

A comprehensive survey on noise annoyance from construction and domestic renovation

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ABSTRACT

Construction noise is of particular concern in the densely populated Hong Kong, due to the close proximity of residential buildings to new developments or redevelopments, as well as domestic renovation activities within those high-rise and multi-flatted buildings. As part of the review on construction noise control in Hong Kong, a public survey with more than 5,000 households over the territory was conducted. This socio-acoustic survey was the first of its kind and its scale in Hong Kong, and was specifically designed for gauging public opinions related to construction noise and domestic renovation noise. It was done with reference to ISO/TS 15666:2003 on assessment of noise annoyance, and a high response rate of 76% was achieved through face-to-face interviews. This paper will give an account of the design and methodology adopted in the survey, and its key findings and implications to possible options in improving the noise environment near construction sites or domestic flats under renovation.

1. INTRODUCTION

Hong Kong is one of the most densely populated metropolitan cities in the world with a density of about 7,100 people per square km in 2020. Owing to the scarcity of land resources, over 7 million inhabitants are housed in the developed land of about 270 square km, and as a result, the urban settings are highly compact and dominated by high-rise buildings. In tandem with economic growth, a number of mega-sized infrastructural projects such as Shatin-Central Link¹, Kai Tak Development², Three Runway System³, Central-Kowloon Route⁴, etc. are currently under construction. In parallel, to cope with the intense housing demand, many residential developments and urban renewal projects are also underway. Also, alongside with the population intake of new developments, domestic renovations of newly purchased / aged flats are actively pursuing by many owners / tenants. All these projects / works are often executed in close proximity to residential blocks and/or in neighbouring flats. As a result, construction noise and domestic renovation noise are often the concern of the local communities.

¹ A 17 km railway linking a number of urban population nodes in the New Territories, Kowloon and Hong Kong Island.

² A huge and highly complex development project spanning over 320 hectares with the largest available land fronting Victoria Harbour, providing quality living environment mixed with community, housing, business, tourism and infrastructural uses for around 90 000 residents.

³ Upgrading of the existing dual-runway system of the Hong Kong International Airport into a three-runway system. The scale of the project is almost equal to building a new airport next to the existing one.

⁴ A 4.7 km dual 3-lane trunk road comprising 3.9 km tunnel in Central Kowloon linking Yau Ma Tei Interchange in West Kowloon with road network on Kai Tak Development and Kowloon Bay in East Kowloon.

With implementation of the Noise Control Ordinance (**NCO**) [1] in 1989 and the Environmental Impact Assessment Ordinance (**EIAO**) [2] in 1998 respectively, legislative frameworks have been in place to protect residents against excessive exposure of construction noise. For instances, the use of Powered Mechanical Equipment (**PME**) for carrying out construction work including domestic renovation during the restricted hours (i.e. 7pm to 7am during normal weekdays and anytime on a general holidays) is subject to the control of the Construction Noise Permit (**CNP**) system under the NCO; noise from construction work of major infrastructural projects during the non-restricted hours is subject to the control and monitoring requirements under the EIAO. Besides, the Environmental Protection Department (**EPD**) of the Government of the Hong Kong Special Administrative Region has been keeping abreast of the latest developments on quieter construction methods / technologies and promoting their adoption by the local construction trade through established partnerships.

Despite the above measures have, to some extent, helped alleviate the construction noise impact, the EPD strives to address the growing aspiration for a tranquil living environment from the community. Against this background, a socio-acoustic survey on noise annoyance from general construction and domestic renovation engaging more than 5,000 households across the territory as well as meetings with other stakeholders were conducted during 2018-19. The survey was the first of its kind and scale in Hong Kong. The ensuing paragraphs outline the design of the survey and its result which laid the foundation for exploring enhancements in management and control of construction and domestic renovation noises in Hong Kong.

2. APPROACHES AND METHODOLOGIES

2.1 Socio-acoustic survey

The socio-acoustic survey aimed at collecting public views on the degree of annoyance regarding different types of environmental noises, in particular, whether the respondents were annoyed in the past 12 months or in the past 10 years or so by (i) noise from general construction (e.g. construction / demolition, road maintenance work, renovation / maintenance of buildings etc.) and/or (ii) noise from domestic renovation. The survey also collected responses on whether the respondents had carried out domestic renovations in their premises, and their willingness to consider quieter alternative renovation methods with extra costs in order to reduce noise nuisance to their neighbours.

The survey only covered land-based non-institutional population aged 18 or above in Hong Kong. Hotel transients, inmates of institutions and persons living on board vessels were not covered. For sample selection, the Frame of Quarters (a database of identifiable postal addresses) maintained by the Census and Statistics Department of the Government was used [3]. Based on a scientifically designed sampling scheme, samples were selected from the records of all permanent and temporary structures in Hong Kong. All households sampled were approached for interview and a household member aged 18 or above was randomly selected by Kish grid method for interview. Survey data were collected through face-to-face interviews during household visits.

