases of environmental noise. Additionally, the unpredictability of noise exposure may cause residents to make more noise complaints, for people are likely to complain about the unusual conditions of the noise rather than the noise annoyance itself (Luz *et al.*, 1983).

The interviewees had initially made indirect noise complaints by contacting security officers or the block managers. This is in agreement with the argument of Gass and Neu (2006), who insisted that people tended to perceive indirect complaints as a positive approach. As the interviewees found no significant change in noise exposure after making the indirect complaints, and as the frequency of the complaints increased, it was observed that the type of complaints has been changed

into making direct contact with their upstairs neighbours or making official complaints to the authorities.

*P10: I had turned on some music while I was sleeping (not to hear the noise) and tried to use earplugs as well, but all of them were not helpful to sleeping soundly ... I had called a security officer, asked for an official announcement within the building, but nothing had changed, so I visited them (upstairs neighbours) ... I wasn't quite sure, but the man upstairs seemed a bit drunk and kept shouting at me. So I called police ... he shouted at the policemen as well and made more noise, he jumped purposely after the (policemen) had went away ... I called the National Environmental Dispute Resolution Commission ... it took a long time and many stages.*

In a recent study on military noise found that people who had made complaints about military noise reported higher noise annoyance than others (Nykaza *et al.*, 2013). The stress level can be reduced after using vigilant coping when favourable outcomes are expected. However, negative emotions might be provoked by the realisation that nothing can be done to improve the situation (Folkman and Lazarus, 1988; Folkman, 2013). Likewise, two interviewees (P5 and P10) reported that they had experienced significantly reduced noise exposure after making a number of complaints to their upstairs neighbours and relevant authorities. Their narratives indicated low noise annoyance and relatively weak negative emotions, or even a positive feeling about their apartments and their upstairs neighbours. In contrast, three interviewees (P6, P7, and P8) reported that their complaints had not been effective in managing the noise problems. Their narratives indicated high noise annoyance and strong negative emotions towards the noise issue, their dwellings, and their upstairs neighbours. Unsuccessful coping strategies might even increase the noise annoyance (Botteldooren *et al.*, 2003), and sometimes unreasonable complaints might be made after being ignored (Luz *et al.*, 1983). It is therefore necessary for authorities to establish effective procedures for dealing with noise complaints, particularly on floor impact sounds.



### 3.3.4 Health effects

Exposure to noise has been found to cause health problems (Tarnopolsky *et al.*, 1980; Ising and Kruppa, 2004; Wallenius, 2004; Maschke and Niemann, 2007). Road traffic noise was found to raise complaints about nervousness and headache (Fyhri and Klæboe, 2009) as well as disturbed sleep which increases the secretion of stress hormones (Ising and Kruppa, 2004). In addition, annoyance caused by the noise of wind turbines was found to induce negative health complaints and psychological distress (Pedersen and Waye, 2007; Bakker *et al.*, 2012). Findings from the present study suggested that the interviewees felt that exposure to floor impact noise caused health issues.

*P6: ... it (the continuous noise) makes us stressed very much and I think it's harmful to health physically and mentally.*

*P7: I lost so much weight because I've been so stressed by the noise.*

*P12: I've been experiencing dizziness before moving into this apartment, and it's become worse because I've been hearing the noise continuously ... my wife gave premature birth and the noise might not be the biggest reason, but I'm pretty sure that the stress caused by noise influenced it.*

*P14: The noise disturbs my sleeping. I have eye problems, so I should take enough rest, but eventually it (my eye problem) is getting worse ... the noise causes stress and I can't sleep.*

Lercher and Kofler (1996) reported that residents exposed to noise above 55 dBA worried more about their health and gave poorer health ratings. Kroesen *et al.* (2008) found that annoyance induced by aircraft noise significantly increased concerns about negative health effects of noise. Similarly, interviewees of the present study expressed concerns about the negative effects of floor impact noise on their physical and mental health. The concerns included those about stress, mental problems, and physical health risks such as headaches or indigestion.

*P3: It (floor impact noise) can cause a great deal of stress ... I might have some health problems, such as, indigestion.*

*P4: If I were exposed to noise constantly, I believe I would have some mental problems.*

*P5: I believe floor impact noise is really bad for health ... noise at night, when we are supposed to sleep, will make us very tired.*

### **3.3.5 Intervening conditions**

Strauss and Corbin (1990) introduced the term ‘conditions’ as one of the basic components of a paradigm that could be developed in the axial coding phase to explain the relationships among the categories that emerge. Conditions provide further answers to questions about why, where, how, and what happens (Corbin and Strauss, 2008). The present study identified several conditions that had positive or negative intervening effects on the interviewees’ noise perception, coping, and health. They included attitudes to authorities and neighbours, noise sensitivity, past experience, and dwelling satisfaction.

#### **3.3.5.1 Attitude to authorities**

It was observed that negative attitudes to authorities had been developed because of unsuccessful complaints. Moreover, the attitude to authorities affected the individual’s noise perception and coping strategies. Some of the interviewees (P6 and P8) expressed their negative attitudes to governmental authorities due to the unpleasant procedure of making official complaints or after getting unsatisfactory results from the complaints. Guski (1999) previously suggested that the negative attitude of residents can be reduced by the authorities showing willingness to communicate and cooperate with the complainant. Another interviewee (P7) revealed her negative attitude to the government since there was lack of relevant policies, particularly with regard to floor impact noise. It was suggested that proper policies such as restrictions on indoor activities and higher standards of building construction are needed to deal with the increasing number of noise complaints.

*P6: I can't live with it (noise from upstairs) ... the centre (Floor Noise Management Centre) is no use, they didn't offer any proper solution ... I don't want to call them (the authorities including floor noise management centre) again.*

*P8: It (noise from upstairs) is more than annoying ... I've called the centre (Floor Noise Management Centre) but they said they had nothing to do, so I called the commission (National Environmental Dispute Resolution Commission) and they said I should call the centre (Floor Noise Management Centre, which I had already called). It was quite disappointing ... (since then,) I have just tried anything I could do by myself to stop them (upstairs neighbours) making noise.*

*P7: We need a restriction, for example, we don't and we won't throw litter anywhere because we know we would pay a fine for that if we do that ... some regulations should be made for this issue, that's why laws and policies exist ... I've contacted twelve (government) officials so far who work on legislation (to suggest legislation on the issue of floor impact sounds).*

Some interviewees expressed their negative attitudes to construction companies. They believed that poor sound insulation in buildings caused the noise problems and that construction companies were the responsible authority for this issue. Besides, acoustic comfort was expected in properties built by major construction companies.

*P2: ... we (my husband and I) just try not to hear it (noise from upstairs) ... I think construction companies have the biggest responsibility. Everyone makes noise in their daily lives ... that's why I don't want to complain (to my upstairs neighbours), it's one of reasons ... I think apartment buildings should be built to high standards of sound insulation ... I believe that buildings built by brand (major) companies would be better and quieter indoors.*

*P3: I haven't made any noise complaints to my neighbours ... I suppose they (buildings built by major companies) would be more trustworthy*

*... they (construction companies) should build better buildings which have fewer problems.*

Previous studies have reported that attitudes to authorities and policies affect noise annoyance (Guski, 1999; Laszlo *et al.*, 2012) and coping strategies (Stallen, 1999). Some recent studies have also confirmed the significant effects of attitude to authorities on annoyance and coping (Pedersen *et al.*, 2007; Kroesen *et al.*, 2008; Pennig and Schady, 2014). Negative attitudes to the government and policies were found to heighten the interviewee's negative perceptions of the noise and trigger the employment of different coping behaviours.

One interviewee (P8) increased the number of contacts with his upstairs neighbours after being disappointed by governmental authorities. He had been hitting the ceiling of his apartment to make retaliatory noise to his upstairs neighbours. Another interviewee (P6) also had experienced dissatisfactory procedures and results from making complaints to governmental authorities and reported that he did not want to contact the authorities anymore. He also reported that he wanted to move house. It implies that disappointment with governmental authorities may reduce the number of noise complaints made to them but increase the number of complaints to upstairs neighbours; also it can be discussed that negative attitudes to governmental authorities may increase the employment of avoidant coping behaviours.

It was also noteworthy that the interviewees who mainly regarded poor construction as the main reason for floor impact noise (P2 and P3) had made few noise complaints to both governmental organisations and their upstairs neighbours. It was found that those who had negative attitudes to construction companies had mostly employed avoidant coping behaviours or cognitive coping. It can thus be suggested that apartment dwellers adopt differing noise coping strategies depending on their attitude to the authorities.

#### 3.3.5.2 Attitude to neighbours

Attitudes to noise source have been suggested to significantly affect annoyance induced by environmental noise (Fields, 1993; Guski, 1999; Stallen, 1999; Kroesen *et al.*, 2008). The present study revealed that negative attitudes to neighbours had

been developed throughout the series of experiences following the noise exposure. In addition, the attitudes again affected the residents' coping strategies.

*P14: Lack of people's consideration is the biggest problem ... residents should be careful in their homes for their neighbours ... I used to go upstairs or ring them to ask them to be careful and be quiet, but I gave up. I've already complained so many times but they never listened, they're exactly the same as before.*

This study also observed that having relationship problems with upstairs neighbours was a critical part causing the negative attitude to neighbours. Relationship problems were found to be caused sometimes by the adopted vigilant coping strategies. Some of the interviewees reported that they developed relationship problems with their upstairs neighbours after making noise complaints to them. Their complaints caused their neighbours to make more noise, namely, retaliatory noise. It can therefore be said that relationship problems between neighbours might change the characteristic of the noise source into retaliatory noise, which was noted in Table 3-3 as being one of the three themes of noise exposure. The exposure to retaliatory noise increased annoyance of the interviewees and prompted further complaints. Further health issues were also reported. The more frequent health complaints can be explained by not only noise annoyance, but also the stress caused by the relationship problems, including exposure to retaliatory noise.

*P7: I went upstairs (to complain about the noise) ... since then, we (my husband and I) could feel they (upstairs neighbours) intended to make the noise, to bother us ... we couldn't sleep every night ... my husband shot a video at the opposite building. When I watched his video, I was so shocked. They bounced a basketball, rolled a dumbbell, walked in high heels, and scraped a table and chairs ... they are crazy ... their personality is the biggest problem ... I've done everything, I sent the video to the broadcasting centre, reported them to the police ... I've lost too much weight, the whites (of my eyes) had become red for several weeks.*

This study also identified a very different kind of attitudes towards neighbours. One interviewee (P13) reported that he had never complained about noise to his neighbours and did not intend to do so in the future. This was because he had received noise complaints from his downstairs neighbours and knew how receiving complaints felt and how difficult it was to keep the children quiet. Although Maschke and Niemann (2007) proposed that annoyance caused by noise of neighbours could be heightened by the hearer's knowledge of the noisemaker, the present study observed that having empathy with upstairs neighbours may decrease the level of annoyance as well as the frequency of noise complaints.

Typically, few opportunities exist for residents to get to know their neighbours in the same apartment block. It is suggested that opportunities for promoting closeness between neighbours would reduce neighbour disputes in apartment buildings. It might be also worthwhile to explore how positive relationships between neighbours can mitigate not only negative noise perceptions but also vigilant coping behaviours which may result in causing worse situations.

*P13: They (upstairs neighbours) make noise until late but I'm trying to be sympathetic ... I haven't complained about it (the noise) and I won't, because I know how it feels (to receive noise complaints) ... people downstairs have complained several times asking us to keep our children quiet ... I know it's very hard to control them (children), particularly, it's very difficult to make them not make noise.*

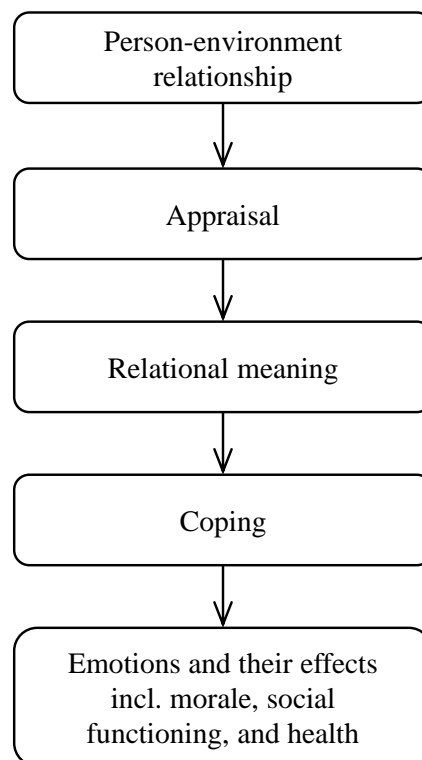
Lazarus (2006) presented a revised model explaining stress and coping (Figure 3-4). It is not much different from his original transactional stress model (Lazarus, 1966) which several studies have adopted (van Kamp, 1990; Lercher, 1996; Guski, 1999; Stallen, 1999; Pennig and Schady, 2014). In this model, appraisal of stress is first influenced by the person-environment relationship. 'Person' represents one's goals, beliefs about self and the world, and personal resources. 'Environment' represents harms, threats, challenges, and benefits. According to the model (Figure 3-4), coping is suggested to be employed based on one's appraisals and relational meaning; positive or negative emotions and their effects including social functioning and health are finally affected by this process.

***Antecedents*****Person:**

- Goals and goal hierarchies
- Beliefs about self and world
- Personal resources

**Environment:**

- Harms / losses
- Threats
- Challenges
- Benefits



**Figure 3-4. Lazarus' revised model of stress and coping (2006)**

This model (Figure 3-4) can be adopted to explain attitudes to neighbours. First, the association between an individual who has his/her own attitudes to neighbours (i.e., person) and exposure to floor impact sounds (i.e., environment) is regarded as the person-environment relationship. Noise annoyance and disturbance are perceived after being exposed to the noise (i.e., appraisal) and different coping strategies are employed based on one's attitude to neighbours (i.e., relational meaning). Vigilant coping is likely to be used when the individual has a negative attitude to his/her upstairs neighbours or relationship problems with them, whereas avoidant coping strategies may be used when the individual has an empathy with his/her upstairs neighbours. Use of vigilant coping might cause some retaliatory noise to be made by the upstairs neighbours or increase negative emotions and health risks.

### 3.3.5.3 Noise sensitivity

Noise sensitivity has been noted as a significant indicator of annoyance caused by environmental noise (Fields, 1993; Guski, 1999; Paunović *et al.*, 2009). Likewise, annoyance induced by floor impact noise was found to be affected by noise

sensitivity (Ryu and Jeon, 2011). The present study confirmed the close link between noise sensitivity and noise perception. Interviewees who were more sensitive to noise reported more annoyance and disturbance caused by floor impact noise. Noise sensitivity has actually been acknowledged as a stable personality trait that includes different attitudes towards a wide range of environmental sounds (Zimmer and Ellermeier, 1999). The present study expanded this notion, suggesting that an individual's noise sensitivity can be heightened by circumstances such as repeated exposure to noise or changes of situation; it is also suggested that noise sensitivity might be heightened because of other noise-sensitive family members.

*P9: Before I moved in, I wasn't sensitive (to noise) at all, but after experiencing this (exposure to floor impact noise) for a long time, I became very sensitive to it.*

*P4: After my baby was born, I definitely became sensitive ... I wasn't that sensitive before.*

*P5: Actually, my husband is so sensitive to noise and I became sensitive as well.*

#### 3.3.5.4 Past experience

Rabkin and Struening (1976) noted past experience as a factor that contributes to one's perception of stressful events. Ipsen (2002) also highlighted the importance of the knowledge that an individual gains through life, and Fyhri and Klæboe (2006) suggested that careful attention should be given to people who had been previously affected by noise. It was obvious from the present study that previous exposure to floor impact noise affected one's noise perception. Interviewees who had exposed floor impact noise in their previous apartments or from their previous upstairs neighbours reported that they had become more sensitive to noise and got more annoyed with the noise. Past experience includes most of the key themes that were discovered in the present study, such as annoyance, disturbance, coping, and health effects. Thus, there is no doubt that people with past noise experiences are more likely to have negative noise perceptions and employ more coping strategies.



*P8: Their (current upstairs neighbours') noise is very similar to that of the previous ones (upstairs neighbours) ... I once thought they (current and previous upstairs neighbours) were families. Their footsteps sound really similar, very noisy ... I had no idea about floor impact noise before they (the previous upstairs neighbours) moved in, but had become more and more sensitive (to noise).*

*P14: We (my husband and I) suffered so much (from noise problems) in the previous building. That (noise problem in the previous apartment) was one of the biggest reasons that we moved house ... it is worse over here ... I suppose we became more sensitive than before.*

### 3.3.5.5 Dwelling satisfaction

Noise annoyance is closely related to the perceived well-being of an individual, and it has been suggested that reduced noise annoyance could improve overall satisfaction with one's residential area (Öhrström, 2004). In addition, Jeon *et al.* (2010b) addressed the strong correlation between dissatisfaction with a noisy indoor environment and annoyance caused by floor impact noise. The present study showed that continuous exposure to noise and perceiving noise annoyance and disturbance, coupled with unsatisfactory procedures or outcomes of the adopted coping strategies, affected satisfaction with one's dwelling. It was also noteworthy that several interviewees expressed their wish to move house along with noise annoyance.

*P3: The biggest thing I'm not satisfied with in my apartment is the noise ... it's the biggest issue ... I want to move to the top floor apartment (not to hear any noise coming from upstairs).*

*P9: I like everything about my home, except the noise.*

The narratives of interviewees who were highly satisfied with their dwelling contained more words and expressions of high noise annoyance and negative emotions towards their neighbours and relevant authorities. It was also observed that they had used more coping behaviours than the other interviewees. It implies that dwelling satisfaction has effects on one's noise perception and coping behaviours.

The excerpt below is from the transcript of an interviewee (P8) who had contacted governmental authorities and his upstairs neighbours several times to make noise complaints, and who had been hitting the ceiling of his apartment to make retaliatory noise to his upstairs neighbours.

