KEEPING NOISE AT BAY – THE CHALLENGE OF PLANNING A HELIPAD AT AN URBAN HOSPITAL

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Provision of a helipad at an existing regional acute hospital, Queen Mary Hospital (QMH), in urban area of Hong Kong, was proposed in its redevelopment project to further enhance its emergency medical services. QMH provides 24-hour Accident and Emergency services and serves as a territory-wide tertiary and quaternary referral centre for many advanced and complex services. The proposed helipad enables point-to-point transfer of patients to the hospital and thus the chance of delay due to traffic congestion during emergency transfer can be greatly reduced. However, as QMH is in close proximity to high-rise residential developments and there are many existing site constraints, it is a great challenge to plan the helipad to ensure compliance with the relevant daytime noise planning standard under the Environmental Impact Assessment Ordinance. The potential noise impact of helicopters in evening and night periods for meeting the 24-hour operation need of emergency medical services is also a big concern. Therefore, the avoidance-minimization-mitigation principle in a comprehensive manner is applied in the proactive planning process. After careful considerations of site constraints and various alternatives, the helipad is planned at the rooftop of a high-rise hospital building to achieve larger separation distance and provide more noise screening to the residential developments nearby. An array of practicable noise mitigation measures, such as quieter helicopters, flight sector design and noise barriers, has been developed to minimize the helicopter noise impact in early planning stage. This paper discusses the noise planning approaches and various measures adopted, which can be considered for planning other new helipads in Hong Kong.

Keywords: Hospital Helipad, Noise Mitigation Measures

1. Introduction

There have been developments of helicopter landing sites in the urban area of Hong Kong, for example, the government heliport near the Hong Kong Convention and Exhibition Centre in Wan Chai and the expanded commercial heliport facilities at the Macau Ferry Terminal in Sheung Wan (as shown in Fig. 1). These two heliports are located at the waterfront of Victoria Harbour in noisy commercial areas. They are also distanced from residential developments and hence the potential noise impact of helicopter operations has been addressed without great difficulties. Compared with the aforesaid cases, there exist more constraints and challenges in planning a new helipad for emergency medical services at an existing urban hospital in close proximity to residential developments.

As shown in Fig. 1, Queen Mary Hospital (QMH) is located in Pok Fu Lam at the western part of Hong Kong Island. Being one of the largest regional acute hospitals in Hong Kong, QMH provides 24-hour Accident and Emergency (A&E) services and serves as a territory-wide tertiary and quaternary referral centre for many advanced and complex services such as neonatal intensive care, coronary care, burns and reconstructive surgery and neurosurgery for the entire territory. Provision of a
rooftop helipad was proposed in QMH’s redevelopment project featuring the use of the northern site of the hospital for construction of a single new hospital block (“New Block”). The helipad is expected to be put into operation in 2024. Among all public hospitals, helipads for emergency casualty evacuation are currently only provided at Pamela Youde Nethersole Eastern Hospital (PYNEH) in the eastern part of Hong Kong Island and Tuen Mun Hospital (TMH) in the New Territories (as shown in Fig. 1). Given that the A&E Department of QMH has been designated as one of the five major trauma centres and the only designated liver transplant centre in Hong Kong, the provision of a helipad at this major acute hospital is considered essential in facilitating the upgrade of helicopter emergency medical services in the territory so as to meet the long-term needs of the community.

In the planning of the proposed helipad at QMH, various factors have been taken into account. They include (i) infrastructural problems of the hospital site, (ii) design standards and safety requirements for the helipad and flight paths of the helicopters, (iii) emergency service requirements and workflow logistics to facilitate clinical convenience for a modern acute hospital, and (iv) associated environmental impacts, in particular the noise impact from emergency helicopter operations. This paper gives an account of the proactive planning mechanisms, helicopter noise impact assessment and development of practicable measures to keep helicopter noise at bay.

Figure 1: Location of the existing and proposed helipads

2. Proactive planning

2.1 Statutory Environmental Impact Assessment (EIA) process

Located within 300m from the nearest existing residential development, the provision of a rooftop helipad at the New Block of QMH is classified as a designated project\(^1\) under Item B.2, Schedule 2 of the Environmental Impact Assessment Ordinance (EIAO) [1]. The project is required to undergo

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\(^1\) Designated Projects (DP) are projects or proposals that may have adverse impacts on the environment and are defined in Schedules 2 and 3 of the EIAO. The project proponent of a DP is in general required to conduct an EIA study for obtaining an Environmental Permit before construction or operation of the DP.
the statutory EIA process to obtain an Environmental Permit from the Environmental Protection Department (EPD) for the construction and operation of the helipad. The EIA shall be conducted in accordance with the Technical Memorandum on EIA Process (EIAO-TM) which covers key EIA process steps and issues representing the state-of-the-art EIA practices in Hong Kong. The statutory EIA Process aims to protect the environment through proactive and early considerations of environmental friendly designs, options and alternatives; avoidance and prevention of adverse environmental consequence in order to influence key decision makings throughout the life cycle of the designated project. The proactive planning of this project shows how the cardinal principles of the EIA, viz. avoidance-minimization-mitigation, in the order of priority, was applied throughout the EIA process.