The survey was conducted in accordance with *ISO/TS 15666 – 2003 Acoustics – Assessment of noise annoyance by means of social and socio-acoustic surveys* [4], which aimed at avoiding any presumptions. A well-structured questionnaire was designed for the survey data collection, in which noise-induced annoyance was defined as individual's adverse reaction towards noise or dissatisfaction, nuisance, bother, or disturbance due to noise. Interviewees were asked to scale their responses from 0 to 10 regarding different types of environmental noises, including noises from general construction and domestic renovation, where 0 was not at all annoyed and 10 was extremely annoyed. As regards the 0 to 10 numerical scale, reference had been made to the approximations on annoyance distributions analyzed with an exposure-response model [5]. Different categories of responses were adopted for facilitating the interpretation of the numerical scale, by denoting the upper scores of 8, 9 and 10 as “highly annoyed”, while the

scores of 4, 5, 6, 7 were interpreted as “annoyed”; the scores of 1, 2, 3 were interpreted as “slightly annoyed” and 0 was interpreted as “not annoyed”.

Prior to the commencement of the survey, a pilot survey was conducted and 50 households were successfully enumerated through face-to-face interviews. Based on the feedback from the survey team, the questionnaire and the operational procedures were refined.

To ensure high-quality survey results, quality control measures were adopted, including training of enumerators, monitoring of the interviewing process by fieldwork supervisors and validation of collected data. The data collection was done via tablets and data were uploaded directly into the database to prevent human error during data entry. Independent checking of at least 15% of the completed questionnaires was conducted.

2.2 Stakeholder engagement

Apart from the socio-acoustic survey, over 20 stakeholder engagement events in form of questionnaires and/or face-to-face meetings with the representatives from the construction trade (including contractors and project proponents) and the property management trade were conducted to collect their views on possible options for further managing noises from general construction and domestic renovation.

3. RESULT AND DISCUSSION

3.1 Overall observation

A total of 6,669 households were identified under the above sampling scheme. Amongst them, 5,962 households were successfully contacted, and 5,066 were successfully enumerated (accounting for the projected population up to 6,324,700 people) while 896 were non-responded. The response rate of 76% was achieved in the survey, which was considered satisfactory.

Among the different types of environmental noises, the percentages of interviewees annoyed by noises from domestic renovation and general construction ranked the top and the third respectively. The extent of annoyance caused by noises from general construction and domestic renovation in the past 12 months was presented as **Figure 1** below. A total of 40.5% and 67.3% of the interviewees indicated various degrees of annoyance (1-10) due to construction noise and domestic renovation noise respectively, in the past 12 months. **Figure 2** showed that, when the concerned time period was widened to cover the past 10 years, the percentages of the interviewees with the experience of “being annoyed” increased to 48.1% and 74.3% respectively. Overall, noise from domestic renovation led to higher degree of annoyance as compared to noise from general construction. It also revealed that majority of the interviewees did have recent (in the past 12 months) unpleasant experience for both categories of noises as compared to the more distant past (1 to 10 years).

Interviewees were asked to suggest time periods in which construction and domestic renovation noise would bring least annoyance to them. As presented in **Figure 3**, noise from daytime works was found generally tolerated in weekdays but the extent of tolerance would progressively be reduced on Saturdays and Sundays.

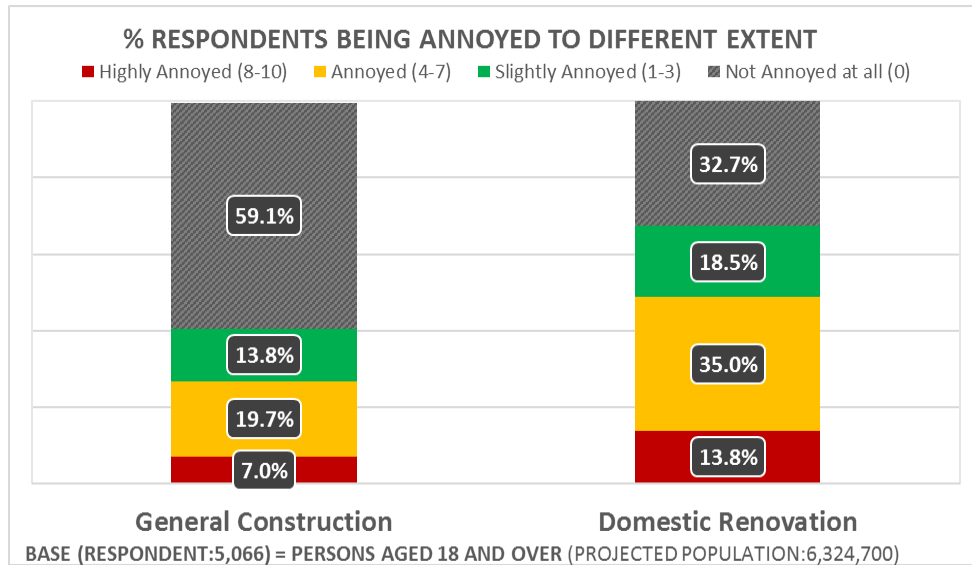


Figure 1: Annoyance response with respect to noise from general construction and domestic renovation in past 12 months⁵