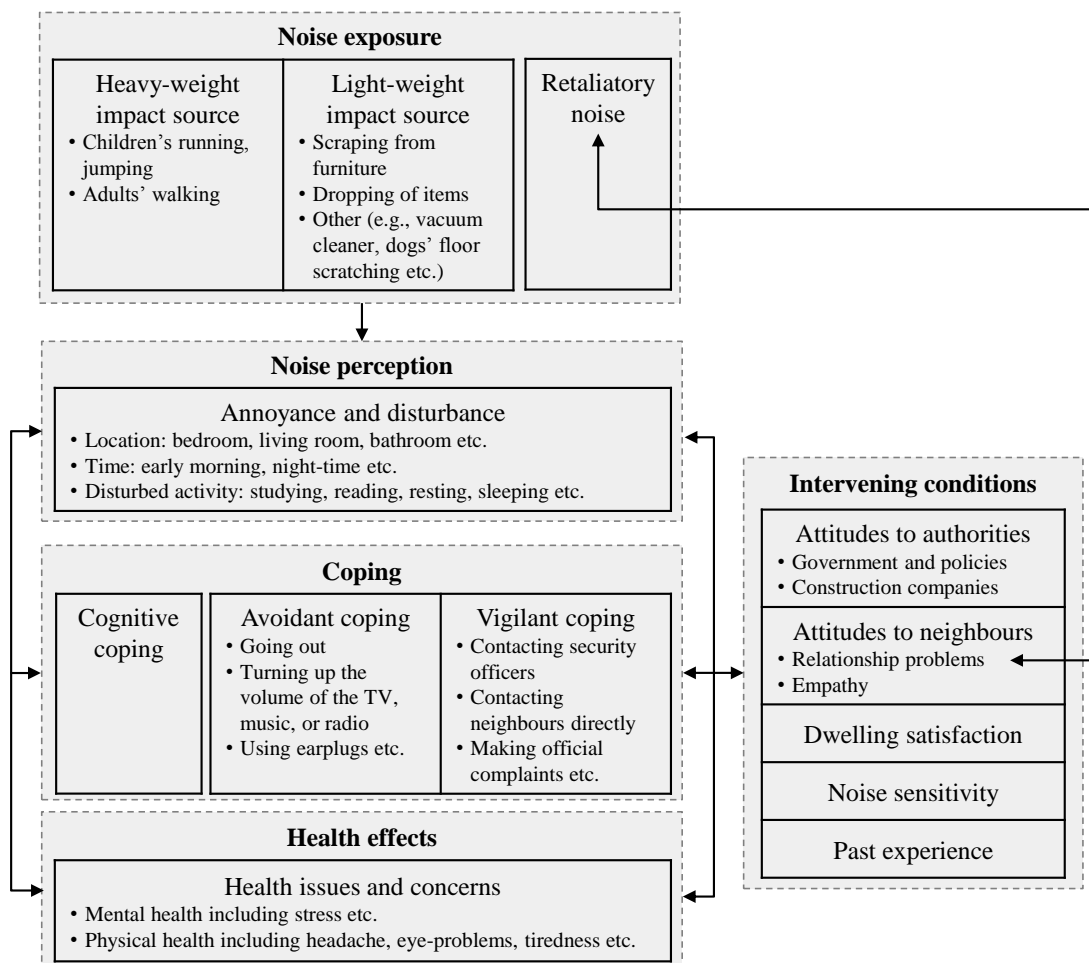
*P8: It (my apartment) is located in a great place, close to the mountains, fresh air, it's very quiet outside ... I don't want to move (house) ... as I said earlier, I'm very happy with it (my apartment), except the noise from the current upstairs neighbours.*

### **3.4 Summary and concluding remarks**

This qualitative study was designed utilising a research method of grounded theory. Semi-structured interviews of apartment building residents were conducted and the narratives of the interviewees were analysed by constant comparative procedures and major coding phases of grounded theory (Corbin and Strauss, 2008). Key themes were identified and those closely related to each other were grouped together in higher-order categories. A conceptual model was developed based on the identified categories. The findings of this study yielded valuable insights into perceptions and reactions to floor impact noise and enabled description of the relationships among the non-acoustic factors. The conceptual model illustrated in this study also supported previous conceptual models that explained perceptions and reactions to environmental noise (Lercher, 1996; Guski, 1999; Stallen, 1999).

Figure 3-5 represents the findings of the qualitative study and it illustrates the key themes, categories, and their relationships. Floor impact noise sources in apartment buildings were classified into heavy-weight and light-weight impact sources, and footsteps were the source that the interviewees had most frequently encountered. Most of the interviewees reported night-time and morning noises, which disturbed their sleep. Avoidant coping strategies (e.g., going out or turning up the volume of the TV or music) were the most common coping behaviours that the majority of interviewees had employed; it was also more likely to be used at the beginning of the noise exposure. Vigilant coping strategies (e.g., making noise complaints to the upstairs neighbours or to relevant authorities) were particularly

found to be adopted when the noise problem could not be effectively solved by avoidant coping strategies.



**Figure 3-5. A model summarising the findings of the qualitative study**

Each individual's attitudes to relevant authorities and upstairs neighbours (i.e., noise source) evolved throughout the exposure to the noise. Residents who had negative attitudes to governmental authorities were observed to stop making complaints to the governmental authorities; they kept making complaints directly to their upstairs neighbours or tended to use avoidant coping. Another type of authority to which the interviewees reported their negative attitudes was construction companies. It was found that those who had negative attitudes to construction companies were more likely to use cognitive or avoidant coping strategies rather than using vigilant coping. Besides, negative attitude to neighbours was also worth noting. Retaliatory noise was found to be one option for people who had relationship problems with their neighbours. Having negative attitudes to neighbours or

relationship problems with them triggered the residents to use vigilant coping behaviours. However, those who had empathy with their upstairs neighbours were reluctant to use vigilant coping; they used more cognitive or avoidant coping strategies. Here, it was proposed that positive attitude to neighbours may decrease the level or frequency of vigilant coping but increase that of avoidant coping.

Noise sensitivity, past experience, and dwelling satisfaction were also suggested to affect one's noise perceptions and coping behaviours. In particular, noise sensitivity was observed to be heightened by repeated exposure to noise, changes of situation, and the presence of other noise-sensitive family members. Furthermore, residents who had past experience of exposure to floor impact sounds and those who were highly satisfied with their dwellings reported relatively stronger negative perceptions of the noise issue and had made more noise complaints.

The previously developed theoretical models of environmental noise (Guski, 1999; Stallen, 1999) were recently validated through empirical studies about airplane and railway noise (Kroesen et al., 2008; Pennig and Schady, 2014). Similar approach was required to test the key non-acoustic variables and the conceptual model for floor impact noise. Therefore, in the following study, social survey was designed to confirm the findings of the qualitative study using empirical data.

## **4 Quantitative study**

### **4.1 Introduction**

While a method of qualitative research is suitable to explore meanings of individuals' behaviours and underlying attitudes and emotions, quantitative research is of use to measure the prevalence of their behaviours and attitudes, and identify the hypothesised paths among variables. In order to test and extend the findings from the qualitative study (e.g., key themes and their relationships), a path model was first hypothesised and a survey questionnaire was developed based on the suggestions made by the qualitative study and previous studies on environmental noise. Survey responses were collected from a large sample of residents in apartment buildings. The data was analysed using structural equation modelling in order to assess multiple relationships among several variables in the model.

### **4.2 Hypotheses**

To test a path model, each path was hypothesised based on previous theoretical and empirical studies. A number of studies have confirmed that noise sensitivity is one of key indicators to account for subjective reactions to noise (Job, 1988; Nivison and Endresen, 1993; Lercher and Kofler, 1996; van Kamp *et al.*, 2004; Paunović *et al.*, 2009; Fyhri and Aasvang, 2010). Therefore, it was assumed that noise sensitivity would have a positive direct impact on perceived disturbance and a positive indirect impact on noise annoyance (H1).

Stallen (1999) developed a theoretical framework for environment noise annoyance based on a psychological stress theory (Lazarus, 1966) and referred to perceived threat, namely, perceived disturbance as primary appraisal which was a major determinant of noise annoyance. This is in line with the suggestion made by Guski (1999) insisting that actual interferences affect one's reported annoyance. The relationship between perceived disturbance and noise annoyance was later empirically tested in an aircraft noise study (Kroesen *et al.*, 2008). Kroesen *et al.* tested a structural equation model regarding aircraft noise annoyance and found that perceived disturbance had a positive impact on annoyance. The present study also

hypothesised a positive impact of disturbance on annoyance caused by floor impact sound (H2).

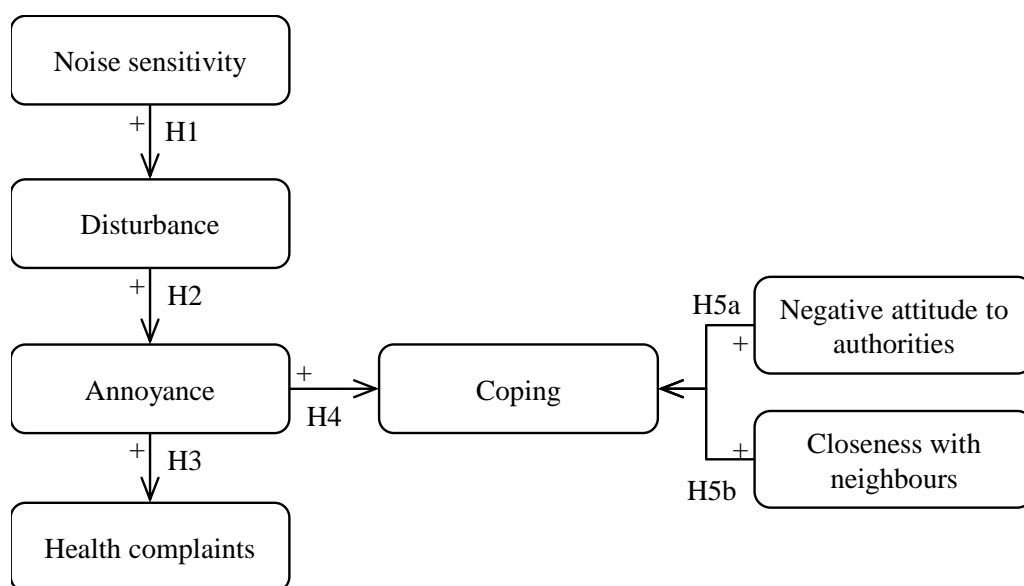
Noise exposure has been found to lead to physical and mental problems (Lercher, 1996; Guski, 1999; Bluyssen *et al.*, 2011). The relationship between noise annoyance and health has also been confirmed in empirical studies (Pedersen and Waye, 2007; Fyhri and Klæboe, 2009; Bakker *et al.*, 2012; Babisch *et al.*, 2013). Road traffic noise annoyance was found to be associated with subjective health complaints such as sleep disturbance, nervousness, and headache (Fyhri and Klæboe, 2009). Recent questionnaire surveys also reported significant impacts of wind turbine noise annoyance on self-reported health complaints and psychological distress (Pedersen and Waye, 2007; Bakker *et al.*, 2012). The present study assumed that annoyance induced by floor impact sounds would be positively associated with health complaints (H3).

It has been highlighted that coping has a close link with noise annoyance (Lercher, 1996; Guski, 1999; Stallen, 1999; Hatfield *et al.*, 2002; Haines *et al.*, 2003). Stallen (1999) suggested perceived control and coping as major determinants of annoyance. Haines *et al.* (2003) reported various coping strategies that children used when they were exposed to environmental noises. Recent empirical studies on aircraft and railway noise validated the relationship between noise annoyance and coping; it was found that annoyance positively affect individuals' coping capacity (Kroesen *et al.*, 2008; Pennig and Schady, 2014). The prior qualitative study found that residents in apartment buildings used avoidant coping behaviours the most. Focusing on avoidant coping strategies, the present study hypothesised that avoidant coping would be positively affected by annoyance (H4).

Attitudinal variables have been highlighted to explain the subjective reactions to noise (Fields, 1993; Lercher, 1996; Guski, 1999; Stallen, 1999; Elmenhorst *et al.*, 2012). Fields (1993) addressed that attitudes to authorities and noise source may affect one's subjective reactions to noise. Guski (1999) also stated that people who were aware of the importance and necessity of noise source showed low noise annoyance, and Pedersen *et al.* (2009) found that residents reported relatively low level of annoyance when they benefited economically from wind farms as owners or co-owners of wind turbines. Stallen (1999) highlighted the relationship between attitudes and coping and it was later supported by the empirical studies also confirmed that attitudes to authorities and noise source significantly affected one's

coping (Kroesen *et al.*, 2008; Pennig and Schady, 2014). The findings from the prior qualitative study also noted the relationship between attitudes and coping. In particular, it proposed that negative attitude to authorities and positive attitude to neighbours (i.e., noise source) may affect individuals to employ more avoidant coping instead of vigilant coping (e.g., making noise complaints). Therefore, this study hypothesised that negative attitude to authorities and closeness with neighbours (i.e., positive attitude to noise source) would affect avoidant coping positively (H5a, H5b).

The proposed hypotheses were then developed as a conceptual model which explains the relationships between the non-acoustic factors and noise annoyance caused by floor impact sound. As shown in Figure 4-1, the relationships among the seven endogenous factors consisting of noise sensitivity, disturbance, annoyance, health complaints, coping, negative attitude to authorities, and closeness with neighbours were to be tested.



**Figure 4-1. A hypothesised conceptual model**

Two of previous empirical studies on environmental noises tested reciprocal relationships between specific variables. Kroesen *et al.* (2008) tested two reciprocal relationships between ‘disturbance – annoyance’ and ‘annoyance – coping’, and Pennig and Schady (2014) tested that between ‘annoyance – coping’. Nonetheless, unbiased estimates of reciprocal effects between two variables can be obtained when both variables have at least one instrumental variable, for the estimation of the

reciprocal relationship requires estimating the error covariance between instrumental variables (Smith-Lovin and Tickamyer, 1978; Wong and Law, 1999). Since disturbance included in the conceptual model of present study had only one instrumental variable and the two other variables (annoyance and coping) had none, a decision was made to hypothesise one direction for each path instead of reciprocal relationships in order to yield the appropriate and accurate estimates for understanding impacts of each variable on another.

### 4.3 Methods

#### 4.3.1 Participants

Both online and paper surveys were developed; the online survey was designed using Google forms. Using the method of online survey questionnaire allows researchers to recruit a large sample, and its reliability has been validated in comparison to paper methods (Gosling *et al.*, 2004; Ekman *et al.*, 2006). Participants of the present study were asked to respond to either method which their preferred, and the majority selected the online survey. The surveys were conducted in Korea in October and November 2014, and 569 questionnaires (547 online and 22 on paper) were completed and collected from around the country. Of the 569 completed questionnaires, 82 were excluded since they involved duplicate data or outliers, or were completed by participants with no experience of hearing floor impact sound (Table 4-1).

**Table 4-1. Number of the collected, excluded, and analysed survey responses**

	Collected	Excluded			Analysed
		Duplicate	Outliers	No experience	
Online	547	42	5	33	467
Paper	22	0	0	2	20
SUM	569		82		487

As listed in Table 4-2, 66.9% of the respondents were female and 33.1% were male. Most participants (77.8%) were in their 20s, 30s, or 40s, and approximately 70% were educated to university degree level or higher. In addition, almost half of the participants were married (54.8%) and almost half of them were homeowners

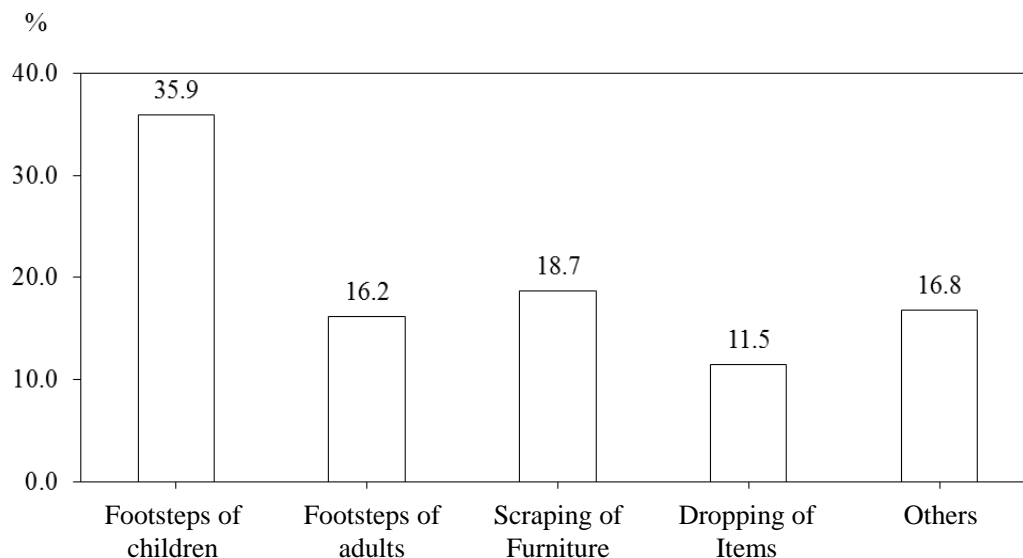


(54.2%). Age of the apartment buildings in which the participants lived were asked using five different options (less than 5 years, 5 to 10 years, 10 to 15 years, 15 to 20 years, and more than 20 years) and the number of participants were evenly distributed in each building age option.

**Table 4-2. Demographic characteristics of the survey respondents (N = 487)**

Demographic characteristic	Details	N	%
Gender	Male	161	33.1
	Female	326	66.9
Age	Teens	42	8.6
	20s	134	27.5
	30s	145	29.8
	40s	100	20.5
	50s	45	9.2
	60s or older	21	4.3
Education	High school or equivalent	93	19.1
	Studying at a university or college	52	10.7
	University or college graduate	272	55.9
	Postgraduate or above	70	14.4
Marital status	Married	267	54.8
	Single	211	43.3
	Divorced, widowed, etc.	9	1.8
Home-ownership	Owned	264	54.2
	Rented (deposit rent)	174	35.7
	Rented (monthly rent)	44	9.0
	Other	5	1.0
Building age (years)	< 5	95	19.5
	5–10	109	22.4
	10–15	103	21.1
	15–20	92	18.9
	> 20	88	18.1

As Figure 4-2 presents, 52.1 percent of the participants reported the major noise source they had encountered was footsteps of children and adults. Noise caused by scraping of furniture and dropping of items accounted for 18.7 and 11.5 respectively. Of 16.8 percent who selected others, some indicated that they had been exposed to all of the noises (footsteps, scraping of furniture, and dropping of items) and some mentioned scraping of a vacuum cleaner or scratching of the floor by dogs.



**Figure 4-2. Major noise sources to which the participants had been exposed**

### 4.3.2 Questionnaire development

The questionnaire consisted of questions about participants' demographic characteristics, perceptions of floor impact sounds (e.g., annoyance), and attitudinal factors (e.g., closeness with upstairs neighbours). As listed in Table 4-3, latent variables in the hypothesised conceptual model (Figure 4-1) were assessed by several observed variables, and all of them were evaluated using 5-point scales ranging from 1 ("Not at all") to 5 ("Extremely").

#### 4.3.2.1 Annoyance and disturbance

Two questions were used to measure annoyance: one concerning perceived annoyance and the other pertaining to changes in annoyance compared to that experienced a year earlier. The second question of noise annoyance was developed based on the earlier suggestion that adaptability could influence noise annoyance (Lercher, 1996). Measurement items for disturbance were determined according to previous studies (Griffith and Langdon, 1968; NASA, 1978; Fidell *et al.*, 2002; Öhrström, 2004; Kroesen *et al.*, 2008). Fidell *et al.* (2002) used two items to determine whether aircraft noise had disturbed participants' sleep or interfered with conversation or listening to the radio. Öhrström (2004) measured indoor disturbances

caused by road traffic noise and considered conversation, radio or TV, concentration, rest or relaxation, difficulties in falling asleep, and being woken by noise. Kroesen *et al.* (2008) also assessed perceived disturbance caused by aircraft noise and considered five activities including sleep, conversation, and resting. The present study asked the respondents to rate the extent to which they had been disturbed by noise with respect to five different types of activity: sleeping, watching TV or listening to the radio or music, having conversations, quiet activities, and resting.