2.2 Avoidance of noise problem by careful site selection among alternatives

The existing helipads at two public hospitals have their own operation constraints due to their territorial locations (as shown in Fig. 1). The helipad at TMH operates during daytime only as there are high-rise buildings nearby making it not preferable for safe landing during evening and night hours. PYNEH is located at the eastern part of Hong Kong Island and its operation is often affected by low visibility due to foggy weather during spring season. To enhance the helicopter emergency medical services covering the whole territory, it is essential to explore alternative hospital sites for developing a helipad in the western and southern part of Hong Kong. In selecting hospital site for the additional helipad, the classification and functionality of the potential hospitals, site constraints and environmental factors were taken into consideration.

A comparison of the environmental benefits and dis-benefits of the alternative options including a new helipad at the other existing acute hospitals were made with a view to recommending the preferred option to avoid environmental impacts to the maximum practicable extent under the EIA[2]. In this case, after considering various environmental factors including noise impacts, QMH as a major regional acute hospital providing a wide range of complex medical services was considered the most suitable site for developing a new helipad. The evaluation on environmental factors for the potential sites also revealed the development option at QMH could achieve larger separation distance from nearest noise sensitive receivers (NSR) and avoid affecting large population as compared with other hospital sites.

It is existing practice that if any patient needs to be transferred to QMH through air transportation, the helicopter is required to land at existing government heliport at Wan Chai (as shown in Fig. 1). The use of the Wan Chai heliport had been considered as an alternative to the proposed project at QMH. Due to the need of up to 20 minutes road transportation time to QMH, it is considered unfavourable to helicopter medical emergency services and emergency patients.

2.3 Minimization of noise problem by consideration of alternative design options

Alternative design options for the helipad and helicopter flight sectors were evaluated with a view to recommending preferred designs that will minimize the unavoidable helicopter noise impacts as far as practicable.

2.3.1 Alternative siting of helipad

Various options of helipad siting as illustrated in Fig. 2 had been explored and examined. The review revealed that there was insufficient vacant space at ground level of QMH for developing a helipad. The option of adjacent hillside areas of QMH was considered not suitable due to relatively long distance between the helipad and A&E Department as well as the potential ecological impacts on the adjacent country parks. As the existing hospital building blocks were not designed to cater for helicopter landing, their building structures were not capable of supporting the load of a helipad and a helicopter.

Taken into account various factors including medical planning, hospital operation, patient delivery time, etc., the helipad was eventually proposed to be sitting at the rooftop of the New Block of QMH, where the A&E Department is located at the lower floor. To minimize potential helicopter noise

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impact, the helipad was proposed with further setback to the north eastern side to maximize separation distance from and the noise screening effect due to the building structure of the New Block to the NSRs.

![Figure 2: Alternatives of helipad siting (source: [2])](image)

2.3.2 Design of flight sectors

The flight sectors had been designed to minimize the helicopter noise impact. Four options of flight sectors including those at the north-west, east, south and south-west of QMH had been reviewed. In order to balance the flight safety concerns and the possible disturbances to the community, the associated noise impact on NSRs, terrain conditions, obstacle clearances and ambient conditions were thoroughly considered in choosing the suitable flight sectors. The sectors at north-west and south of QMH as shown in Fig. 3 were considered the optimum operation zones which would be able to avoid affecting the densely populated residential areas and hence to minimize the overall exposure of helicopter noise at NSRs yet still fulfilling the safety requirements. In view of the geographical locations of the high ground and the built-up areas in the vicinity of the proposed helipad, the east and south-west sector were not considered. Being the future user of the proposed helipad and the authority on the civil aviation matters respectively, the Government Flying Services (GFS) and the Civil Aviation Department (CAD) had been consulted for the practicality of the flight sectors.
2.4 Helicopter noise impact assessment

As this project would bring in a new noise source to a relatively tranquil urban environment with residential premises including student halls of the University of Hong Kong in the vicinity, the irregular helicopter operations and the unique nature of helicopter noise due to its rotor and blade characteristics may have potential of causing noise disturbances to the neighbourhood if not properly dealt with. During the public inspection period for the project profile, some members of the public expressed concern on the potential noise nuisance from helicopter operations and there were requests for noise impact assessment to take into account the effect of wind speed and wind direction due to the nearby hilly topology. The approach and methodologies adopted in the operational helicopter noise impact assessment are discussed in the following sections.