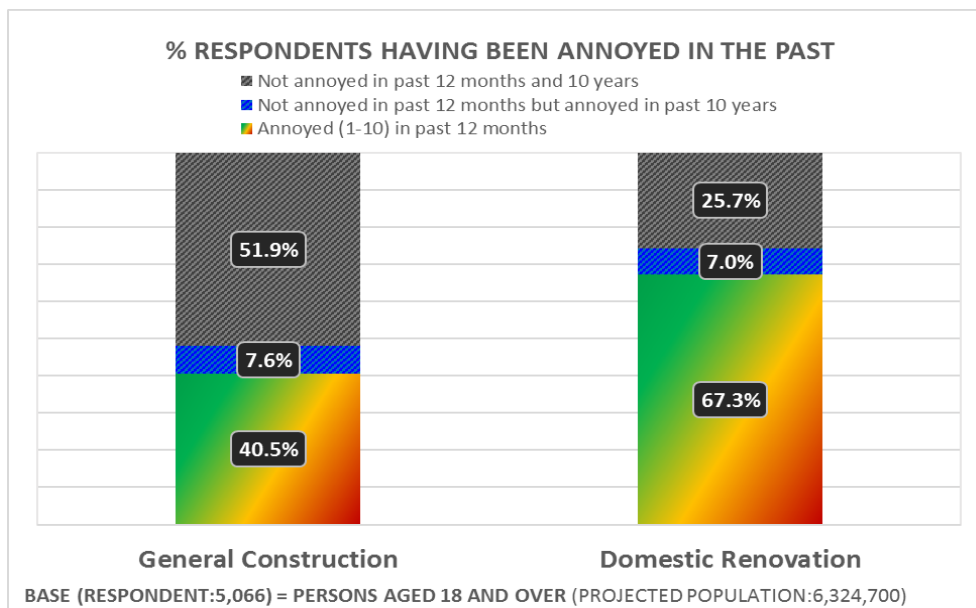


Figure 2: Population annoyed by noise from general construction and domestic renovation in past 12 months and past 10 years

⁵ Sum of column may not be equal to 100% as some interviewees did not answer the relevant question.

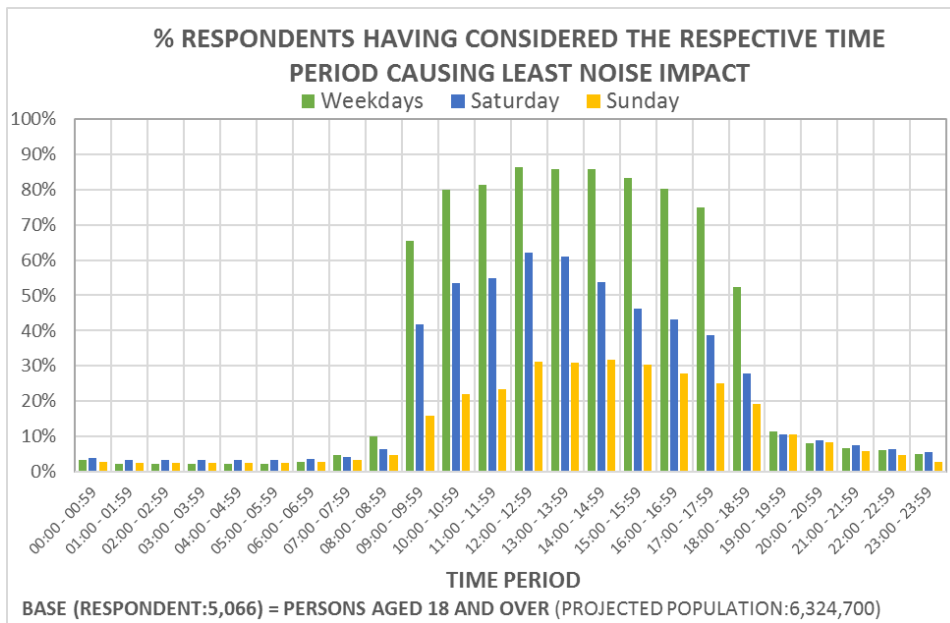


Figure 3: Time periods during which the noise impact from general construction and domestic renovation was considered least

3.2 Noise from general construction

Amongst the 48.1% of interviewees who had the experience of “being annoyed” due to noise from general construction in the past 10 years, as presented in **Figure 4**, the time of annoyance by construction noise mainly occurred during 0900 to 1900 hours in weekdays which reflected the typical period of noisy construction works. On the other hand, construction noise during the restricted hours (i.e. 1900 to 0700) only annoyed 1 – 4% of the interviewees. Such findings illustrated that the CNP system in place is effective in protecting the serenity when majority of the population needed it most (i.e. during the night hours).