**Table 4-3. Overview of latent variables, observed variables, and question items**

Latent variable	Label	Item of the observed variable
Annoyance	A1	Noise annoyance caused by floor impact sounds
	A2	Noise annoyance caused by floor impact sounds compared with 1 years ago
Disturbance	D1	Sleeping
	D2	Watching TV, listening to the radio or music
	D3	Having conversations (incl. on the phone)
	D4	Reading, studying, and other quiet activities
	D5	Resting
Coping	C1	Going out
	C2	Turning up the volume of the TV or music
	C3	Trying to concentrate on other activities
Health complaints	H1	Headache or dizziness
	H2	Stomach-ache or indigestion
	H3	Tiredness or sense of fatigue
Noise sensitivity	NS	General sensitivity to noise
Negative attitude to authorities	AT1	The government and policies
	AT2	Construction companies
Closeness with upstairs neighbours	R1	General closeness
	R2	Sharing gifts or food
	R3	Visiting or inviting

#### 4.3.2.2 Coping

Hatfield *et al.* (2002) used a single-item question to assess perceived control; they asked participants how much personal control they felt when they heard aircraft noise. Kroesen *et al.* (2008) measured coping capacity using three questionnaire items (e.g., feeling of powerlessness). Earlier, Folkman and Lazarus (1988) identified avoidant coping as the most common coping strategy. In other words, it is prone to

concentrate on something else or increase the volume of music when people are exposed to noise (Haines *et al.*, 2003) rather than directing attention to the problem to prevent or control it (Folkman and Lazarus, 1988). Through the prior qualitative study, most residents in apartment buildings reported behavioural coping strategies more frequently than cognitive coping. Moreover, avoidant coping was found to be the most frequently used coping behaviours. The interviewees in the qualitative study reported that they had gone out or tried to concentrate on other activities when they had heard noises from upstairs. Based on the previous findings, three avoidant coping behaviours were measured in this study: going out, increasing the volume of the TV or music, and concentrating on other activities.

#### 4.3.2.3 Health complaints

Negative health effects have been acknowledged as one of the common noise effects (Nivison and Endresen, 1993; Guski, 1999; Fyhri and Klæboe, 2009) and some question items were suggested in order to measure health effects such as tiredness and headaches (NASA, 1978). Fyhri and Klæboe (2009) asked participants to answer about their physical symptoms including tiredness and headaches arising from road traffic noise. Moreover, Bakker *et al.* (2012) assessed the relationship between psychological distress and wind turbine noise using a health questionnaire. To evaluate subjective health complaints affected by floor impact noise, the survey questionnaire included three questions about physical symptoms (headache, stomach ache, and tiredness) which were found to be the common health complaints among the interviewees of the prior qualitative study.

#### 4.3.2.4 Attitudinal variables

In their aircraft noise annoyance study, Kroesen *et al.* (2008) measured attitudes to authorities by asking respondents about their attitudes to the airport (Schiphol) and the government. Likewise, Pennig and Schady (2014) also assessed participants' general attitudes to responsible authorities and institutions of railway. The government and construction companies were frequently reported as responsible authorities for the floor impact noise issue in the qualitative study; the interviewees argued that lack of policy on the noise issue and poor sound insulation performance

caused the floor impact noise problems. Attitudes to government and policy and attitudes to construction companies were separately asked to the participants. In terms of measurement of attitudes to noise source, Fields (1993) noted fear of danger from the noise source and beliefs about the importance of the noise source. Pedersen and Waye (2007) asked participants whether they held negative or positive attitudes toward wind turbines. Kroesen *et al.* (2008) measured negative attitudes to noise source by asking participants to rate the extent to which they agreed with several statements regarding personal beliefs and attitudes toward the noise source. In this study, individuals' relationships with their neighbours were measured to assess their attitudes to noise source since the occurrence of floor impact sounds depends on neighbours' activities and living patterns. Three questions were used in order to assess participants' closeness with neighbours. The first question aimed to assess overall closeness with their upstairs neighbours. The other two items asked how often they had shared gifts or food with their upstairs neighbours and how frequently they had visited or invited their upstairs neighbours. The latter two questions were developed based upon the assumption that these behaviours would reflect people's closeness with their upstairs neighbours as they are common behavioural patterns between close neighbours.

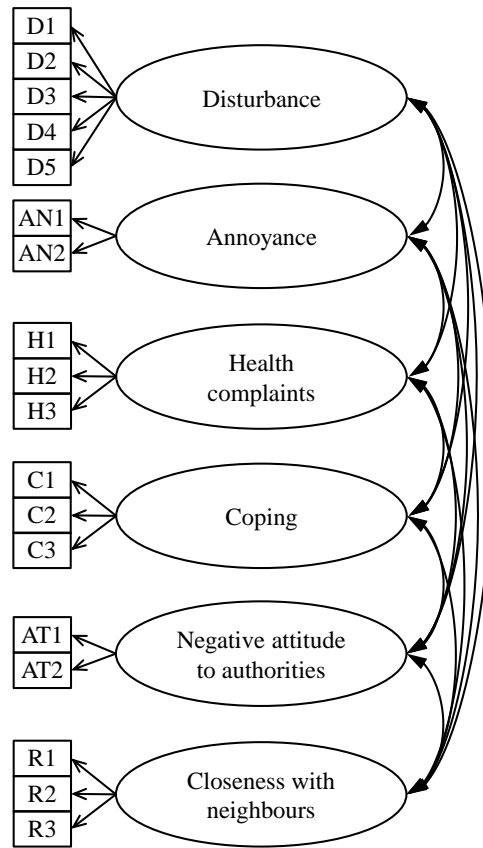
#### **4.3.3 Statistical analysis: Structural equation modelling**

The hypothesised conceptual model was tested employing an approach of structural equation modelling (SEM). Before moving on to present how the analysis was carried out and what was found, it is imperative to account for SEM briefly. SEM is a statistical approach that seeks to explain the relationships among several variables. It examines the structure of interrelationships in a series of equations, similar to a series of multiple regression equations (Hair *et al.*, 2010). These equations simultaneously depict all of the relationships among the dependent and independent variables. Latent variables are represented by multiple observed variables. This technique is useful since the researcher can test relationships among latent variables which cannot be directly measured. Also the relationships among the variables can be tested at once so that the researcher can estimate causal effects, direct, and indirect effects in a single model. It also tests error variables; every observed variable is associated with an error variable and these errors are estimated

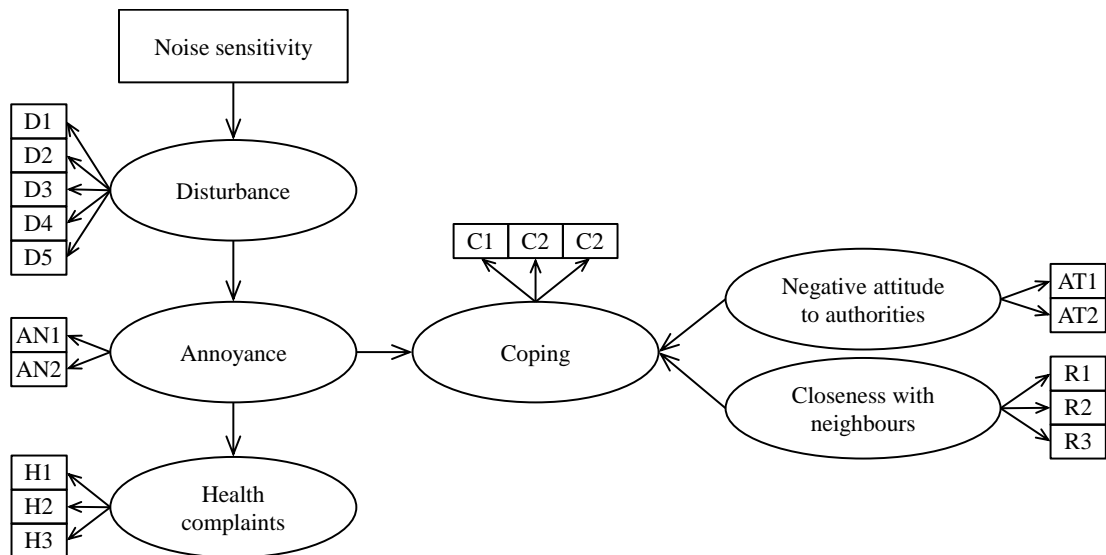
at the same time. SEM is distinguished by its three characteristics: 1) estimation of multiple and interrelated dependence relationships, 2) an ability to represent unobserved concepts in these relationships and account for measurement error in the estimation process, and 3) defining a model to explain the entire set of relationships (Hair *et al.*, 2010).

It should be noted that SEM is a technique for a large sample and more than 200 samples are needed in general (Barrett, 2007; Kline, 2011). It was earlier suggested the ratio of an ideal sample size to the number of free parameters would be 20:1 (Tanaka, 1987). For example, minimum 200 samples are needed if 10 parameters require statistical estimates in a model (Jackson, 2003). However, Bentler and Chou (1987) suggested another ratio of 5:1 since 20:1 that Tanaka (1987) proposed was unrealistically high. The number of parameters in the hypothesised model in this study was 24 and the number of samples which were finally used in the analysis was 487, so that the sample size of the present study actually satisfied even the higher ratio (20:1).

As Figure 4-3 presents, the validity and reliability of each set of scales were first assessed by confirmatory factor analysis (CFA). CFA is useful for testing previously developed theoretical hypotheses (Rogelberg, 2006). It is a requirement of SEM to examine whether each latent variable is indicated by appropriate indicators, namely, observed variables (Cavanagh and Romanoski, 2008). It also tests if the latent variables can be tested in a single path model. Next, Figure 4-4 illustrates the path model. The latent variables (e.g., Disturbance) were represented by the observed variables (e.g., D1, D2) which were validated in CFA, and each latent variable was linked to another latent variable based on each hypothesis. Both CFA and path analysis were tested using AMOS 22.0 (SPSS Inc., Chicago, IL) and Cronbach's alphas of each scale item was separately calculated in SPSS 21.0 (SPSS Inc., Chicago, IL).



**Figure 4-3. A model for confirmatory factor analysis (CFA)**



**Figure 4-4. A model for path analysis**

## 4.4 Results

### 4.4.1 Reliability and validity

Results from the factor analysis (CFA) are summarised in Table 4-4. Convergent validity was assessed via factor loadings of each observed variable and average variance extracted (AVE), and reliability was examined via composite reliability (CR, otherwise known as construct reliability) and Cronbach's alpha. AVE is a summary measure of convergence among a set of items representing a latent variable (Hair *et al.*, 2010). AVE is calculated as the total of all squared standardised factor loadings ( $L_i$ ) divided by the number of items:

$$AVE = \frac{\sum_{i=1}^n L_i^2}{n} \quad (1)$$

CR is for assessing reliability and internal consistency of the measured variables representing a latent construct (Hair *et al.*, 2010). It is computed from the squared sum of factor loadings ( $L_i$ ) for each construct and the sum of the error variance terms for a construct ( $e_i$ ):

$$CR = \frac{(\sum_{i=1}^n L_i)^2}{(\sum_{i=1}^n L_i)^2 + (\sum_{i=1}^n e_i)} \quad (2)$$

Factor loadings were statistically significant ( $p < 0.001$ ) and greater than 0.6. The AVE ranged from 0.518 to 0.751 and the CR ranged from 0.731 to 0.909 and the Cronbach's alphas ranged from 0.690 to 0.912. All values representing both convergent validity and reliability were found to be in acceptable ranges (Hair *et al.*, 2010). To assess the degree to which a latent variable is distinct from other latent variables, discriminant validity was also examined. If the AVE for each construct is greater than its shared variance with any other construct, discriminant validity is supported (Fornell and Larcker, 1981; Farrell, 2010; Götz *et al.*, 2010). Average shared variance (ASV) can be computed as the total of squared shared variances divided by the number shared variances. As Table 4-4 presents, ASV of each construct was lower than its AVE value and thus, a good discriminant validity was proven (Fornell and Larcker, 1981). Therefore, the CFA results confirmed that internal consistency exists and the variables are reliable and have good construct validity.



**Table 4-4. Results of confirmatory factor analysis**

RMSEA = 0.050; GFI = 0.942; CFI = 0.976;  $\chi^2/df = 2.221$

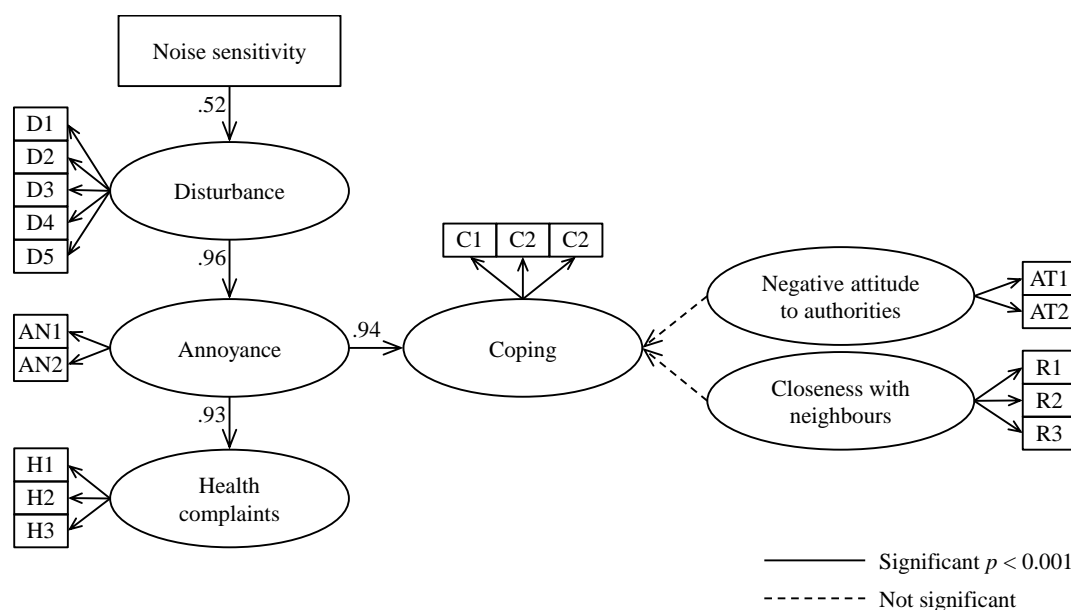
Observed variable	Factor loading $p < 0.001$	AVE	CR	Cronbach's alpha	ASV
AN1	0.960	0.751	0.856	0.843	0.315
AN2	0.762				
D1	0.794	0.666	0.909	0.912	0.447
D2	0.830				
D3	0.741				
D4	0.852				
D5	0.859				
H1	0.840	0.729	0.889	0.904	0.443
H2	0.790				
H3	0.926				
C1	0.686	0.518	0.762	0.756	0.433
C2	0.790				
C3	0.677				
AT1	0.919	0.588	0.731	0.690	0.120
AT2	0.576				
R1	0.689	0.678	0.861	0.839	0.005
R2	0.959				
R3	0.799				

#### 4.4.2 Results from the path analysis

The structural model was tested using maximum likelihood estimation. In order to measure validity of the path model itself, some significant fit indices require to be noticed. As researchers have argued different cut-off values for each fit index, some of the values are listed in Appendix 5. First, goodness-of-fit index (GFI) is widely used fit index to measure the model fit and the higher value which is close to 1 indicates the better fit. GFI of the path model estimated in this study was 0.932 indicating a good fitting model. However, GFI is known as an early attempt to produce a fit statistic which is less sensitive to sample size so that is suggested to be used as only guidance (Marsh and Jackson, 1999; Hair *et al.*, 2010). Alternatively, adjusted root mean square error of approximation (RMSEA) also represents how well a model fits a population. Lower RMSEA values indicate better fit and it was suggested to be lower than 0.07 or 0.08 to be referred to as a good RMSEA (Hair *et al.*, 2010; Arbuckle, 2013). RMSEA of the tested model was 0.055 which was lower

than the cut-off value indicating the model fit well. Next, normed Chi-square ( $\chi^2/df$ ) is a ratio of Chi-square to the degrees of freedom for the model which also shows how well the model fits. There have been some debates over the acceptable range of this measure but the estimated  $\chi^2/df$  value of the tested path model was 2.479, which was within the acceptable range that has been proposed (Carmines and McIver, 1981; Marsh and Hocevar, 1985; Hair et al., 2010). The last fit index is comparative fit index (CFI) which compares the fit of a tested model to that of an independent model (otherwise, known as a null model) which is a model in which observed variables are uncorrelated. CFI above 0.9 are generally associated with a model that fits well (Hair et al., 2010; Arbuckle, 2013). CFI of the model estimated in this study was 0.967. On the whole, the fit indices suggested that the path model was a good fitting model.

The standardised estimates of the path analysis were plotted in Figure 4-5 and some indirect effects were listed in Table 4-5. It was found that noise sensitivity had a positive direct impact on disturbance ( $\beta = 0.518, p < 0.001$ ) indicating those who were sensitive to noise were more easily disturbed by floor impact sounds. Noise sensitivity also influenced annoyance indirectly via disturbance ( $\beta = 0.496, p < 0.001$ ). In addition, noise sensitivity had indirect effects on health complaints ( $\beta = 0.460, p < 0.001$ ) and coping ( $\beta = 0.468, p < 0.001$ ) via disturbance and annoyance. Disturbance had a positive direct effect on noise annoyance ( $\beta = 0.959, p < 0.001$ ) and it had indirect effects on health complaints and coping, 0.888 and 0.905 respectively ( $p < 0.001$ ). These findings suggest that more frequent disturbance increases not only noise annoyance but also subjective health complaints and coping. Noise annoyance positively affected coping ( $\beta = 0.944, p < 0.001$ ) and health complaints ( $\beta = 0.927, p < 0.001$ ). Therefore, the findings suggest that increased noise annoyance may lead people to employ avoidant coping behaviours more frequently and to report more health complaints. In addition, mean differences compared between those who reported low noise annoyance and high noise annoyance also confirmed the findings. People who responded that they were highly annoyed with floor impact sounds reported more coping behaviours and health complaints than those who reported low noise annoyance (Table A-2 and A-3 in Appendix 6). On the other hand, the path analysis found no significant impact of the two attitudinal variables (negative attitude to authorities, closeness with neighbours) on coping.



**Figure 4-5. Results of the path analysis**

**Table 4-5. Indirect effects of noise sensitivity and disturbance on annoyance, health complaints, and coping**

	Noise sensitivity	Disturbance
Annoyance	0.50**	
Health complaints	0.46**	0.89**
Coping	0.47**	0.91**

\*\* $p < 0.001$ , \* $p < 0.05$

## 4.5 Discussions

### 4.5.1 Comparison with previous studies

Previously suggested conceptual models have focused on environmental noise and subjective reactions to it (Guski, 1999; Stallen, 1999; Kroesen *et al.*, 2008). The conceptual models were tested in recent empirical studies and the relationships between annoyance caused by aircraft and railway noise with non-acoustic factors were explained (Kroesen *et al.*, 2008; Pennig and Schady, 2014). In contrast, the present study examined noise annoyance induced by floor impact noise, which is categorised as building noise rather than environmental noise. The findings from this

study confirm that the theoretical model for environmental noise is applicable to other noises sources.

In the present study, disturbance was found to be associated with noise annoyance directly and to have indirect impacts on health complaints and coping. Moreover, noise annoyance had direct effects on health complaints and coping. All these results are in line with previous studies which have insisted the close relationships among noise perceptions and reactions (Lercher, 1996; Guski, 1999; Stallen, 1999; Boman and Enmarker, 2004; Öhrström, 2004; Kroesen *et al.*, 2008; Pennig and Schady, 2014).

Kroesen *et al.* (2008) assumed noise sensitivity would be associated either directly or indirectly with disturbance, annoyance, and coping. However, the effect of noise sensitivity remained unclear in their study. The present study found that noise sensitivity had a direct impact on disturbance and indirect impacts on annoyance, health complaints, and coping. Guski (1999) earlier insisted that noise sensitivity, as one of personal factors, influences one's long-term somatic effects, and Fyhri and Klæboe (2009) also found a positive relationship between noise sensitivity and subjective health complaints. The relationship between coping and noise sensitivity was also addressed in previous studies (Jelínková, 1988; Pulles *et al.*, 1990). Thus, these findings confirm that noise sensitivity is one of the key variables to explain subjective responses to building as well as environmental noises (Job, 1988; Stansfeld, 1992; Fields, 1993; Nivison and Endresen, 1993; Lercher and Kofler, 1996; van Kamp *et al.*, 2004; Paunović *et al.*, 2009; Fyhri and Aasvang, 2010; Ryu and Jeon, 2011).

Two variables were found to be not significant in the present study. It was assumed that negative attitude to authorities and closeness with neighbours would have direct effects on coping. These paths were found to be significant in previous empirical studies on aircraft and railway noise (Kroesen *et al.*, 2008; Pennig and Schady, 2014). Inconsistency between the previous studies and the present study might be explained by three reasons. First, measurement of coping was different. Kroesen *et al.* (2008) focused on assessing cognitive coping strategies and did not measure behavioural coping since they assumed behavioural coping might cause both positive and negative outcomes. Pennig and Schady (2014) combined the measurement of cognitive and behavioural coping adopting the six questions which was earlier developed for assessing subjective coping capacity toward environmental

noise (NASA, 1978). Contrary to the two previous studies (Kroesen *et al.*, 2008; Pennig and Schady, 2014), this study focused on assessing behavioural coping strategies because the prior qualitative study found that the behavioural coping strategies were dominantly reported by the residents who actually had been exposed to floor impact sounds in apartment buildings. Second, relationships between authorities and noise sources were different. Negative attitude to authorities assessed in the present study was not of the kind that Kroesen *et al.* (2008) and Pennig and Schady (2014) measured. The occurrence of aircraft and railway noise can be ascribed to relevant authorities such as airports, railway institutes, or the governments since the noise sources are regarded as being run by the authorities. In contrast, the source of floor impact sounds is simply the upstairs neighbours, not any authority. Third, noise sources were entirely different. The present study measured the participants' attitudes to neighbours (i.e., noise source) with which they can have personal relationships, whereas the noise sources that the previous studies focused on (Kroesen *et al.*, 2008; Pennig and Schady, 2014) were aircraft and railway which people cannot have personal relationships with. Kroesen *et al.* (2008) and Pennig and Schady (2014) measured attitudes to the noise sources by asking respondents about the importance or financial benefits of the noise sources. Since such social evaluations cannot be made of each resident's upstairs neighbours, the present study instead assessed the respondents' closeness with their upstairs neighbours.

## **4.5.2 Moderation effects**

### **4.5.2.1 Multiple-group moderation**

Moderation effects of several variables were examined in addition to the path analysis. Moderation tests allowed the findings from the prior qualitative study, particularly the findings of intervening conditions, to be confirmed or extended. The noteworthy moderators were divided into categorical variables (e.g., type of the major noise source was footsteps or not, whether they had empathy with their upstairs neighbours or not) and continuous variables (e.g., how far they had negative attitude to authorities). The moderation effects of the categorical variables were assessed through a multiple-group analysis and those of the continuous variable were

examined by an interaction moderation test (Hair *et al.*, 2010; Kline, 2011); both tests were also carried out using AMOS 22.

Four moderators were tested in the multiple-group analysis. First, as Figure 4-2 described earlier, more than a half of the participants reported they had been exposed to noise of footsteps the most; the prior qualitative study also found that heavy-weight impact noise source was the major noise. Thus, a moderation effect that footstep noise might have was tested. Next, the qualitative study proposed empathy as one of the aspects of residents' attitudes to their upstairs neighbours and included empathy in the category of intervening conditions. A moderation effect of empathy was tested and it was assessed by a question asking the participants whether they had received any noise complaint from their downstairs neighbours. The third moderator was past experience which was classified as one of the intervening conditions in the qualitative study. The participants were asked if they had been previously heard floor impact noise from previous upstairs neighbours or in previous apartments. Dwelling satisfaction was tested as the fourth moderator; it was also noted by the qualitative study as one of the intervening conditions. The participants were asked how far they were satisfied with their apartments, and the collected responses were divided into low and high satisfaction groups.

**Table 4-6. Results of multiple-group analyses**

\*\* $p < 0.001$ , \* $p < 0.05$

Moderator	Group	Path	Estimates
Noise source	Footsteps ( $N = 254$ )	Noise sensitivity	0.580**
	Others ( $N = 233$ )	– Disturbance	0.441**
Empathy	With ( $N = 291$ )	Negative attitude to authorities	0.146*
	Without ( $N = 196$ )		0.040
Past experience	With ( $N = 384$ )	– Coping	0.034
	Without ( $N = 103$ )		0.164*
Dwelling satisfaction	Low ( $N = 239$ )		0.175*
	High ( $N = 248$ )		-0.005

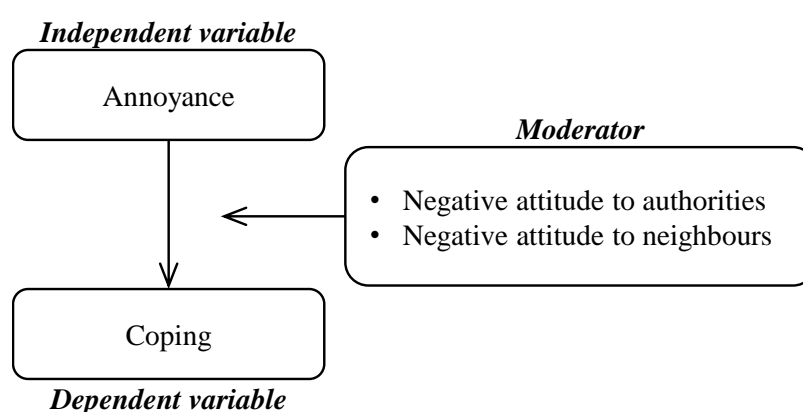
As the figures in Appendix 7 shows, the same structural model was tested across different groups in order to test the moderation effects of the moderators. The model fit of the multiple-group analyses indicated that the models fit well (RMSEA = 0.019; GFI = 0.911; CFI = 0.963;  $\chi^2/df = 1.895$ ). Table 4-6 presents two paths in which

significant differences between groups were found: ‘noise sensitivity – disturbance’ and ‘negative attitude to authorities – coping’. First, footstep noise was found to increase the impact size of noise sensitivity on disturbance. Moreover, noise sensitivity’s indirect effects on annoyance, coping, and health complaints were found to be higher for the group who had been exposed to footstep noise (Figure A-2 and A-3 in Appendix 7). This finding implies that noise sensitivity might be more crucial to predict one’s perceptions and reactions to floor impact sounds, particularly to noise of footsteps. The other moderators (empathy, past experience, and dwelling satisfaction) were found to moderate the path between negative attitude to authorities and coping which were found to be not significant in the original path model. Even though the impact sizes were relatively small, negative attitude to authorities had a positive influence on coping when the residents 1) have empathy with their upstairs neighbours, 2) do not have any past experience of noise exposure, and 3) are not satisfied with their dwellings much.

#### 4.5.2.2 Interaction moderation

Another moderation test was the interaction moderation test. Negative attitude to authorities and closeness with neighbours were not found to be significantly associated with coping in the path model (Figure 4-5). As Figure 4-6 illustrates, it was tested whether a relationship between annoyance (i.e., an independent variable) and coping (i.e., a dependent variable) changes according to the value of negative attitude to authorities and neighbours (i.e., moderators). These two moderators were measured using the following statements: “I believe the major reason for the floor impact sound problem is: 1) poor construction, 2) lack of policies on floor impact sound, and 3) lack of consideration between neighbours”. The participants scored how far they agreed with each statement on 5-point scale ranging from 1 (“Not at all”) to 5 (“Extremely”). Before carrying out the interaction moderation test, all variables were mean-centred (the mean value of the variables were subtracted from the data) to reduce multi-collinearity (Cohen, 2003; Paillé and Mejía-Morelos, 2014). As Figure 4-7 describes, each interaction construct was computed from multiplying each independent variable by each moderator (e.g., annoyance  $\times$  negative attitude to neighbours).

The impact of negative attitude to authorities on the relationship between annoyance and coping was found to be statistically significant ( $\beta = 0.115, p < 0.001$ ) and negative attitude to neighbours also had a significant effect on the relationship between annoyance and coping ( $\beta = -0.125, p < 0.05$ ). Figure 4-8 and 4-9 were plotted in order to interpret the moderation effects visually. Predicted values of coping were calculated under different conditions (high and low values of annoyance, and high and low values of each moderator) and the predicted relationship was illustrated by simple slopes between annoyance and coping at the different levels of the two moderators. In order to choose variables for representing high and low values, those of one standard deviation above and below the mean were used (Dawson, 2014). Figure 4-8 shows that negative attitude to authorities strengthened the positive relationship between annoyance and coping. However, the relationship was weakened by another moderator, negative attitude to neighbours (Figure 4-9). These findings imply that those who strongly believe that construction companies or governmental authorities are responsible for the noise problem might be more likely to use avoidant coping behaviours when they perceive high noise annoyance. Besides, it can be predicted that people who have strong negative attitudes to their upstairs neighbours may not use avoidant coping behaviours but more vigilant coping strategies when they are highly annoyed with floor impact sounds. These findings are in line with what the prior qualitative study suggested.



**Figure 4-6. A model describing moderation effects of negative attitude to authorities and neighbours on the relationship between annoyance and coping**



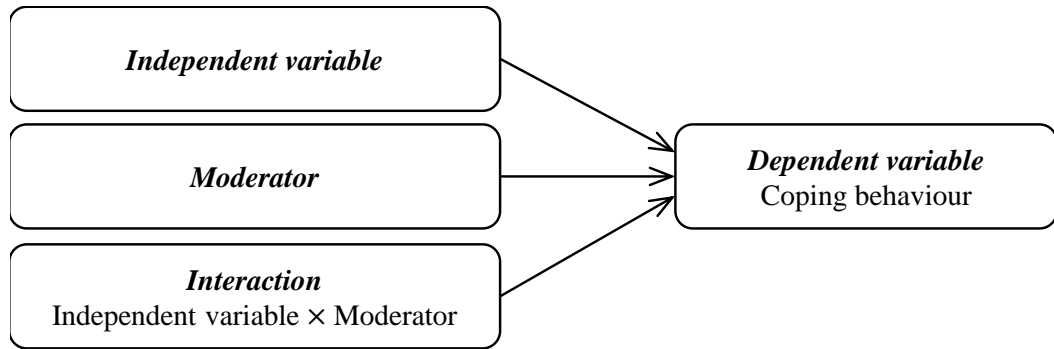


Figure 4-7. A model of interaction moderation effects to be tested

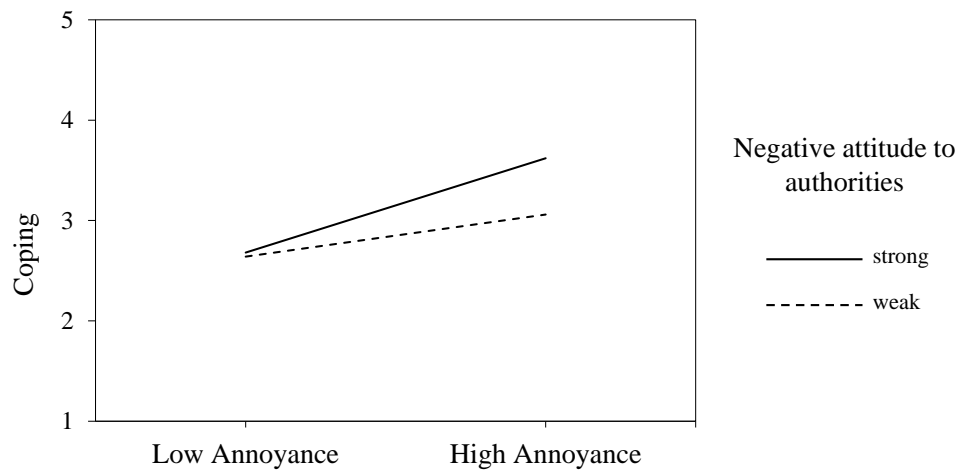


Figure 4-8. Moderation effects of negative attitude to authorities on the relationship between annoyance and coping

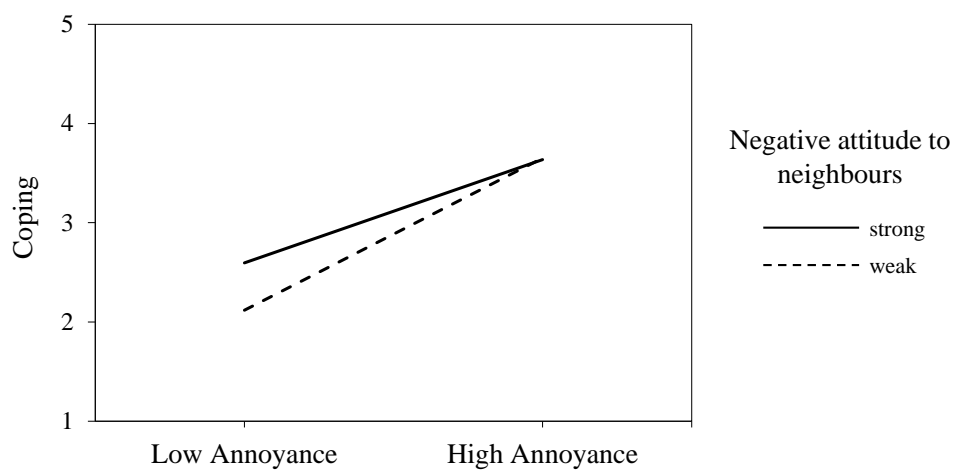
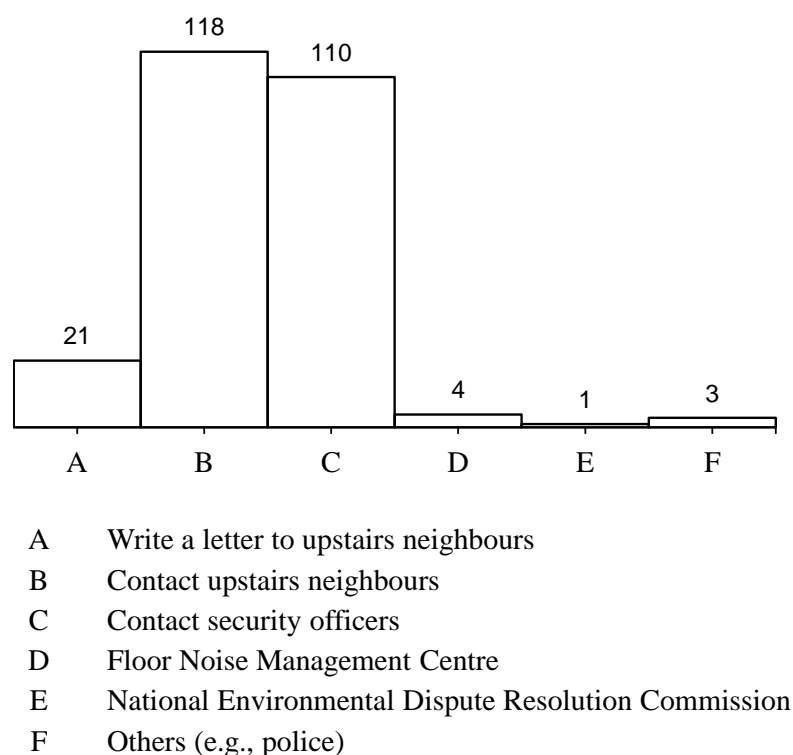


Figure 4-9. Moderation effects of negative attitude to neighbours on the relationship between annoyance and coping

### 4.5.3 Type of noise complaints

The participants were asked to choose any types of noise complaints which they had made. 173 participants out of 487 answered that they had made noise complaints; the types of noise complaints are shown in Figure 4-10. The majority of the participants had contacted their upstairs neighbours ( $N = 118$ ) or security officers ( $N = 110$ ) and both types of complaints are unofficial ways of making complaints. Few numbers of official noise complaints may be explained by residents' low expectation of successful complaints and satisfactory results (Hume and Thomas, 1993; van Wiechen *et al.*, 2002), or lack of information and knowledge about how to make official noise complaints. Moreover, physical closeness might be another reason. In other words, noise source (upstairs neighbours) or security officers were physically close to the residents, and thus, the residents might be prone to contact them rather than making any official complaints about the noise. However, further investigation is still recommended to understand why there was a huge disparity between unofficial and official complaints about floor impact sounds.



**Figure 4-10. Number of participants who had made noise complaints**

#### 4.5.4 Development or change in noise sensitivity

Another comment would be made on subjective noise sensitivity. Previously, the qualitative study suggested that people's noise sensitivity might be heightened when they have been continuously exposed to noise, when situations were changed (e.g., after having a baby), and when their family members or cohabitants are sensitive to noise. The survey questionnaire included a question asking if the participants' families or cohabitants were sensitive to noise. Mean differences were compared, and it was found that those who lived with noise sensitive families or cohabitants reported higher level of personal noise sensitivity than others (Table A-4 in Appendix 6). Belojević *et al.* (2003) proposed that one's personality traits have influences on personal noise sensitivity; it was also argued that subjective noise sensitivity might be affected in a specific situational context, by meaning of noise, mood, motivation, and other variables (Cohen and Weinstein, 1981; Belojević *et al.*, 2003). However, the influence of family's or cohabitant's noise sensitivity on personal noise sensitivity has not been tested in detail. Thus, further research is recommended to understand whether one's subjective noise sensitivity might be affected by other family member's or cohabitant's noise sensitivity, as well as by other situational factors such as changes in situations.

## 4.6 Summary

A conceptual model was developed to explain relationships between the non-acoustic factors and annoyance caused by floor impact sounds. The model contained seven endogenous variables: noise sensitivity, disturbance, annoyance, health complaints, coping, negative attitude to authorities, and closeness with neighbours. The survey questions were developed based on the suggestions from previous theoretical and empirical studies on environmental noise and the findings of the prior qualitative study. A single question was used to measure noise sensitivity. Five different disturbed activities were asked and two questions were asked to measure noise annoyance. Three physical symptoms were asked to measure the participants' health complaints. Three major avoidant coping behaviours suggested in the qualitative study were asked to assess coping. The participants were asked about their negative attitudes toward the government and construction companies, and their

closeness with their upstairs neighbours. The research data was collected from a larger sample than that of the interviews, and the findings from the quantitative study supported and extended what the previous studies have found.