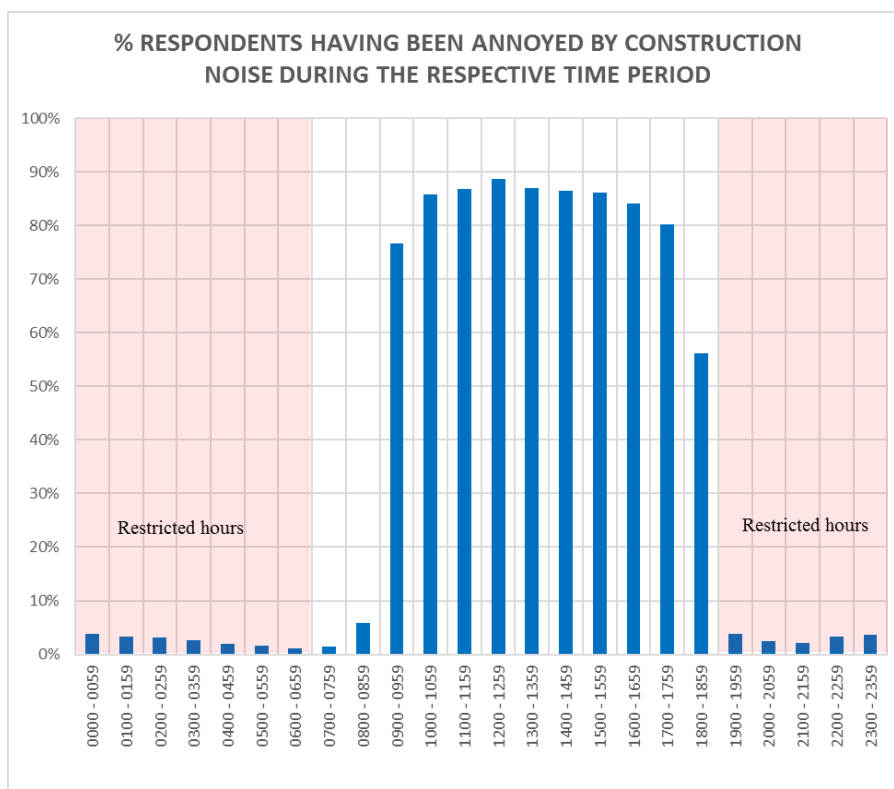


Figure 4: The time periods of construction noise annoyance during weekdays in the past 10 years

The survey also revealed that while nearly half of interviewees had “annoyed” experience due to construction noise in the past 10 years, only a minority (4%) of them did lodge complaints. The reasons of interviewees lodging or not lodging complaints against construction noise were presented as **Figure 5**.

Amongst the majority of interviewees who had been annoyed by construction noise (96%), reasons of not lodging complaints included “noise not affecting daily life” (40.7%); “noise lasted for short time” (21.4%); “informed about the work in advance” (15.5%); and “understood the noise mitigation and constraints” (10.2%). In other words, for the majority of interviewees, although construction noise (particularly during non-restricted hours) was perceived, the extent of annoyance had not extensively led to expressed grievance through available complaint channels, implying it is overall still tolerable or considered as part of the package of living in a vibrant city.

For those minority of the interviewees (4%) who lodged complaints, their reasons were rather straight-forward that they considered the noise was affecting their sleep (54%); be intolerable (24%); or affecting their daily lives (21%).