The path analysis found that noise sensitivity had a positive direct impact on disturbance, and indirect impacts on noise annoyance, subjective health complaints, and avoidant coping behaviours. Disturbance was found to be positively associated with annoyance, health complaints, and coping. Annoyance also had positive impacts on health complaints and coping. Negative attitudes to authorities and closeness with neighbours were assumed to be associated with coping but no significant impact was found in the path analysis. The results from the path analysis were discussed along with a comparative perspective with previous empirical studies on environmental noise annoyance (Kroesen *et al.*, 2008; Pennig and Schady, 2014).

Apart from the path analysis, moderation effects of several variables were tested. It was found that noise of footsteps increased the positive impact size of noise sensitivity on disturbance. Empathy, past experience, and dwelling satisfaction were found to affect the relationship between negative attitudes to authorities and coping. In addition, negative attitudes to authorities and neighbours were found to influence the relationship between noise annoyance and avoidant coping behaviours. Confirming the findings of the prior qualitative study, it was suggested that people who have negative attitudes to authorities may use more avoidant coping behaviours when they are highly annoyed with floor impact sounds, while those who have negative attitudes to their upstairs neighbours may use more vigilant coping behaviours rather than avoidant coping.

By testing the non-acoustic variables that the prior qualitative study found to be of significance (e.g., avoidant coping, health complaints, noise sensitivity, and negative attitudes to authorities etc.), the results from the present quantitative study made valuable attempts to explain how far the variables are correlated with one another and to understand the perception of floor impact sound in apartment buildings in more details.

## 5 Conclusions

### 5.1 Summary of the present study

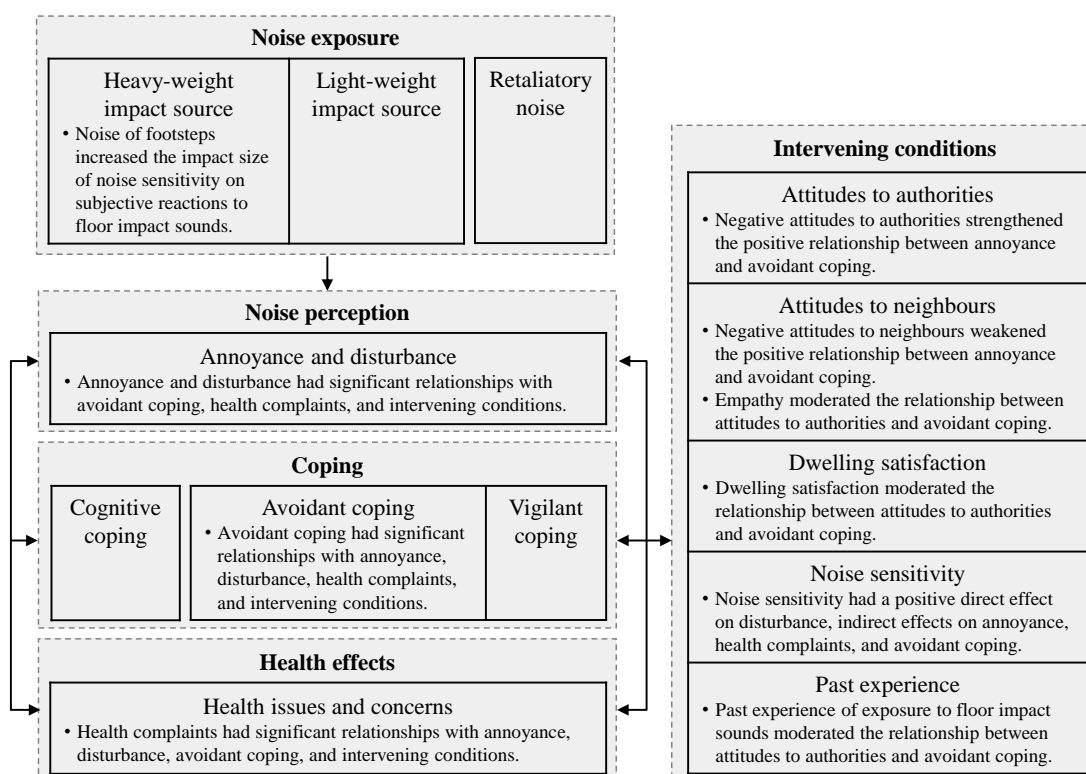
It has been shown that the present study is comprised of two experiments: one qualitative and one quantitative. According to Bryman (2006), using both qualitative and quantitative research approaches allows the weakness of one method to be offset by the strengths of the other, and the findings of one method can be used to provide contextual explanations for the results of another. Throughout the process of undertaking the two studies, some advantages were gained such as comprehensiveness, complexity, and confirmation (Glik *et al.*, 1986; Morse, 2003). Firstly, the research was comprehensive, as it employed both methods, thereby allowing the issues to be addressed more widely and more completely (Morse, 2003; O'Cathain *et al.*, 2007). Secondly, by only undertaking a quantitative study, it might not have been possible to explain the intricacies of the issues. Indeed, the qualitative part of the present investigation was helpful for understanding the complexities of the circumstances which were surrounding the noise exposure, as well as aiding the researcher in probing different individuals' experiences, underlying attitudes, and perceptions. The findings from the previous qualitative study could be confirmed by carrying out further investigations using quantitative methods with larger sample sizes. Thirdly, this research also achieved confirmation. Confirmation is one of the criteria to evaluate the trustworthiness or rigour of a study (Lincoln and Guba, 1985), and the use of both methods increases the validity and credibility of the research (Greene *et al.*, 1989; Barbour, 1999; Creswell *et al.*, 2003; Bryman, 2006).

The present research aims to improve our understanding of the perception of floor impact sounds in apartment buildings. Firstly, a qualitative study was conducted to explore experiences of floor impact sounds. Grounded theory was used as a research methodology and semi-structured interviews were conducted with 14 apartment residents. The findings yielded insights into how the interviewees perceived floor impact sounds, and the ways in which their experiences varied. It was found that the interviewees had been most frequently exposed to the sound of footsteps. The interviewees reported negative emotional responses (disturbance and annoyance) when exposed to floor impact sounds. It was observed that people had

used not only cognitive coping but also behavioural coping strategies. Behavioural strategies were divided into avoidant and vigilant coping. Avoidant coping strategies included leaving the room, wearing earplugs, turning up the volume of the TV or music to mask the floor impact sounds, and trying to concentrate on other activities. On the other hand, vigilant copers tended to approach the issue by making noise complaints, both to the relevant authorities as well as to their neighbours or security officers, when the noise problem could not be effectively solved by avoidance strategy. In addition, floor impact sounds were found to lead to health complaints and concerns. Intervening conditions, that contained attitudes to authorities and neighbours, noise sensitivity, past experience, and satisfaction with housing, were found to be associated with noise exposure, noise perception, coping, and health effects. A conceptual model was developed from these findings, as well as from previous researches on environmental noise. It was based upon five key themes: noise exposure, noise perception, coping, health effects, and intervening conditions.

A quantitative study, based upon this conceptual model, was then carried out to estimate the relationships between the associated non-acoustic variables and the annoyance caused by floor impact sounds. Structural equation modelling was employed to test the conceptual model. The findings showed that noise sensitivity had positive impacts on perceived disturbance; in other words, greater noise sensitivity led to greater perception of disturbance. Moreover, disturbance was positively correlated with noise annoyance, whilst annoyance also influenced health complaints and coping. Contrary to other empirical studies on environmental noise, path analysis revealed that the impacts of negative attitude to authorities and neighbours on coping were not statistically significant. This inconsistency between the present study and other studies can be explained by differences in measurement of coping strategy, noise source, and the participants' relationships with authorities and the noise source. In addition to path analysis, two types of moderation tests were carried out. Firstly, multiple-group moderation tests were performed, and moderating variables affecting the relationships among the non-acoustic variables were found: 1) exposure to footstep noise, 2) predictability, 3) empathy, 4) marital status, and 5) house ownership. Secondly, an interaction moderation effect of negative attitude to upstairs neighbours was examined. It was found that such attitudes may weaken the positive relationship between annoyance and avoidant coping. In other words, those who strongly believe that inconsiderate neighbours are responsible for noise

problems might use more vigilant, rather than avoidant, coping strategies when they are highly annoyed with floor impact sounds. This quantitative study confirmed and extended the findings of the prior qualitative study as well as those of previous studies on environmental noise.



**Figure 5-1. Overview of the findings from the present study using both qualitative and quantitative approaches**

## 5.2 Recommendations for future research

Some suggestions can be made for future research that employs a quantitative research method. Contrary to previous studies on environmental noise (Kroesen *et al.*, 2008; Pennig and Schady, 2014), the present study did not include noise level in the conceptual model, for this study was originally designed to probe non-acoustic factors that are relevant to noise annoyance. In addition, field measurements of floor impact noise cannot be done easily as floor impact noise occurs intermittently and considerably depends on the daily lives of upstairs neighbours. However, long-term recording and field measurements of the noise are still recommended because they would facilitate further understanding of the relationship between the noise exposure

and the key non-acoustic factors which that have been discovered in the present study.

Another suggestion is related to the measurement of coping. The coping strategies that were examined in the quantitative study were all avoidant coping behaviours because these were found to be the most frequently used strategies in the qualitative study. Although avoidant coping is acknowledged to be the most common coping strategy (Folkman and Lazarus, 1988), it is recommended that future investigations include questions regarding the assessment of other coping strategies, such as cognitive and vigilant coping. Several previous studies have examined the relationship between noise annoyance and making complaints (Hume *et al.*, 2002; Maziul *et al.*, 2005; Nykaza *et al.*, 2013). People are more likely to use avoidant coping strategies rather than making complaints when exposed to problematic environmental noises because they do not believe noise complaints to authorities will lead to significant change (Hume *et al.*, 2002). However, the present study showed that a number of participants of both interviews and surveys had made noise complaints about floor impact sounds. This may be because the residents in apartments are able to contact their neighbours (i.e., noise source) directly when exposed to floor impact sounds and are more likely to expect significant changes after making complaints. The additional measurement of other coping strategies would provide opportunities to further investigate the relationships between, attitudinal variables, and annoyance. What should be noted when assessing vigilant coping is that the majority of the participants had made noise complaints in unofficial ways, thus, it is suggested that noise complaints are separated into unofficial and official approaches, and examined accordingly.

Other recommendations can be made on the sampling of participants. First, the participants in this study lived in various apartment buildings with different floor structures. The newer buildings were built with the thicker concrete slabs to reduce floor impact noise levels. For instance, the use of a slab thickness greater than 210 mm is recommended. The physical characteristics of the resilient isolators (e.g., dynamic stiffness) used in the floor structures of the buildings also differ (Kim *et al.*, 2009). Further study is thus required to compare perceptions and reactions to floor impact noise across various types of floor structures. Second, as the present study sampled only those who lived in apartment buildings in Korea, its focus has primarily been on heavyweight buildings and did not consider lightweight buildings



such as those with wooden structures. Lightweight floors have low mass and low structural damping compared to heavyweight floors, and these characteristics result in the dynamic response being greater, which is perceived as problematic to floor vibration. Therefore, for future studies, it is necessary to investigate the perceptions and reactions to floor impact noise in lightweight buildings. Third, cultural factors might also affect people's perceptions and reactions to floor impact noise. Unlike many Western countries, heavyweight impact noise induced by footsteps is commonly regarded as a major building noise in Korea because most Koreans do not wear shoes in their homes. Therefore, people living in Western countries may have different attitudes to footsteps noise and floor impact noise. Further research that involves a cross-cultural perspective is therefore suggested to cover different, geographically specific indoor life styles. Furthermore, in a broader context, the findings of the present study might be adopted, tested, and extended in future research that focuses on other types of buildings noise such as airborne noise.

## Appendices

Appendix 1. Pre-interview questionnaire.....	91
Appendix 2. Sample of the coding procedure .....	93
Appendix 3. Survey questionnaire .....	95
Appendix 4. Online survey questionnaire (Google forms) .....	101
Appendix 5. Interpreting model fit indices .....	102
Appendix 6. T-test results .....	103
Appendix 7. Samples of path models for multiple-group moderation tests.....	104

## Appendix 1. Pre-interview questionnaire

### 1. Age

### 2. Gender

- ① Male
- ② Female

### 3. Occupation

### 4. Annual household income (million)

- ① Under KRW 19.99
- ② KRW 20 to 39.99
- ③ KRW 40 to 59.99
- ④ Over KRW 60

### 5. How many people of these age categories live in your household?

*Incl. yourself*

3 or under	3 to 7	8 to 13	14 to 19	20 to 64	65 or older

### 6. Home ownership

- ① Owned
- ② Rented (Deposit rent)
- ③ Rented (Monthly rent)
- ④ Other:

### 7. How old is your apartment building?

- ① Less than 5 years
- ② Over 5 years, up to 10 years
- ③ Over 10 years, up to 15 years
- ④ Over 15 years, up to 20 years
- ⑤ Over 20 years

### 8. How many bedrooms in your apartment?

### 9. How long have you been living at this apartment?

**10. How long have you lived in apartment buildings so far?**

**11. How many hours do you spend inside this home?**

**12. Is there anyone under the age of 19 on your upstairs?**

- ① Yes
- ② No
- ③ Don't know

*If Yes, how many?*

3 or under	3 to 7	8 to 13	14 to 19

## Appendix 2. Sample of the coding procedure

---

**Q: Did you have any reasons for choosing this apartment?**

A: It's well-located, and it's close to city centre and my parents' house as well.

Brand-name wasn't important to me, but I just considered the scale of the block, I prefer a bigger block ... I'm happy with this apartment but it has been ten years (since the building was built) and I think it's time to move out because I can see some flaws sometimes ... I feel happy in this apartment. [DWELLING SATISFACTION]

**Q: Have you ever heard some noise in your apartment?**

A: The people upstairs have a boy and moved in last year. Floor impact sounds from upstairs has been a problem since then... The child keeps jumping up and down at night [HEAVY-WIGHT IMPACT NOISE SOURCE] ... I don't think it's regular but it sounds louder at night, particularly after 9 or 10 p.m. [DISTURBANCE] It seems they (upstairs neighbours, parents of the kid) don't control him. I think it's possible to some degree (to control their child). I know it's not easy to stop children from making noise in the daytime, but parents should prevent them from jumping up and down at night. Of course I can understand it (noise from upstairs) during the afternoon [ATTITUDES TO NEIGHBOURS] but I'm very annoyed with it at night [ANNOYANCE] because it's quieter, so I can hear that (noise from upstairs) far more at night ... when we (my family) are about to go to bed, after 9 or 10 p.m.? I can hear it. I once woke up [DISTURBANCE] to the sound of moving bookshelves [HEAVY-WIGHT IMPACT NOISE SOURCE] at 3 in the morning so I told a block manager about that. [VIGILANT COPING] This (noise issue) is what I'm not happy with this apartment. [DWELLING SATISFACTION] I've never thought about that (floor impact noise) before moving in because I'm not that sensitive to noise ... my husband is sensitive to it (noise) so that makes him irritated more. He sometimes tells me that he doesn't want to live in an apartment and wants to move to a house [NOISE SENSITIVITY] ... it makes my husband really nervous. I think it has a bad effect on health. [HEALTH CONCERNS] Although I can hear it (floor impact sound), I try to disregard it [COGNITIVE COPING] because it's coming from their daily lives. But my husband tends to be sensitive [NOISE SENSITIVITY] to that and again, I would

---

---

*rather ignore it. [COGNITIVE COPING]*

**Q: When you are here at home, how much does the noise disturb or annoy you?**

A: *It is true that I'm annoyed [ANNOYANCE] sometimes but I just try not to mind too much ... I can hear it (noise from upstairs) but I try not to mind too much [COGNITIVE COPING] ... I've made (a noise complaint) once [VIGILANT COPING] but I just don't want to complain about it again, to them or somewhere else, to authorities. Too complicated. [ATTITUDES TO AUTHORITIES]*

**Q: Have you heard some floor impact sounds where you lived previously, or in this building before the current upstairs neighbours moved in?**

A: *Previous upstairs neighbours were quite old and quieter than them (the current upstairs neighbours). [PAST EXPERIENCE] Although relationship with them (the current upstairs neighbours) is neither good nor bad at the moment, [ATTITUDES TO NEIGHBOURS] sometimes we're disturbed by their child's noise. [DISTURBANCE] But we try to be sympathetic as we also have a child. [ATTITUDES TO NEIGHBOURS]*

**Q: What would you say is the major reason for the floor impact sound problem?**

A: *It can be better if the buildings are built well [ATTITUDES TO AUTHORITIES] and I think people's awareness of the issue needs to be changed, too. They also need to educate their children not to make noise at night. [ATTITUDES TO NEIGHBOURS] I don't think that measures for the issue have been taken well, block manager sometimes informs people that there have been some complaints about the noise, and that's all. [ATTITUDES TO AUTHORITIES] I don't think these measures have been effective unless each resident takes care not to make noise. [ATTITUDES TO NEIGHBOURS] ... we've laid out a thick mat on the floor because we don't want to pass noise to our downstairs. The mat goes from the living room to the kitchen. We make sure that our child doesn't jump up and down at night and play only on the mat. I reckon that consideration for others is important, [ATTITUDES TO NEIGHBOURS] and the construction companies should've built the apartment buildings with this issue in mind. [ATTITUDES TO AUTHORITIES]*

---

### **Appendix 3. Survey questionnaire**

Thank you for your precious time.

*Korea Institute of Civil Engineering and Building Technology* is conducting a research on resolution method of floor impact sounds in apartment buildings and this survey is a part of the research.

All of your answers will be kept strictly confidential.

#### **Contact details**

Dr. Kyoung Woo Kim

Korea Institute of Civil Engineering and Building Technology (kwmj@kict.re.kr)

Dr. Lee Pyoung Jik

University of Liverpool (p.j.lee@liverpool.ac.uk)

Park Sang Hee

University of Liverpool (s.park@liverpool.ac.uk)

#### **Eligibility**

To be eligible for completing this survey, you need to

*be a resident of an apartment building*

**AND**

*have heard floor impact sounds from your upstairs neighbours*

**1. Age****2. Gender**

- ① Male
- ② Female

**3. Education**

- ① High school or equivalent
- ② Studying at a university or college
- ③ University or college graduate
- ④ Postgraduate or above

**4. Employment Status**

- ① Permanent / Full-Time worker
- ② Temporary / Part-Time worker
- ③ Self-employed
- ④ Student (incl. pupil at school or those in training)
- ⑤ Homemaker (looking after family home)
- ⑥ Not in paid work or retired
- ⑦ Other:

**5. Annual household income (million)**

- ① Under KRW 19.99
- ② KRW 20 to 29.99
- ③ KRW 30 to 39.99
- ④ KRW 40 to 49.99
- ⑤ KRW 50 to 59.99
- ⑥ Over KRW 60

**6. Marital Status**

- ① Married
- ② Single
- ③ Divorced, separated or widowed etc.

**7. How many people of these age categories live in your household?***Incl. yourself*

3 or under	3 to 7	8 to 13	14 to 19	20 to 64	65 or older



**8. House ownership**

- ① Owned
- ② Rented (Deposit rent)
- ③ Rented (Monthly rent)
- ④ Other:

**9. Property size**

- ① Less than 62.81m<sup>2</sup>
- ② 66.12 to 95.87 m<sup>2</sup>
- ③ 99.17 to 128.93 m<sup>2</sup>
- ④ 132.23 to 161.98 m<sup>2</sup>
- ⑤ 165.29 m<sup>2</sup> or more

**10. How old is your house?**

- ① Less than 5 years
- ② Over 5 years, up to 10 years
- ③ Over 10 years, up to 15 years
- ④ Over 15 years, up to 20 years
- ⑤ Over 20 years

**11. How satisfied are you with the current apartment?**

- Not at all      Slightly      Moderately      Very      Extremely
- 

**12. Please answer the questions about upstairs neighbours.**

12a. How many people of these age categories live in upstairs neighbours?

"I don't know."

3 or under	3 to 7	8 to 13	14 to 19	20 to 64	65 or older

12b. On the whole, how close are you with your upstairs neighbours?

- Not at all      Slightly      Moderately      Very      Extremely
- 

12c. How often do you share gifts or food with your upstairs neighbours?

- Not at all      Slightly      Moderately      Very      Extremely
- 

12d. How often do you visit and invite your upstairs neighbours?

- Not at all      Slightly      Moderately      Very      Extremely
-

**13. What is the main source of noise from upstairs that you can hear from your house?**

- ① Footsteps of children
- ② Footsteps of adults
- ③ Scraping of furniture
- ④ Dropping of items
- ⑤ Other:

**14. How annoyed are you by hearing the floor impact sounds caused by upstairs?**

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**15. Compared with 1 year ago, how annoyed are you by hearing the floor impact sounds caused by upstairs?**

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**16. How much has the noise (floor impact sounds) interfered with these aspects of your home life?**

16a. Sleeping

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

16b. Watching TV and listening to radio or music

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

16c. Having a conversation (incl. on the telephone)

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

16d. Reading, studying, and other quiet activities

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

16e. Resting

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**17. How much does the noise from upstairs influence your health?**

17a. Headache / dizziness

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

17b. Stomachache / indigestion

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

17c. Tiredness / sense of fatigue

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**18. How often have you done these to avoid the noise from upstairs?**

18a. Go out (make an appointment with friends etc.)

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

18b. Turn the volume up of TV or music

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

18c. Concentrate on other activities

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**19. Have you ever made complaints about noise from upstairs?**

① Yes

② No

*If YES, how did you make complaints? You may select more than one.*

③ Writing a letter

④ Direct contact or visit

⑤ Security/property management office

⑥ Floor Noise Management Centre

⑦ National Environmental Dispute Resolution Commission

⑧ Other:

**20. Have you ever experienced exposure to floor impact sounds in your dwelling in the past (by previous upstairs neighbours or in previous apartments)?**

① Yes

② No

**22. Have you ever received any noise complaint from your downstairs neighbours?**

① Yes

② No

**23. How sensitive are you to noise in general?**

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**24. How sensitive are your family members (or cohabitants) to noise in general?**

"I'm not living with anybody else."

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**25. How much are you agree with the following statements?**

*I believe the major reason for the floor impact sound problem is*

25a. Lack of consideration between neighbours

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

25b. Poor construction

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

25c. Lack of policies on floor impact sound

Not at all	Slightly	Moderately	Very	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

***This is the end of the survey.  
Thank you very much for your time.***

## Appendix 4. Online survey questionnaire (Google forms)



### 설문조사

\*Required

윗층으로부터 오는 층간소음은 얼마나 성가신지 평가해주세요

\*

1 2 3 4 5

전혀 성가시지 않음 ● ● ● ● ● 엄청나게 성가심

1년 전과 비교할 때, 윗층으로부터 오는 층간소음에 대해 느끼는 성가심은 심해졌습니까?

\*


1 2 3 4 5

전혀 심해지지 않았음 ● ● ● ● ● 엄청나게 심해졌음

« Back

Continue »

63% completed

Powered by  
 Google Forms

This content is neither created nor endorsed by Google.

[Report Abuse](#) - [Terms of Service](#) - [Additional Terms](#)

Figure A-1. Screen capture of online survey: questions about noise annoyance with floor impact sounds

## Appendix 5. Interpreting model fit indices

**Table A-1. Suggested cut-off values of model fit indices**

Fit indices	Acceptable range
$\chi^2/df$	1 to 3 <sup>a, d</sup>
<i>Normed Chi-square</i>	2 to 5 <sup>c</sup>
CFI	above 0.92 <sup>d</sup>
<i>Comparative fit index</i>	above 0.95 <sup>f</sup> close to 1.00 <sup>e</sup>
RMSEA	under 0.07 <sup>d</sup>
<i>Root mean square error of approximation</i>	under 0.08 <sup>e</sup>
GFI	above 0.90 <sup>d</sup>
<i>Goodness-of-fit index</i>	close to 1.00 <sup>e</sup>
Components of construct validity	Acceptable range
AVE	above 0.5 <sup>b, d</sup>
<i>Average variance extracted</i>	
CR	above 0.7 <sup>d</sup>
<i>Composite reliability or Construct Reliability</i>	

<sup>a</sup> Carmines and McIver (1981)

<sup>b</sup> Fornell and Larcker (1981)

<sup>c</sup> Marsh and Hocevar (1985)

<sup>d</sup> Hair *et al.* (2010)

<sup>e</sup> Arbuckle (2013)

<sup>f</sup> Byrne (2013)

## Appendix 6. T-test results

**Table A-2. T-test results comparing coping between those who reported low noise annoyance ( $N = 244$ ) and high noise annoyance ( $N = 243$ )**

\*\* $p < 0.001$ , \* $p < 0.05$

Noise annoyance	Going out		
	Mean	SD	$t$
Low	1.36	0.803	-9.299**
High	2.27	1.292	
Noise annoyance	Turning up the volume up of TV or music		
	Mean	SD	$t$
Low	1.61	0.938	-12.633**
High	2.94	1.350	
Noise annoyance	Trying to concentrate on other activities		
	Mean	SD	$t$
Low	1.75	1.018	-11.693**
High	2.95	1.244	

**Table A-3. T-test results comparing health complaints between those who reported low noise annoyance ( $N = 244$ ) and high noise annoyance ( $N = 243$ )**

\*\* $p < 0.001$ , \* $p < 0.05$

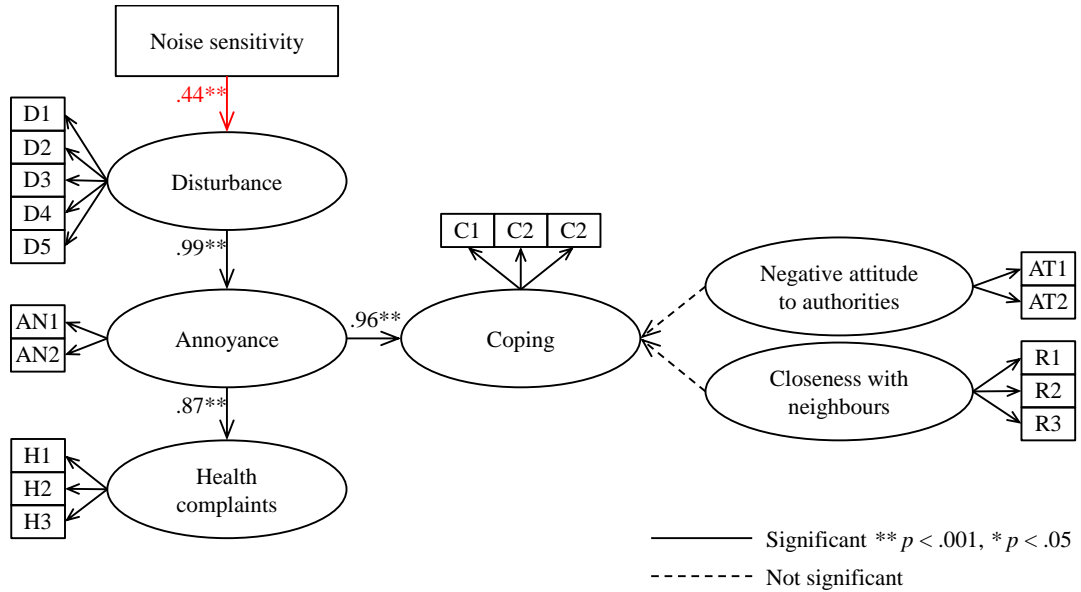
Noise annoyance	Headache / dizziness		
	Mean	SD	$t$
Low	1.27	0.697	-13.062**
High	2.56	1.367	
Noise annoyance	Stomachache / indigestion		
	Mean	SD	$t$
Low	1.16	0.503	-11.538**
High	2.16	1.255	
Noise annoyance	Tiredness / sense of fatigue		
	Mean	SD	$t$
Low	1.52	0.891	-16.167**
High	3.21	1.360	

**Table A-4. T-test results comparing the participants' noise sensitivity between those who reported their families (or cohabitants) had low noise sensitivity ( $N = 167$ ) and high noise sensitivity ( $N = 320$ )**

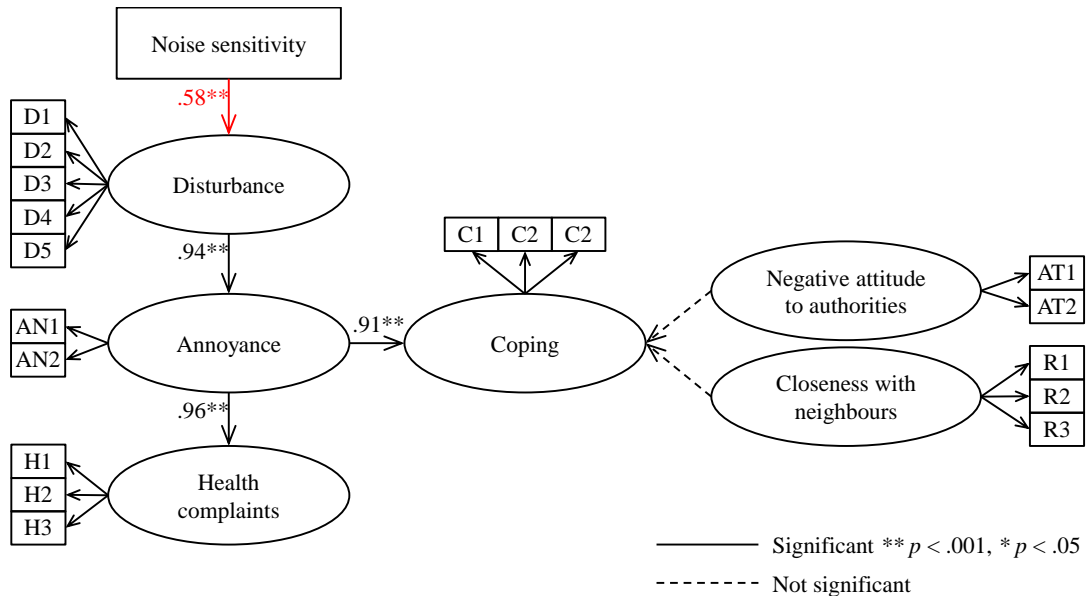
\*\* $p < 0.001$ , \* $p < 0.05$

Noise sensitivity of family (or cohabitant)	Personal noise sensitivity		
	Mean	SD	$t$
Low	2.31	1.052	-12.110**
High	3.45	0.952	

**Appendix 7. Samples of path models for multiple-group moderation tests**

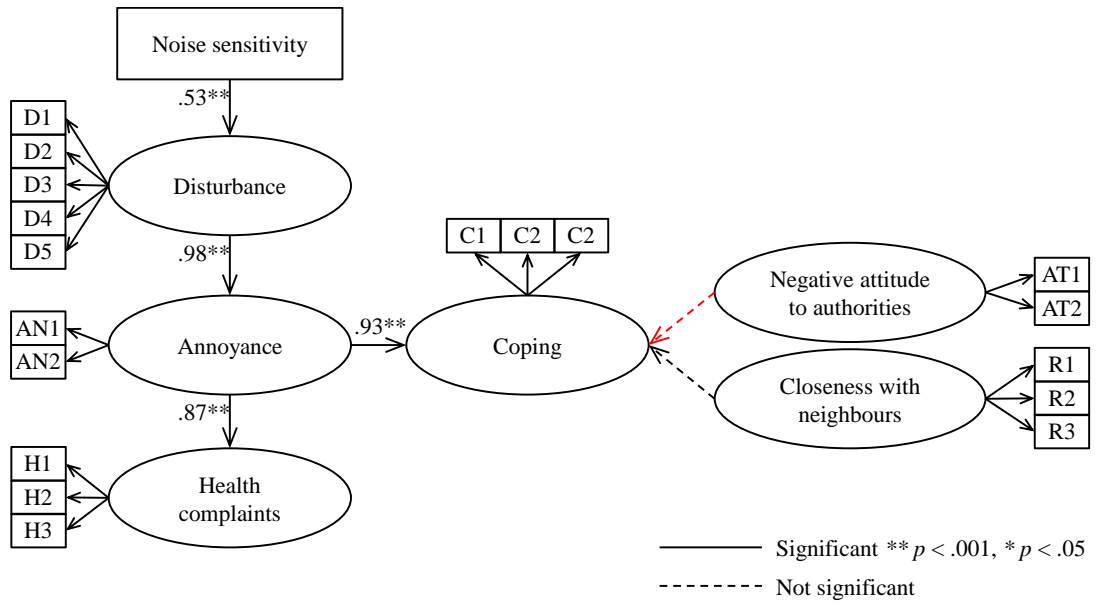


**Figure A-2. Multiple-group analysis: a causal model of the group who had been exposed to other noises ( $N = 233$ )**

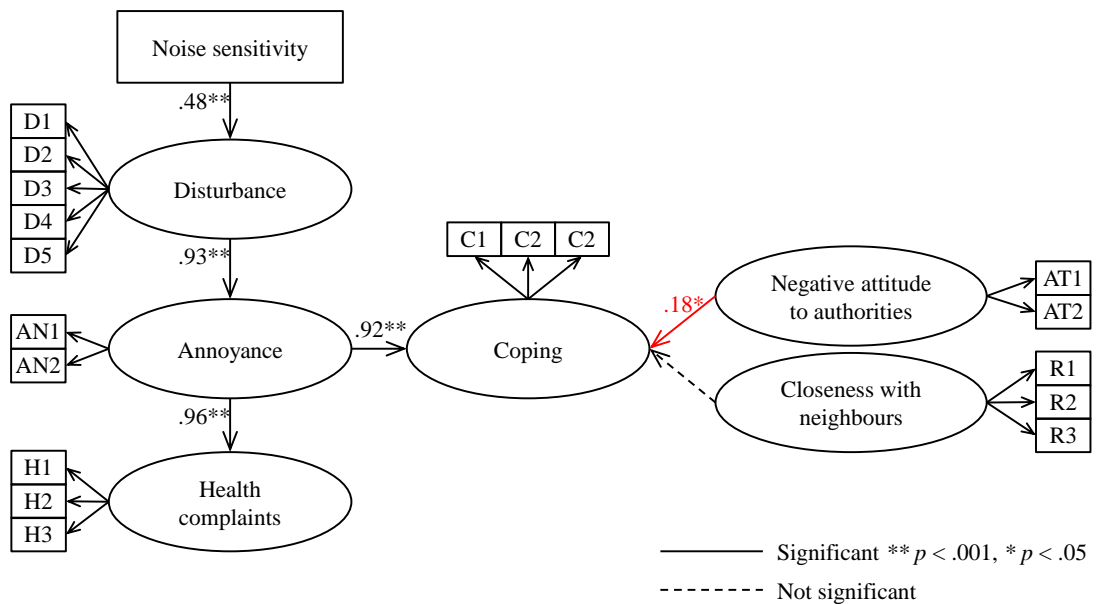


**Figure A-3. Multiple-group analysis: a causal model of the group who had been exposed to footstep noise ( $N = 254$ )**





**Figure A-4. Multiple-group analysis: a causal model of the group who were satisfied with their apartments (N = 248)**



**Figure A-5. Multiple-group analysis: a causal model of the group who were not satisfied with their apartments (N = 239)**

## List of references

- Arbuckle, J. L. (2013) IBM SPSS Amos 22 user's guide, Amos Development Corporation  
[ftp://public.dhe.ibm.com/software/analytics/spss/documentation/amos/22.0/en/Manuals/IBM\\_SPSS\\_Amos\\_User\\_Guide.pdf](ftp://public.dhe.ibm.com/software/analytics/spss/documentation/amos/22.0/en/Manuals/IBM_SPSS_Amos_User_Guide.pdf)
- Babisch, W., Pershagen, G., Selander, J., Houthuijs, D., Breugelmans, O., Cadum, E., Vigna-Taglianti, F., Katsouyanni, K., Haralabidis, A. S., and Dimakopoulou, K. (2013) Noise annoyance – a modifier of the association between noise level and cardiovascular health?, *Science of the Total Environment* 452, 50-57 (doi:10.1016/j.scitotenv.2013.02.034)
- Bakker, R. H., Pedersen, E., van den Berg, G. P., Stewart, R. E., Lok, W., and Bouma, J. (2012) Impact of wind turbine sound on annoyance, self-reported sleep disturbance and psychological distress, *Science of the Total Environment* 425, 42-51 (doi:10.1016/j.scitotenv.2012.03.005)
- Barbour, R. S. (1999) The case for combining qualitative and quantitative approaches in health services research, *Journal of Health Services Research and Policy* 4, 39-43 (doi:10.1177/135581969900400110)
- Barrett, P. (2007) Structural equation modelling: adjudging model fit, *Personality and Individual Differences* 42, 815-824 (doi:10.1016/j.paid.2006.09.018)
- Belojević, G., Jakovljević, B., and Slepcević, V. (2003) Noise and mental performance: personality attributes and noise sensitivity, *Noise & Health* 6, 77-89
- Belojević, G., Öhrström, E., and Rylander, R. (1992) Effects of noise on mental performance with regard to subjective noise sensitivity, *International Archives of Occupational and Environmental Health* 64, 293-301 (doi:10.1007/Bf00378288)
- Bentler, P. M., and Chou, C. P. (1987) Practical issues in structural modeling, *Sociological Methods & Research* 16, 78-117 (doi:10.1177/0049124187016001004)
- Berglund, B., Lindvall, T., and Schwela, D. H. (1999) *Guidelines for community noise*, World Health Organization, Geneva
- Berry, B. F., and Flindell, I. H. (2009) Estimating dose-response relationships between noise exposure and human health impacts in the UK (Technical report, BEL 2009 - 002)  
<http://www.defra.gov.uk/environment/quality/noise/igcb/publications/healthreport.htm>
- Björkman, M. (1991) Community noise annoyance: importance of noise levels and the number of noise events, *Journal of Sound and Vibration* 151, 497-503 (doi:10.1016/0022-460X(91)90549-Y)
- Bluhm, G., Nordling, E., and Berglund, N. (2004) Road traffic noise and annoyance – an increasing environmental health problem, *Noise & Health* 6, 43-49