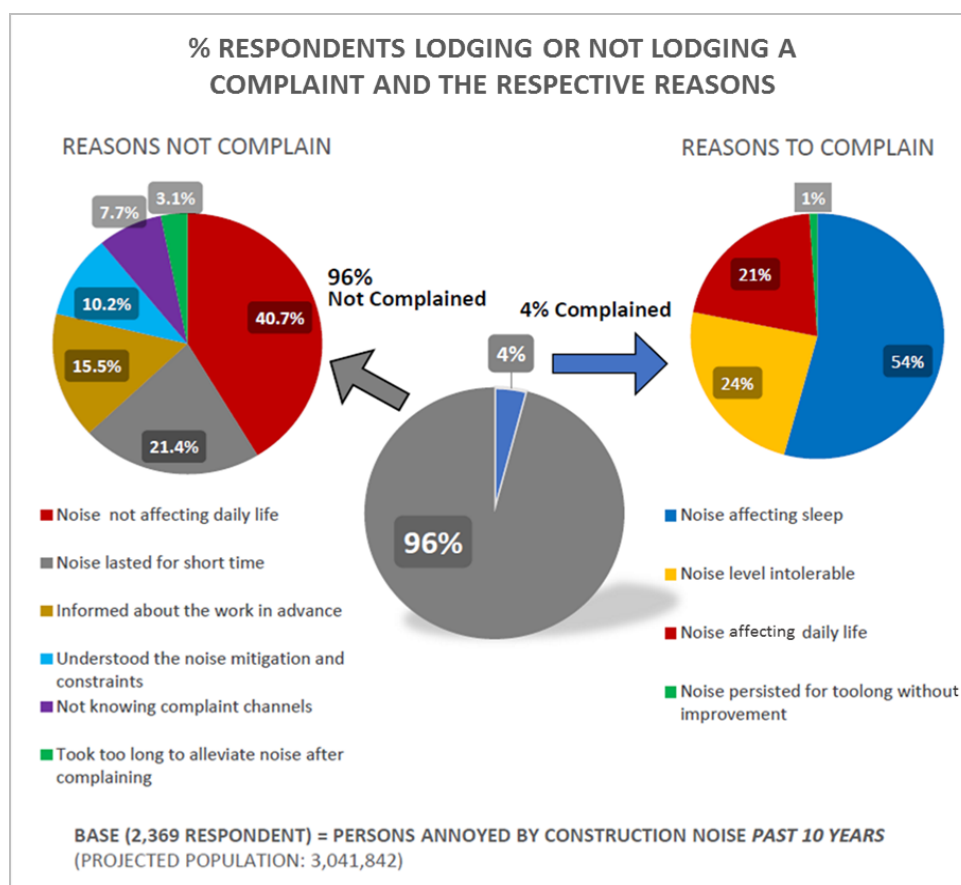


Figure 5: Reasons for lodging or not lodging a complaint against noise from general construction

Specifically, the interviewees were asked to rate their annoyance levels with respect to different types of construction activities, if they were annoyed by construction noise in the past 10 years. Shown in **Figure 6**, amongst all categories, percussive piling, general site activities (including Site Formation and Superstructure Construction) and road maintenance were the “top 3” annoying construction activities.

In terms of the percentage of “highly annoyed” or the sum of the percentages for all different annoyance levels, the above “top 3” annoying construction activities overwhelmed the others. This was probably due to the use of conventional machines operated with a percussive mode that often created intrusive impact noises. Hence, should effective measures be in place to

tackle the “top 3” construction activities, the overall annoyance caused by general construction could be substantially reduced. Meanwhile, quiet construction methods and practices have been gradually gaining popularity in Hong Kong, including non-percussive piling / demolition, expandable chemical rock breaking etc. [6]. With wider adoption of these quiet construction methods and practices in coming years, it is believed that annoyance caused by general construction could be further reduced.

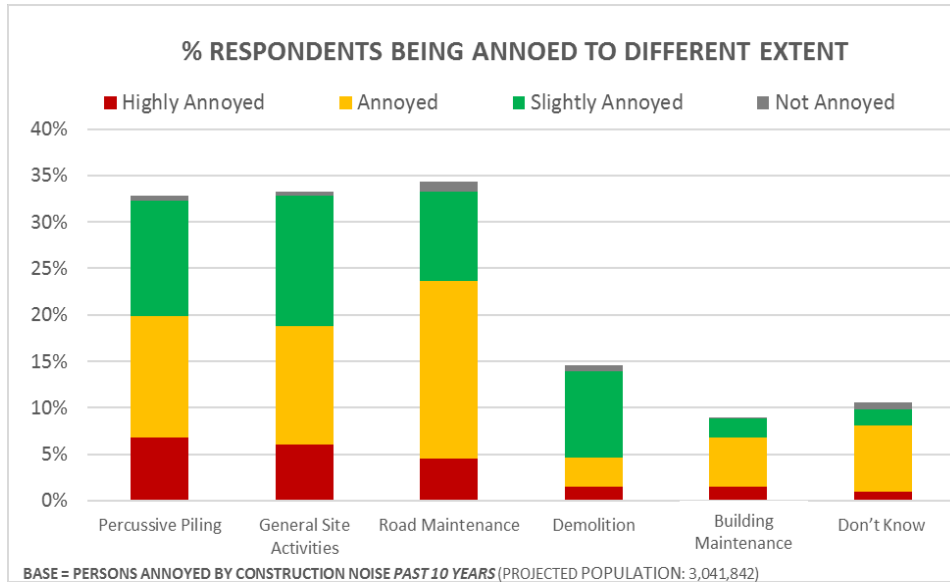


Figure 6: Annoyance response with respect to different construction activities

3.3 Noise from domestic renovation

As mentioned above, 67.3% and 74.3% of the interviewees expressed different extents of annoyance regarding domestic renovation noise in the past 12 months and in the past 10 years respectively. As compared to noise from general construction (and indeed all other environmental noise sources), in terms of both (i) the percentage of “highly annoyed” and (ii) the sum of percentages for different extent of annoyance, it was illustrated that noise from domestic renovation was perceived to be more annoying. The noise from domestic renovation was ranked top in terms of percentages of respondents highly annoyed was also consistent with the results from an earlier analysis of Hong Kong’s acoustical environment in 2012 [7].

In the survey, the annual number of domestic renovations was also examined. It was estimated that not less than 1.25 million households conducted domestic renovations in the past 30 years, which would be equivalent to over 41,000 domestic renovation projects per year, indicating the scale and severity of the noise nuisance associated with domestic renovation in Hong Kong. Nevertheless, similar to general construction, the vast majority (92%) of the interviewees annoyed by noise from domestic renovation did not lodge their complaints, reflecting that they adopted a similar attitude of accepting it as part of the vibrant city.

From management perspective, the Building Management Ordinance [8] is in place to facilitate Owners Corporation (OC) of flats in buildings to provide for the management of buildings. The Ordinance consolidates the legal status of the Deeds of Mutual Covenant (DMC), which defines the rights, interests, and obligations of owners among themselves, and empowers the OC to appoint Property Management bodies (PM) to assist in managing the buildings.

In the survey, it was revealed that 84% of the interviewees were living in buildings with property management services (Figure 7). Currently, PM have been providing services to a variety of housing in Hong Kong, ranging from public housing (rental / purchased), subsidiary housing to private residential estates, etc., and hence having a large coverage amongst domestic premises. The survey revealed that amongst various complaint channels, up to 94%

of the complainants lodged their complaints via PM (**Figure 8**). This has further affirmed the role and importance of PM to act as mediators for domestic renovation noise disputes, and providing aids and solutions to PM could maximize the effectiveness in tackling noise from domestic renovation.

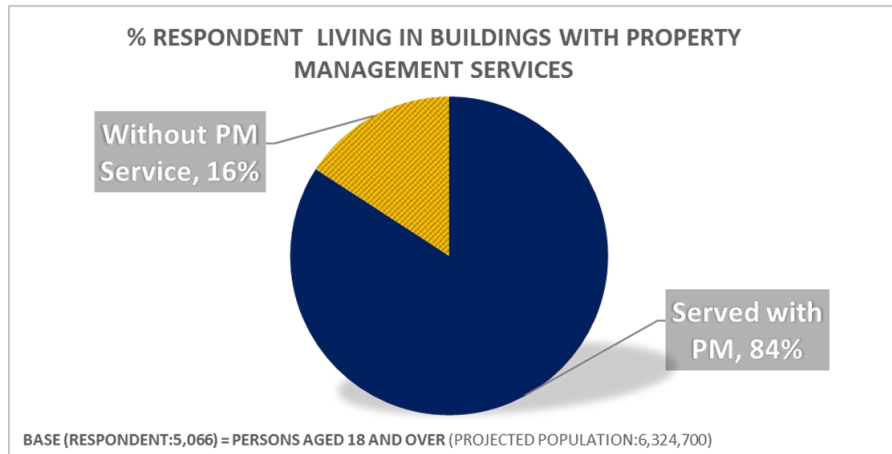


Figure 7: Percentage of respondents living in buildings with property management services

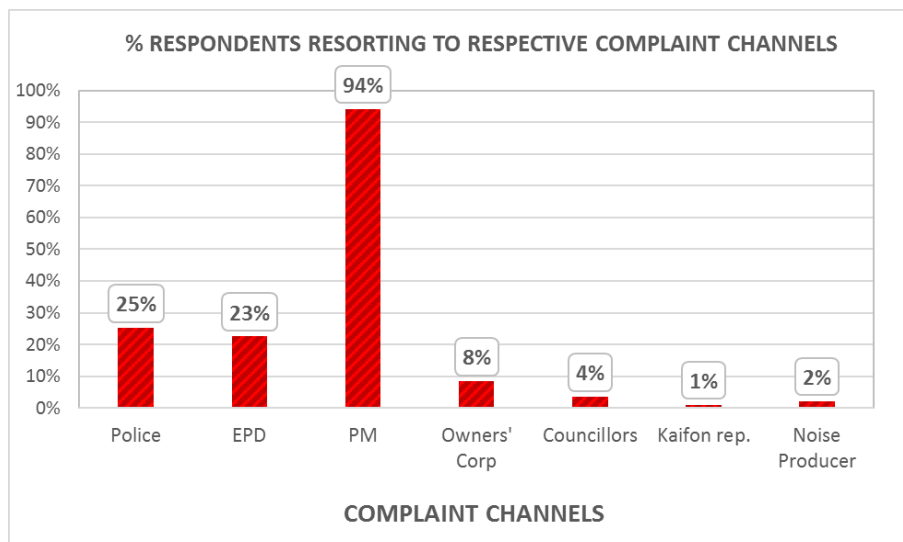


Figure 8: Channels for lodging domestic renovation noise complaints

In order to take the opportunity of the survey to further explore the community's attitudes towards paying for quietness, additional questions were asked to gauge the interviewees' willingness to "pay" for quietening their own domestic renovation, at the expense of (i) prolonged renovation period or (ii) additional cost, as a result of adopting quiet measures. Majority of the interviewees (66%) did not incline to prolong their renovation period in order to reduce the potential noise disturbances to their neighbours (**Figure 9**). Similarly, the majority (75%) did not incline to pay extra costs for quietening their own works (**Figure 10**). As relatively fewer interviewees are willing to pay extra in return of less noise annoyance to the neighbourhood, a more pragmatic approach to address domestic renovation noise would be desirable so as to raise public awareness in minimizing renovation noise and to promote good renovation practices within the current building management framework.