- Bluyssen, P. M., Janssen, S., van den Brink, L. H., and de Kluizenaar, Y. (2011) Assessment of wellbeing in an indoor office environment, *Building and Environment* 46, 2632-2640 (doi:10.1016/j.buildenv.2011.06.026)
- Boman, E., and Enmarker, I. (2004) Factors affecting pupils' noise annoyance in schools: the building and testing of models, *Environment and Behavior* 36, 207-228 (doi:10.1177/0013916503256644)
- Botteldooren, D., Lercher, P., and Verkeyn, A. (2003) Noise annoyance and coping: a soft analysis, *Proceedings of the 8th International congress on noise as a public health problem, ICBEN 2003*
- Bowen, G. A. (2008) Grounded theory and sensitizing concepts, *International Journal of Qualitative Methods* 5, 12-23
- Bringer, J. D., Johnston, L. H., and Brackenridge, C. H. (2004) Maximizing transparency in a doctoral thesis1: the complexities of writing about the use of QSR\* NVIVO within a grounded theory study, *Qualitative Research* 4, 247-265 (doi:10.1177/1468794104044434)
- Bryant, A., and Charmaz, K. (2010) Grounded theory research: methods and practices, in *The Sage handbook of grounded theory*, edited by A. Bryant, and K. Charmaz, Sage, London, 1-28
- Bryman, A. (2006) *Mixed methods*, Sage (doi:10.4135/9781446262566)
- Bryman, A. (2012) *Social research methods*, Oxford university press
- Buchta, E., and Vos, J. (1998) A field survey on the annoyance caused by sounds from large firearms and road traffic, *Journal of the Acoustical Society of America* 104, 2890-2902 (doi:10.1121/1.423911)
- Burnard, P. (1991) A method of analysing interview transcripts in qualitative research, *Nurse Education Today* 11, 461-466 (doi:10.1016/0260-6917(91)90009-Y)
- Byrne, B. M. (2013) *Structural equation modeling with AMOS: basic concepts, applications, and programming*, Routledge
- Carmines, E. G., and McIver, J. P. (1981) Analyzing models with unobserved variables, in *Social measurement: current issues*, edited by G. W. Bohrnstedt, and E. F. Borgatta, Sage
- Cavanagh, R. F., and Romanoski, J. T. (2008) Sequential application of Rasch analysis and structural equation modeling to investigate elementary school classroom learning culture, in *Classroom culture and dynamics*, edited by E. P. Velliotis, Nova Publishers
- Cha, S. G. (2015) A method study of civil complaint reduction using management system of layer noise (in Korean), *Proceedings of the KSNVE Annual Spring Conference*
- Charmaz, K. (2006) *Constructing grounded theory: a practical guide through qualitative analysis*, Sage
- Chiovitti, R. F., and Piran, N. (2003) Rigour and grounded theory research, *Journal of Advanced Nursing* 44, 427-435 (doi:10.1046/j.0309-2402.2003.02822.x)
- Coffey, A., and Atkinson, P. (1996) *Making sense of qualitative data: complementary research strategies*, Sage, Thousand Oaks, CA

- Cohen, D., and Crabtree, B. (2006) Qualitative research guidelines project  
<http://www.qualres.org/HomeSemi-3629.html>
- Cohen, J. (2003) *Applied multiple regression/correlation analysis for the behavioral sciences*, Taylor & Francis
- Cohen, S., and Weinstein, N. (1981) Nonauditory effects of noise on behavior and health, *Journal of Social Issues* 37, 36-70 (doi:10.1111/j.1540-4560.1981.tb01057.x)
- Corbin, J. M., and Strauss, A. (2008) *Basics of qualitative research: techniques and procedures for developing grounded theory*, SAGE, Thousand Oaks, CA (doi:10.4135/9781452230153)
- Coyne, I., and Cowley, S. (2006) Using grounded theory to research parent participation, *Journal of Research in Nursing* 11, 501-515 (doi:10.1177/1744987106065831)
- Creswell, J. W. (1998) *Qualitative inquiry and research design: choosing among five approaches*, Sage, Thousand Oaks, CA
- Creswell, J. W., Plano Clark, V. L., Gutmann, M. L., and Hanson, W. E. (2003) Advanced mixed methods research designs, in *Handbook of mixed methods in social and behavioral research*, edited by A. Tashakkori, and C. Teddlie, Sage, 209-240
- Cutcliffe, J. R. (2000) Methodological issues in grounded theory, *Journal of Advanced Nursing* 31, 1476-1484 (doi:10.1046/j.1365-2648.2000.01430.x)
- Cutcliffe, J. R. (2003) Reconsidering reflexivity: introducing the case for intellectual entrepreneurship, *Qualitative Health Research* 13, 136-148 (doi:10.1177/1049732302239416)
- Dawson, J. F. (2014) Moderation in management research: what, why, when, and how, *Journal of Business and Psychology* 29, 1-19 (doi:10.1007/s10869-013-9308-7)
- Denzin, N. K. (2002) The interpretive process, in *The qualitative researcher's companion*, edited by M. Huberman, and M. B. Miles, Sage, Thousand Oaks, CA, 340-368 (doi:10.4135/9781412986274.n14)
- Dunne, C. (2011) The place of the literature review in grounded theory research, *International Journal of Social Research Methodology* 14, 111-124 (doi:10.1080/13645579.2010.494930)
- Egan, T. M. (2002) Grounded theory research and theory building, *Advances in Developing Human Resources* 4, 277-295 (doi:10.1177/1523422302043004)
- Ekman, A., Dickman, P. W., Klint, Å., Weiderpass, E., and Litton, J. E. (2006) Feasibility of using web-based questionnaires in large population-based epidemiological studies, *European Journal of Epidemiology* 21, 103-111 (doi:10.1007/s10654-005-6030-4)
- Elmenhorst, E. M., Pennig, S., Rolny, V., Quehl, J., Mueller, U., Maaß, H., and Basner, M. (2012) Examining nocturnal railway noise and aircraft noise in the field: sleep, psychomotor performance, and annoyance, *Science of the Total Environment* 424, 48-56 (doi:10.1016/j.scitotenv.2012.02.024)
- Farrell, A. M. (2010) Insufficient discriminant validity: a comment on Bove, Pervan, Beatty, and Shiu (2009), *Journal of Business Research* 63, 324-327 (doi:10.1016/j.jbusres.2009.05.003)

- Fidell, S., Silvati, L., and Haboly, E. (2002) Social survey of community response to a step change in aircraft noise exposure, *Journal of the Acoustical Society of America* 111, 200-209 (doi:10.1121/1.1423927)
- Fields, J. M. (1993) Effect of personal and situational variables on noise annoyance in residential areas, *Journal of the Acoustical Society of America* 93, 2753-2763 (doi:10.1121/1.405851)
- Fields, J. M. (1998) Reactions to environmental noise in an ambient noise context in residential areas, *Journal of the Acoustical Society of America* 104, 2245-2260 (doi:10.1121/1.423770)
- Fields, J. M., De Jong, R. G., Gjestland, T., Flindell, I. H., Job, R. F. S., Kurra, S., Lercher, P., Vallet, M., Yano, T., Guski, R., Felscher-Suhr, U., and Schumer, R. (2001) Standardized general-purpose noise reaction questions for community noise surveys: research and a recommendation, *Journal of Sound and Vibration* 242, 641-679 (doi:10.1006/jsvi.2000.3384)
- Flick, U. (2011) *Introducing research methodology: a beginner's guide to doing a research project*, Sage
- Folkman, S. (2013) Stress: appraisal and coping, in *Encyclopedia of Behavioral Medicine*, edited by M. D. Gellman, and J. R. Turner, Springer, 1913-1915 (doi:10.1007/978-1-4419-1005-9\_215)
- Folkman, S., and Lazarus, R. S. (1988) The relationship between coping and emotion – implications for theory and research, *Social Science & Medicine* 26, 309-317 (doi:10.1016/0277-9536(88)90395-4)
- Fornell, C., and Larcker, D. F. (1981) Structural equation models with unobservable variables and measurement error: algebra and statistics, *Journal of Marketing Research*, 382-388 (doi:10.2307/3150980)
- Fujii, K., Atagi, J., and Ando, Y. (2002) Temporal and spatial factors of traffic noise and its annoyance, *Journal of Temporal Design in Architecture and the Environment* 2, 33-41
- Fyhri, A., and Aasvang, G. M. (2010) Noise, sleep and poor health: modeling the relationship between road traffic noise and cardiovascular problems, *Science of the Total Environment* 408, 4935-4942 (doi:10.1016/j.scitotenv.2010.06.057)
- Fyhri, A., and Klæboe, R. (2006) Direct, indirect influences of income on road traffic noise annoyance, *Journal of Environmental Psychology* 26, 27-37 (doi:10.1016/j.jenvp.2006.04.001)
- Fyhri, A., and Klæboe, R. (2009) Road traffic noise, sensitivity, annoyance and self-reported health – a structural equation model exercise, *Environment International* 35, 91-97 (doi:10.1016/j.envint.2008.08.006)
- Götz, O., Liehr-Gobbers, K., and Krafft, M. (2010) Evaluation of structural equation models using the partial least squares (PLS) approach, in *Handbook of partial least squares*, edited by V. E. Vinzi, W. W. Chin, J. Henseler, and H. Wang, Springer, 691-711 (doi:10.1007/978-3-540-32827-8\_30)
- Gass, S., and Neu, J. (2006) *Speech acts across cultures: challenges to communication in a second language*, Walter de Gruyter (doi:10.1515/9783110219289)

- Glaser, B. G., and Holton, J. (2004) Remodeling grounded theory, *Forum: Qualitative Social Research* 5
- Glaser, B. G., and Strauss, A. L. (1967) *The discovery of grounded theory: strategies for qualitative research*, New Brunswick, NJ : Aldine Transaction, 1967
- Glaser, B. G., Strauss, A. L., and Strutzel, E. (1968) The discovery of grounded theory: strategies for qualitative research, *Nursing Research* 17, 364-365 (doi:10.1097/00006199-196807000-00014)
- Glik, D. C., Parker, K., Muligande, G., and Hategikamana, B. (1986) Integrating qualitative and quantitative survey techniques, *International Quarterly of Community Health Education* 7, 181-200 (doi:10.2190/B3HG-P7BW-5FA7-QCJJ)
- Gosling, S. D., Vazire, S., Srivastava, S., and John, O. P. (2004) Should we trust web-based studies? a comparative analysis of six preconceptions about internet questionnaires, *American Psychologist* 59, 93-104 (doi:10.1037/0003-066X.59.2.93)
- Greene, J. C., Caracelli, V. J., and Graham, W. F. (1989) Toward a conceptual framework for mixed-method evaluation designs, *Educational Evaluation and Policy Analysis* 11, 255-274 (doi:10.3102/01623737011003255)
- Griffith, I. D., and Langdon, F. J. (1968) Subjective response to road traffic noise, *Journal of Sound and Vibration* 8, 16-32 (doi:10.1016/0022-460x(68)90191-0)
- Guski, R. (1999) Personal and social variables as co-determinants of noise annoyance, *Noise & Health* 1, 45-56
- Haines, M. M., Brentnall, S. L., Stansfeld, S. A., and Klineberg, E. (2003) Qualitative responses of children to environmental noise, *Noise & Health* 5, 19-30
- Hair, J. F., Black, W. C., Babin, B. J., and Anderson, R. J. (2010) *Multivariate data analysis: a global perspective*, Upper Saddle River: Prentice Hall
- Hall, F. L., Taylor, S. M., and Birnie, S. E. (1980) Spatial patterns in community response to aircraft noise associated with non-noise factors, *Journal of Sound and Vibration* 71, 361-381 (doi:10.1016/0022-460x(80)90419-8)
- Hatfield, J., Job, R. F. S., Hede, A. J., Carter, N. L., Peploe, P., Taylor, R., and Morrell, S. (2002) Human response to environmental noise: the role of perceived control, *International Journal of Behavioral Medicine* 9, 341-359 (doi:10.1207/S15327558IJBM0904\_04)
- Henwood, K., and Pidgeon, N. (2006) Grounded theory, in *Research methods in psychology*, edited by G. M. Breakwell, S. Hammond, C. Fife-Schaw, and J. A. Smith, Sage, Thousand Oaks, CA, 342-365
- Hickey, G. (1997) The use of literature in grounded theory, *Nursing Times Research* 2, 371-378 (doi:10.1177/174498719700200510)
- Hume, K., Terranova, D., and Thomas, C. (2002) Complaints and annoyance caused by aircraft operations: temporal patterns and individual bias, *Noise & Health* 4, 45-55

- Hume, K., and Thomas, C. (1993) Sleep disturbance due to aircraft noise at a rapidly expanding airport (Manchester airport), Proceedings of the 6th International congress on noise as a public health problem, ICBEN 1993
- Hutchinson, S. A. (1993) Grounded theory: the method, in *Nursing Research: A Qualitative Perspective*, edited by P. L. Munhall, and C. O. Boyd, National League for Nursing Press, New York, 180-212
- Ipsen, D. (2002) The urban nightingale or some theoretical considerations about sound and noise, in *Soundscape Studies and Methods*, edited by H. Järviluoma, and G. Wagstaff, Finnish Society of Ethnomusicology, 185-197
- Ising, H., and Kruppa, B. (2004) Health effects caused by noise: evidence in the literature from the past 25 years, *Noise & Health* 6, 5-13
- ISO/TS 15666 (2003) Assessment of noise annoyance by means of social and socio-acoustic surveys, International Organization for Standardization, Geneva, Switzerland
- Jackson, D. L. (2003) Revisiting sample size and number of parameter estimates: some support for the N: q hypothesis, *Structural Equation Modeling: A Multidisciplinary Journal* 10, 128-141 (doi:10.1207/S15328007SEM1001\_6)
- Jakovljević, B., Paunović, K., and Belojević, G. (2009) Road-traffic noise and factors influencing noise annoyance in an urban population, *Environment International* 35, 552-556 (doi:10.1016/j.envint.2008.10.001)
- Janssen, S. A., Vos, H., Eisses, A. R., and Pedersen, E. (2011) A comparison between exposure-response relationships for wind turbine annoyance and annoyance due to other noise sources, *Journal of the Acoustical Society of America* 130, 3746-3753 (doi:10.1121/1.3653984)
- Jelínková, Z. (1988) Coping with noise in noise sensitive subjects, Proceedings of the 5th International congress on noise as a public health problem, ICBEN 1988
- Jenner, B., Flick, U., von Kardoff, E., and Steinke, I. (2004) *A companion to qualitative research*, Sage
- Jeon, J. Y., Hong, J. Y., and Lee, P. J. (2013) Soundwalk approach to identify urban soundscapes individually, *Journal of the Acoustical Society of America* 134, 803-812 (doi:10.1121/1.4807801)
- Jeon, J. Y., Jeong, J. H., and Ando, Y. (2002) Objective and subjective evaluation of floor impact noise, *Journal of Temporal Design in Architecture and the Environment* 2, 20-28
- Jeon, J. Y., Jeong, J. H., Vorländer, M., and Thaden, R. (2004) Evaluation of floor impact sound insulation in reinforced concrete buildings, *Acta Acustica United with Acustica* 90, 313-318
- Jeon, J. Y., Lee, P. J., Kim, J. H., and Yoo, S. Y. (2009a) Subjective evaluation of heavy-weight floor impact sounds in relation to spatial characteristics, *Journal of the Acoustical Society of America* 125, 2987-2994 (doi:10.1121/1.3081390)
- Jeon, J. Y., Lee, P. J., and Sato, S. (2009b) Use of the standard rubber ball as an impact source with heavyweight concrete floors, *Journal of the Acoustical Society of America* 126, 167-178 (doi:10.1121/1.3148193)

- Jeon, J. Y., Lee, P. J., You, J., and Kang, J. (2010a) Perceptual assessment of quality of urban soundscapes with combined noise sources and water sounds, *Journal of the Acoustical Society of America* 127, 1357-1366 (doi:10.1121/1.3298437)
- Jeon, J. Y., Ryu, J. K., Jeong, J. H., and Tachibana, H. (2006) Review of the impact ball in evaluating floor impact sound, *Acta Acustica United with Acustica* 92, 777-786
- Jeon, J. Y., Ryu, J. K., and Lee, P. J. (2010b) A quantification model of overall dissatisfaction with indoor noise environment in residential buildings, *Applied Acoustics* 71, 914-921 (doi:10.1016/j.apacoust.2010.06.001)
- Jeon, J. Y., and Sato, S. (2008) Annoyance caused by heavyweight floor impact sounds in relation to the autocorrelation function and sound quality metrics, *Journal of Sound and Vibration* 311, 767-785 (doi:10.1016/j.jsv.2007.09.029)
- Job, R. F. S. (1988) Community response to noise – a review of factors influencing the relationship between noise exposure and reaction, *Journal of the Acoustical Society of America* 83, 991-1001 (doi:10.1121/1.396524)
- Job, R. F. S. (1999) Noise sensitivity as a factor influencing human reaction to noise, *Noise & Health* 1, 57-68
- Jones, M., and Alony, I. (2011) Guiding the use of grounded theory in doctoral studies—an example from the Australian film industry, *International Journal of Doctoral Studies* 6, 95-114
- Kim, J. H., Ryu, J. K., and Jeon, J. Y. (2013) Effect of temporal decay on perception of heavy-weight floor impact sounds, *Journal of the Acoustical Society of America* 134, 2730-2738 (doi:10.1121/1.4818743)
- Kim, K. W., Jeong, G. C., Yang, K. S., and Sohn, J. Y. (2009) Correlation between dynamic stiffness of resilient materials and heavyweight impact sound reduction level, *Building and Environment* 44, 1589-1600 (doi:10.1016/j.buildenv.2008.10.005)
- Kline, R. B. (2011) *Principles and practice of structural equation modeling*, Guilford Press, New York
- Korea Environment Institute (2013) A basic study on apartment floor noise management (in Korean)
- Kroesen, M., Molin, E. J., and van Wee, B. (2008) Testing a theory of aircraft noise annoyance: a structural equation analysis, *Journal of the Acoustical Society of America* 123, 4250-4260 (doi:10.1121/1.2916589)
- Kroesen, M., Molin, E. J., and van Wee, B. (2010a) Determining the direction of causality between psychological factors and aircraft noise annoyance, *Noise & Health* 12, 17-25 (doi:10.4103/1463-1741.59996)
- Kroesen, M., Molin, E. J. E., Miedema, H. M. E., Vos, H., Janssen, S. A., and Van Wee, B. (2010b) Estimation of the effects of aircraft noise on residential satisfaction, *Transportation Research Part D* 15, 144-153 (doi:10.1016/j.trd.2009.12.005)
- Kurra, S., Morimoto, M., and Maekawa, Z. (1999) Transportation noise annoyance – a simulated-environment study for road, railway and aircraft noises, Part 1:



- overall annoyance, *Journal of Sound and Vibration* 220, 251-278 (doi:10.1006/jsvi.1998.1928)
- Langdon, F. (1976) Noise nuisance caused by road traffic in residential areas: Part I, *Journal of Sound and Vibration* 47, 243-263 (doi:10.1016/0022-460X(76)90720-3)
- Laszlo, H. E., McRobie, E. S., Stansfeld, S. A., and Hansell, A. L. (2012) Annoyance and other reaction measures to changes in noise exposure – a review, *Science of the Total Environment* 435-436, 551-562 (doi:10.1016/j.scitotenv.2012.06.112)
- Latack, J. C., and Havlovic, S. J. (1992) Coping with job stress: a conceptual evaluation framework for coping measures, *Journal of Organizational Behavior* 13, 479-508 (doi:10.1002/job.4030130505)
- Lazarus, R. S. (1966) *Psychological stress and the coping process*, McGraw-Hill, New York
- Lazarus, R. S. (2006) *Stress and emotion: a new synthesis*, Springer Publishing Company, New York
- Lazarus, R. S., and Folkman, S. (1984) *Stress, appraisal, and coping*, Springer Publishing Company
- Lee, P. J., Kim, J. H., and Jeon, J. Y. (2009) Psychoacoustical characteristics of impact ball sounds on concrete floors, *Acta Acustica United with Acustica* 95, 707-717 (doi:10.3813/Aaa.918199)
- Lee, P. J., Lee, B. K., and Griffin, M. J. (2013) Evaluation of floor vibrations induced by walking in reinforced concrete buildings, *Proceedings of the 42nd International congress on noise control engineering, Internoise 2013*
- Lercher, P. (1996) Environmental noise and health: an integrated research perspective, *Environment International* 22, 117-129 (doi:10.1016/0160-4120(95)00109-3)
- Lercher, P., and Kofler, W. W. (1996) Behavioral and health responses associated with road traffic noise exposure along alpine through-traffic routes, *Science of the Total Environment* 189, 85-89 (doi:10.1016/0048-9697(96)05194-7)
- Lincoln, Y. S., and Guba, E. G. (1985) *Naturalistic inquiry*, Sage
- Lindvall, T., and Radford, E. P. (1973) Measurement of annoyance due to exposure to environmental factors, *The 4th Karolinska institute symposium on Environmental Health, Environmental Research*, 1-36
- Luz, G. A., Raspet, R., and Schomer, P. D. (1983) An analysis of community complaints to noise, *Journal of the Acoustical Society of America* 73, 1229-1235 (doi:10.1121/1.389270)
- Marks, A., and Griefahn, B. (2007) Associations between noise sensitivity and sleep, subjectively evaluated sleep quality, annoyance, and performance after exposure to nocturnal traffic noise, *Noise & Health* 9, 1-7 (doi:10.4103/1463-1741.34698)
- Marsh, H. W., and Hocevar, D. (1985) Application of confirmatory factor analysis to the study of self-concept: first-and higher order factor models and their

- invariance across groups, *Psychological Bulletin* 97, 562 (doi:10.1037/0033-2909.97.3.562)
- Marsh, H. W., and Jackson, S. A. (1999) Flow experience in sport: construct validation of multidimensional, hierarchical state and trait responses, *Structural Equation Modeling: A Multidisciplinary Journal* 6, 343-371 (doi:10.1080/10705519909540140)
- Maschke, C., and Niemann, H. (2007) Health effects of annoyance induced by neighbour noise, *Noise Control Engineering Journal* 55, 348-356 (doi:10.3397/1.2741308)
- Maziul, M., Job, R. F. S., and Vogt, J. (2005) Complaint data as an index of annoyance – theoretical and methodological issues, *Noise & Health* 7, 17-27 (doi:10.4103/1463-1741.31628)
- MBC News (2014) Floor impact noise in apartments, 'revenge product' appeared (in Korean)  
[http://imnews.imbc.com//replay/2014/nwtoday/article/3562652\\_13495.html](http://imnews.imbc.com//replay/2014/nwtoday/article/3562652_13495.html)
- McCann, T. V., and Clark, E. (2004a) Grounded theory in nursing research: part 1 – methodology, *Nurse Researcher* 11, 7-18 (doi:10.7748/nr2004.01.11.2.7.c5918)
- McCann, T. V., and Clark, E. (2004b) Grounded theory in nursing research: Part 3 – application, *Nurse Researcher* 11, 29-39 (doi:10.7748/nr2004.01.11.2.29.c5920)
- McGhee, G., Marland, G. R., and Atkinson, J. (2007) Grounded theory research: literature reviewing and reflexivity, *Journal of Advanced Nursing* 60, 334-342 (doi:10.1111/j.1365-2648.2007.04436.x)
- McMenamin, I. (2006) Process and text: teaching students to review the literature, *PS: Political Science & Politics* 39, 133-135 (doi:10.1017/S1049096506060306)
- Miedema, H. M. E. (2004) Relationship between exposure to multiple noise sources and noise annoyance, *Journal of the Acoustical Society of America* 116, 949-957 (doi:10.1121/1.1766305)
- Miedema, H. M. E., and Oudshoorn, C. G. M. (2001) Annoyance from transportation noise: relationships with exposure metrics DNL and DENL and their confidence intervals, *Environmental Health Perspectives* 109, 409-416 (doi:10.1289/ehp.01109409)
- Miedema, H. M. E., and Vos, H. (1999) Demographic and attitudinal factors that modify annoyance from transportation noise, *Journal of the Acoustical Society of America* 105, 3336-3344 (doi:10.1121/1.424662)
- Miedema, H. M. E., and Vos, H. (2003) Noise sensitivity and reactions to noise and other environmental conditions, *Journal of the Acoustical Society of America* 113, 1492-1504 (doi:10.1121/1.1547437)
- Miedema, H. M. E., Vos, H., and de Jong, R. G. (2000) Community reaction to aircraft noise: time-of-day penalty and tradeoff between levels of overflights, *Journal of the Acoustical Society of America* 107, 3245-3253 (doi:10.1121/1.429396)
- Morse, J. M. (2003) Principles of mixed methods and multimethod research design, in *Handbook of mixed methods in social and behavioral research*, edited by A. Tashakkori, and C. Teddlie, Sage, 189-208

- Muzet, A. (2007) Environmental noise, sleep and health, *Sleep Medicine Reviews* 11, 135-142 (doi:10.1016/j.smrv.2006.09.001)
- NASA (1978) Guski, R., Wichmann, U., Rohrmann, B., Finke, H. O., Construction and application of a questionnaire for social scientific study of the effects of environmental noise (TM-75492)
- NASA (1992) Fields, J. M., Effect of personal and situational variables on noise annoyance: with special reference to implications for en route noise (FAA/AEE-92/03)
- Nivison, M. E., and Endresen, I. M. (1993) An analysis of relationships among environmental noise, annoyance and sensitivity to noise, and the consequences for health and sleep, *Journal of Behavioral Medicine* 16, 257-276 (doi:10.1007/Bf00844759)
- Nykaza, E. T., Hodgdon, K. K., Gaugler, T., Kreckler, P., and Luz, G. A. (2013) On the relationship between blast noise complaints and community annoyance, *Journal of the Acoustical Society of America* 133, 2690-2698 (doi:10.1121/1.4795781)
- O'Cathain, A., Murphy, E., and Nicholl, J. (2007) Integration and publications as indicators of "yield" from mixed methods studies, *Journal of Mixed Methods Research* 1, 147-163 (doi:10.1177/1558689806299094)
- Office for National Statistics (2014) Households and household composition in England and Wales, 2001-11, United Kingdom
- Ö hrström, E. (2004) Longitudinal surveys on effects of changes in road traffic noise-annoyance, activity disturbances, and psycho-social well-being, *Journal of the Acoustical Society of America* 115, 719-729 (doi:10.1121/1.1639333)
- Ö hrström, E., Björkman, M., and Rylander, R. (1988) Noise annoyance with regard to neurophysiological sensitivity, subjective noise sensitivity and personality variables, *Psychological Medicine* 18, 605-613 (doi:10.1017/S003329170000828X)
- Ö hrström, E., and Rylander, R. (1990) Sleep disturbance by road traffic noise – a laboratory study on number of noise events, *Journal of Sound and Vibration* 143, 93-101 (doi:10.1016/0022-460X(90)90570-P)
- Ouis, D. (1999) Exposure to nocturnal road traffic noise: sleep disturbance its after effects, *Noise & Health* 1, 11-36
- Paillé, P., and Mejía-Morelos, J. H. (2014) Antecedents of pro-environmental behaviours at work: the moderating influence of psychological contract breach, *Journal of Environmental Psychology* 38, 124-131 (doi:10.1016/j.jenvp.2014.01.004)
- Pandit, N. R. (1996) The creation of theory: a recent application of the grounded theory method, *The Qualitative Report* 2, 1-14
- Paunović, K., Jakovljević, B., and Belojević, G. (2009) Predictors of noise annoyance in noisy and quiet urban streets, *Science of the Total Environment* 407, 3707-3711 (doi:10.1016/j.scitotenv.2009.02.033)

- Pedersen, E., Hallberg, L. R. M., and Waye, K. P. (2007) Living in the vicinity of wind turbines – a grounded theory study, *Qualitative Research in Psychology* 4, 49-63 (doi:10.1080/14780880701473409)
- Pedersen, E., and Larsman, P. (2008) The impact of visual factors on noise annoyance among people living in the vicinity of wind turbines, *Journal of Environmental Psychology* 28, 379-389 (doi:10.1016/j.jenvp.2008.02.009)
- Pedersen, E., van den Berg, F., Bakker, R., and Bouma, J. (2009) Response to noise from modern wind farms in The Netherlands, *Journal of the Acoustical Society of America* 126, 634-643 (doi:10.1121/1.3160293)
- Pedersen, E., and Waye, K. P. (2004) Perception and annoyance due to wind turbine noise – a dose-response relationship, *Journal of the Acoustical Society of America* 116, 3460-3470 (doi:10.1121/1.1815091)
- Pedersen, E., and Waye, K. P. (2007) Wind turbine noise, annoyance and self-reported health and well-being in different living environments, *Occupational and Environmental Medicine* 64, 480-486 (doi:10.1136/oem.2006.031039)
- Pennig, S., and Schady, A. (2014) Railway noise annoyance: exposure-response relationships and testing a theoretical model by structural equation analysis, *Noise & Health* 16, 388-399 (doi:10.4103/1463-1741.144417)
- Pierrette, M., Marquis-Favre, C., Morel, J., Rioux, L., Vallet, M., Viollon, S., and Moch, A. (2012) Noise annoyance from industrial and road traffic combined noises: a survey and a total annoyance model comparison, *Journal of Environmental Psychology* 32, 178-186 (doi:10.1016/j.jenvp.2012.01.006)
- Pulles, M., Biesiot, W., and Stewart, R. (1990) Adverse effects of environmental noise on health: an interdisciplinary approach, *Environment International* 16, 437-445 (doi:10.1016/0160-4120(90)90012-U)
- Rabkin, J. G., and Struening, E. L. (1976) Life events, stress, and illness, *Science* 194, 1013-1020 (doi:10.1126/science.790570)
- Rechavi, T. B. (2009) A room for living: private and public aspects in the experience of the living room, *Journal of Environmental Psychology* 29, 133-143 (doi:10.1016/j.jenvp.2008.05.001)
- Robson, C. (2002) *Real world research: a resource for social scientists and practitioner-researchers*, Blackwell, Oxford
- Rogelberg, S. G. (2006) *Encyclopedia of industrial and organizational psychology*, Sage
- Rylander, R., and Björkman, M. (1997) Annoyance by aircraft noise around small airports, *Journal of Sound and Vibration* 205, 533-537 (doi:10.1006/jsvi.1997.1022)
- Rylander, R., Björkman, M., Åhrlin, U., Sörensen, S., and Berglund, K. (1980) Aircraft noise annoyance contours: importance of overflight frequency and noise level, *Journal of Sound and Vibration* 69, 583-595 (doi:10.1016/0022-460X(80)90627-6)
- Ryu, J. K., and Jeon, J. Y. (2011) Influence of noise sensitivity on annoyance of indoor and outdoor noises in residential buildings, *Applied Acoustics* 72, 336-340 (doi:10.1016/j.apacoust.2010.12.005)

- Ryu, J. K., Jeong, J. H., and Jeon, J. Y. (2005) The development of a noise annoyance scale for residential noise rating, Proceedings of the 34th International congress on noise control engineering, *Internoise 2005*
- Sato, T., Yano, T., Björkman, M., and Rylander, R. (1999) Road traffic noise annoyance in relation to average noise level, number of events and maximum noise level, *Journal of Sound and Vibration* 223, 775-784 (doi:10.1006/jsvi.1999.2153)
- Sbaraini, A., Carter, S. M., Evans, R. W., and Blinkhorn, A. (2011) How to do a grounded theory study: a worked example of a study of dental practices, *BMC Medical Research Methodology* 11, 128 (doi:10.1186/1471-2288-11-128)
- Scholl (2001) Impact sound insulation: the standard tapping machine shall learn to walk!, *Building Acoustics* 8, 245-256 (doi:10.1260/1351010011501830)
- Schulte-Fortkamp, B., and Fiebig, A. (2006) Soundscape analysis in a residential area: an evaluation of noise and people's mind, *Acta Acustica United with Acustica* 92, 875-880
- Schultz, T. J. (1978) Synthesis of social surveys on noise annoyance, *Journal of the Acoustical Society of America* 64, 377-405 (doi:10.1121/1.382013)
- Smith-Lovin, L., and Tickamyer, A. R. (1978) Nonrecursive models of labor force participation, fertility behavior and sex role attitudes, *American Sociological Review* 43, 541-557 (doi:10.2307/2094778)
- Smyrnova, Y., and Kang, J. (2010) Determination of perceptual auditory attributes for the auralization of urban soundscapes, *Noise Control Engineering Journal* 58, 508-523 (doi:10.3397/1.3484177)
- Stallen, P. J. (1999) A theoretical framework for environmental noise annoyance, *Noise & Health* 1, 69-79
- Stansfeld, S. A. (1992) Noise, noise sensitivity and psychiatric disorder: epidemiological and psychophysiological studies, *Psychological Medicine. Monograph supplement* 22, 1-44 (doi:10.1017/S0264180100001119)
- Stansfeld, S. A., and Matheson, M. P. (2003) Noise pollution: non-auditory effects on health, *British Medical Bulletin* 68, 243-257 (doi:10.1093/bmb/ldg033)
- Stansfeld, S. A., Sharp, D. S., Gallacher, J., and Babisch, W. (1993) Road traffic noise, noise sensitivity and psychological disorder, *Psychological Medicine* 23, 977-985 (doi:10.1017/S0033291700026441)
- Statistics Korea (2011) Population and housing census 2010, Daejeon
- Stern, P. N. (1980) Grounded theory methodology: its uses and processes, *Image* 12, 20-23 (doi:10.1111/j.1547-5069.1980.tb01455.x)
- Strauss, A., and Corbin, J. (1994) Grounded theory methodology, in *Handbook of qualitative research*, edited by N. K. Denzin, and Y. S. Lincoln, Sage, 273-285
- Strauss, A., and Corbin, J. (1998) *Basics of qualitative research: techniques and procedures for developing grounded theory*, Sage, Thousand Oaks, CA
- Strauss, A., and Corbin, J. M. (1990) *Basics of qualitative research: grounded theory procedures and techniques*, Sage

- Tanaka, J. S. (1987) "How big is big enough?": sample size and goodness of fit in structural equation models with latent variables, *Child Development*, 134-146 (doi:10.2307/1130296)
- Tarnopolsky, A., Watkins, G., and Hand, D. J. (1980) Aircraft noise and mental health: I. Prevalence of individual symptoms, *Psychological Medicine* 10, 683-698 (doi:10.1017/S0033291700054982)
- Taylor, S. M. (1984) A path model of aircraft noise annoyance, *Journal of Sound and Vibration* 96, 243-260 (doi:10.1016/0022-460x(84)90582-0)
- The Korea Herald (2013) Neighbors' noise disputes end in murder, arson  
<http://www.koreaherald.com/view.php?ud=20130212000721>
- Turner, D. W. (2010) Qualitative interview design: a practical guide for novice investigators, *The Qualitative Report* 15, 754-760
- Urquhart, C. (2007) The evolving nature of grounded theory method: the case of the information systems discipline, in *The Sage handbook of grounded theory*, edited by A. Bryant, and K. Charmaz, Sage, London, 339-359 (doi:10.4135/9781848607941.n16)
- van Kamp, I. (1990) Coping with noise and its health consequences, Groningen, STYX and PP Publications
- van Kamp, I., Job, R. F. S., Hatfield, J., Haines, M., Stellato, R. K., and Stansfeld, S. A. (2004) The role of noise sensitivity in the noise-response relation: a comparison of three international airport studies, *Journal of the Acoustical Society of America* 116, 3471-3479 (doi:10.1121/1.1810291)
- van Wiechen, C., Franssen, E., de Jong, R., and Lebet, E. (2002) Aircraft noise exposure from Schiphol airport: a relation with complainants, *Noise & Health* 5, 23-34
- Vos, J. (2001) On the annoyance caused by impulse sounds produced by small, medium-large, and large firearms, *Journal of the Acoustical Society of America* 109, 244-253 (doi:10.1121/1.1327576)
- Wallenius, M. A. (2004) The interaction of noise stress and personal project stress on subjective health, *Journal of Environmental Psychology* 24, 167-177 (doi:10.1016/j.jenvp.2003.12.002)
- Weinstein, N. D. (1978) Individual differences in reactions to noise: a longitudinal study in a college dormitory, *Journal of Applied Psychology* 63, 458-466 (doi:10.1037/0021-9010.63.4.458)
- Weinstein, N. D. (1980) Individual differences in critical tendencies and noise annoyance, *Journal of Sound and Vibration* 68, 241-248 (doi:10.1016/0022-460x(80)90468-X)
- WHO (2004a) Niemann, H., Maschke, C., Noise effects and morbidity
- WHO (2004b) Concha-Barrientos, M., Campbell-Lendrum, D., Steenland, K., Occupational noise: assessing the burden of disease from work-related hearing impairment at national and local levels

- Wiener, C. (2007) Making teams work in conducting grounded theory, in *The Sage handbook of grounded theory*, edited by A. Bryant, and K. Charmaz, Sage, London, 293-310 (doi:10.4135/9781848607941.n14)
- Wilson, H. S., and Hutchinson, S. A. (1996) Methodologic mistakes in grounded theory, *Nursing Research* 45, 122-124 (doi:10.1097/00006199-199603000-00012)
- Wong, C. S., and Law, K. S. (1999) Testing reciprocal relations by nonrecursive structural equation models using cross-sectional data, *Organizational Research Methods* 2, 69-87 (doi:10.1177/109442819921005)
- Yang, W., and Kang, J. (2005) Acoustic comfort evaluation in urban open public spaces, *Applied Acoustics* 66, 211-229 (doi:10.1016/j.apacoust.2004.07.011)
- Yardley, L. (2000) Dilemmas in qualitative health research, *Psychology and Health* 15, 215-228 (doi:10.1080/08870440008400302)
- Yoo, S. Y., Lee, P. J., Lee, S. Y., and Jeon, J. Y. (2010) Measurement of sound field for floor impact sounds generated by heavy/soft impact sources, *Acta Acustica United with Acustica* 96, 761-772 (doi:10.3813/Aaa.918330)
- Yu, L., and Kang, J. (2008) Effects of social, demographical and behavioral factors on the sound level evaluation in urban open spaces, *Journal of the Acoustical Society of America* 123, 772-783 (doi:10.1121/1.2821955)
- Zimmer, K., and Ellermeier, W. (1999) Psychometric properties of four measures of noise sensitivity: a comparison, *Journal of Environmental Psychology* 19, 295-302 (doi:10.1006/jevp.1999.0133)