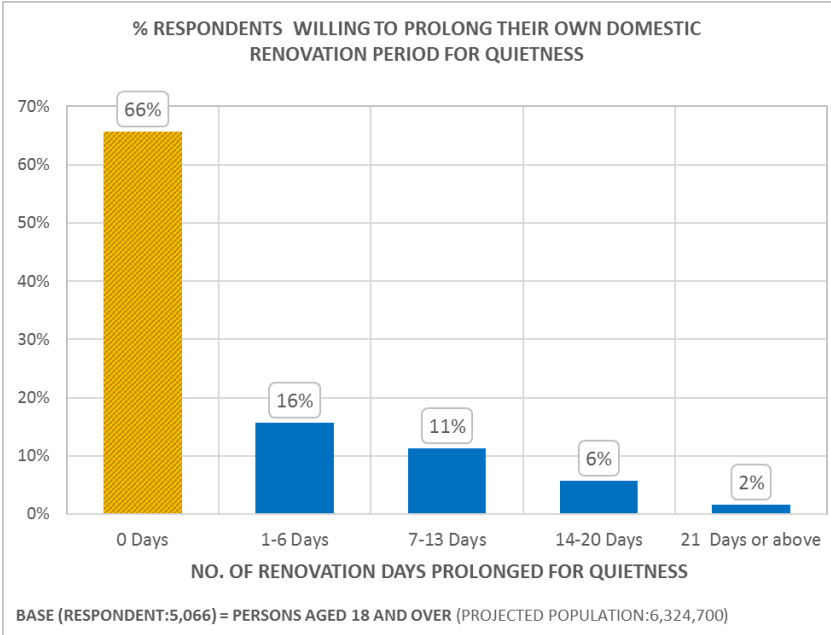


Figure 9: Willingness in prolonging the renovation period for quietness

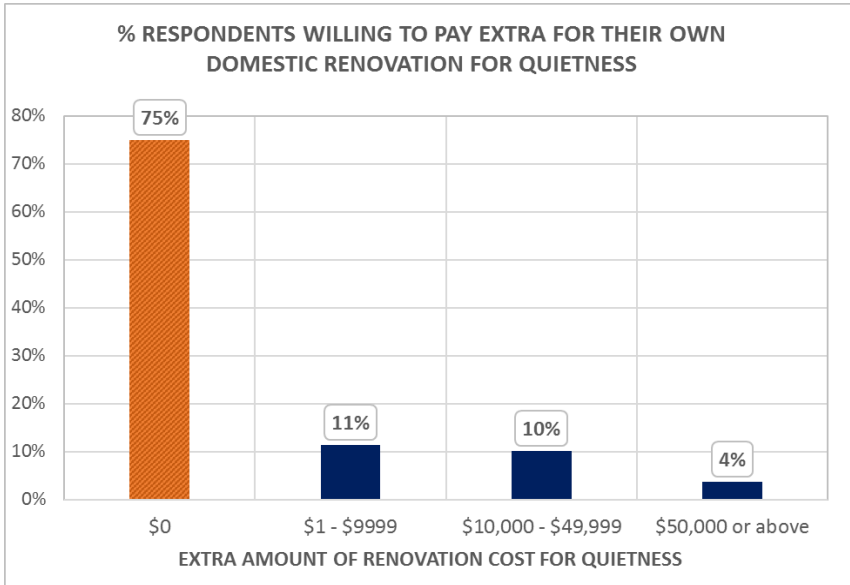


Figure 10: Willingness in paying more for quietness

3.4 Stakeholder engagement

Apart from the socio-acoustic survey among the public, views from the representatives of (i) construction trade (both contractors and project proponents) and (ii) the property management trade were also collected, regarding the feasibility and constraints for further noise control.

For noise from general construction, the importance of early planning for noise reduction was recognized and welcomed by contractors. While there have been quieter construction methods and technologies available in market (e.g. non-percussive piling / demolition), contractors have no insurmountable technical constraints for adopting these quieter methods. Overall, contractors were willing to make changes to bring about progress in adoption of quieter construction. Still, they emphasized that the requirements for adoption of quieter construction and technologies should be spelt out upfront so that they could be factored in during the tendering stage, rather than after the tenders had been awarded or works already in progress, in order to maintain a level playing field amongst themselves. Contractors also indicated that

project proponents should play a key role in adoption of quieter construction methods / technologies, in terms of time given and budgetary issues.

For noise from domestic renovation, similarly, early planning for noise reduction and curtailing of noisy working period was welcomed by contractors who were willing to make changes to bring about quieter renovation. However, most domestic renovation works were carried out by small-scaled contractors / individuals with limited resources, and hence it would require more time to promulgate the availability and the use of quieter gears amongst the contractors / individuals, in order to precipitate a gradual cultural change in the industry.

For project proponents, they generally welcomed early planning and were willing to make changes for quieter construction, as it also means less public complaints on their development sites. Some project proponents did indeed go beyond the statutory requirements to seek reduction in construction noise from their projects. Still, apart from a few keen entities, project proponents were not particularly enthusiastic in introducing additional legislative control on construction noise. Moreover, project proponents generally welcomed the Government to provide incentives and take lead to promote quieter construction.

Amongst the PM sector, it was revealed that PM were generally under pressure to serve both noise producers and receptors within the buildings they managed, thereby facing a dilemma situation. Still, many PM have already implemented some house rules to manage domestic renovation activities within the buildings they managed, such as the limitation of working hour, working date, submission of plans and requirement of early notification. PM welcomed the idea of empowering them via technical and administrative means to better manage domestic renovation noise. On this front, enhancement of DMC to empower the formulation and enforcement of house rules specifically to address domestic renovation noise and noisy working period might be a possible option. It was also observed that the practitioners in the PM sector were not endowed with detailed engineering knowledge on domestic renovation and its associated noise issues, and therefore provision of simple and implementable guidelines would be preferable.

4. CONCLUSION

A comprehensive social-acoustic survey was conducted to collect views from the public on noise annoyance from general construction and domestic renovation. Over 5,000 households were selected randomly through scientific and statistical methods and interviewed face-to-face, accounting for the projected population up to 6,324,700 people. Being the first survey of its scale and nature and with a response rate of 76%, the survey was considered satisfactorily conducted. Apart from the survey, over 20 stakeholder engagement events covering a wide range of industrial and trade groups representing the construction and property management trades were held in order to collect their views and concerns on some possible noise mitigation measures and control options.

The findings of the survey revealed that majority of the population seldom lodged complaints and hence was generally tolerant towards noise from general construction and domestic renovation during daytime in weekdays. As perceived by the public, daytime construction works were found generating greater noise disturbances as compared to night works, which were relatively better managed and controlled under the NCO. Noise from domestic renovation was found to cause greater extent of annoyance than noise from general construction, and hence should be accorded with a higher priority to deal with.

For general construction, the “top 3” annoying construction activities were percussive piling, general site activities (including Site Formation and Superstructure Construction) and road maintenance, and with wider adoption of quieter construction methods and technologies, noise annoyance caused by such activities is expected to be gradually improved. While there would be no insurmountable technical constraints to adopt quieter construction methods and technologies, the requirements for adoption of quieter technologies should be spelt out upfront

so that they could be factored in during the tendering stage in order to maintain a level playing field amongst contractors. On the other hand, project proponents could also play a key role in adoption of quieter construction methods / technologies, in terms of time given and budgetary issues.

As for domestic renovation, the findings revealed that the public was not particularly willing to make their renovation quieter by prolonging their renovation period or paying extra costs, and thus a more pragmatic approach should be adopted to address such noise issue. Given PM are having a large coverage of domestic premises in Hong Kong and were often being the most popular channel for logging complaints, some enhancements of DMC to empower PM for formulation and enforcement of house rules specifically to address noise from domestic renovation and noisy working period might be a possible option. Provision of simple and implementable guidelines for quieter construction would be preferable.

[The opinions in this paper are those of the authors and do not necessarily reflect the views or policies of the Government of the Hong Kong Special Administrative Region of the People's Republic of China.]

REFERENCES

- [1] Noise Control Ordinance, Chapter 400, The Laws of Hong Kong
- [2] Environmental Impact Assessment Ordinance, Chapter 499, The Laws of Hong Kong.
- [3] Census and Statistics Department, HKSAR. Frame of Quarters.
- [4] International Organisation for Standardization. ISO/TS 15666 – 2003 Acoustics – Assessment of noise annoyance by means of social and socio-acoustic surveys.
- [5] Miedema HME, Oudshoorn CG (2001). Annoyance from transportation noise: relationships with exposure metrics DNL and DENL and their confidence intervals. *Environ Health Perspect* 109: 409-416.
- [6] Cheng, K. W., Law, C. W., & Wong, C. L. (2014). Quiet construction: State-of-the-art methods and mitigation measures. In *INTER-NOISE and NOISE-CON Congress and Conference Proceedings* (Vol. 249, No. 6, pp. 2003-2012). Institute of Noise Control Engineering.
- [7] Maurice Yeung, Chi-wing Law, Aaron Lui, Kin-che Lam (2012). Urban Forms in Hong Kong and Their Acoustical Environment. *INTER-NOISE 2012*, New York, U.S.A.
- [8] Building Management Ordinance, Chapter 344, The Laws of Hong Kong