2.4.1 Helicopter noise assessment criteria and methodologies

For this project, the EIAO-TM stipulates the noise standard of 85 dB(A) $L_{\text{max}}$ for assessing the noise impact from helicopter operations on domestic premises that rely on opened windows for ventilation during daytime (i.e. 0700 – 1900 hours). While there is no noise criterion stipulated in the EIAO-TM for helicopter noise during evening and night-time periods (i.e. 1900 to 0700 hours on the next day), the EIAO-TM states that, for noise matters not fully listed in the EIAO-TM, the criteria for evaluating such noise impacts shall be determined on a case by case basis. In a previous EIA study for expansion of the operation of a commercial heliport at Macau Ferry Terminal [3], a noise metric, $L_{\text{eq}}$ (4 hours), was recommended to be adopted for assessing the helicopter noise impact during the evening period from 1900 to 2300 hours. Noise surveys were also conducted to obtain the existing background noise levels in the study area for consideration of the value of $L_{\text{eq}}$ (4 hours) to be adopted. Taken into account the background noise levels obtained for the concerned commercial district and the findings of the studies on relevant overseas practices, a criterion of 65 dB(A) $L_{\text{eq}}$ (4 hours) was eventually
agreed by the Authority for assessment of the helicopter noise from the operation of the expanded heliport, which would be beyond 1900 hours but not after 2300 hours.

In this particular case where the helipad would be operated for medical emergency purposes around the clock, the project proponent conducted a study on local and overseas practices in assessing noise impacts from helicopter operations beyond daytime in order to recommend the suitable noise assessment approach for this project. The study findings revealed that helicopter operations for medical emergency purposes, law enforcement, firefighting, military, etc., were generally exempt from flight restrictions in Singapore, Japan, California in the U.S. and Victoria in Australia. No statutory noise criterion for evening and night-periods had been established in the studied places for these emergency helicopter operations. In view of the findings, there was no additional noise limiting values established in this case for assessing the helicopter noise impact in the evening and night-time period. Notwithstanding this, the project proponent was required to demonstrate in the EIA that all practicable noise mitigation measures had been adopted to minimise the helicopter noise impact for emergency services.

Helicopter was considered a point source. Helicopter noise impacts at NSRs were predicted with the assumption of spherical propagation based on standard acoustical principles and practices. Noise data for helicopters under lateral and non-lateral movements at known separation distance were used for prediction. Reasonably worst-case scenarios in terms of helicopter types, flight paths, flight frequency and flight hours were adopted in the helicopter noise impact assessment. The noise impact from helicopter operation during its manoeuvring over, approach to, and departure from the proposed helipad and flying past NSRs was assessed. Irrespective of the distance from the proposed helipad, all NSRs potentially affected by the flight paths were well covered in the assessment to check the compliance with the above standard.

To address the public concern on wind effect, the EIA reviewed its potential effect on the predicted noise levels, and found that surface wind gradient and wind direction may influence sound propagation especially over long distance. However, these factors are unpredictable as they are not steady and would vary from time to time. To predict the helicopter noise impact for the reasonable case scenario as required with the EIADO-TM, it is considered inappropriate to include the wind effect into the noise assessment. This is in line with the traditional and conscious practices to avoid the wind effect by stating noise levels for a “still air” situation as mentioned by M. House in [4]. It is in fact the practices in some countries (e.g. Japan and Australia) that helicopter noise assessment would not take the effect of wind into account.

The assessment results revealed that, in the base case scenario (with the proposed helipad on roof top and without specific noise mitigation measures), the predicted noise levels at two representative NSRs at about 340m away from the proposed helipad would exceed the noise standard of 85 dB(A) $L_{\text{max}}$ by 1 dB(A) when the helicopters were operating in hovering mode. With careful design of the helipad location, no noise exceedance was found at the NSRs nearer to the proposed helipad as they were screened by the structure of the New Block from the noisiest helicopter operations i.e. hovering movement.

2.5 Mitigation of helicopter noise impact

The EIA was targeted to meet the daytime helicopter noise standard of 85 dB(A) $L_{\text{max}}$ and required to identify and adopt all practicable strategies and measures to minimise the helicopter noise impacts. Confirmation on the acceptance / feasibility of noise mitigation measure proposals from the relevant authorities was sought during the planning stage to ensure that the measures are technically feasible.

2.5.1 Quieter approach and departure procedures

Within the selected flight sectors, helicopter operations are recommended to be in one-way direction with arrival flight from the north and departure flight to the South and vice versa. This minimizes the overall exposure of helicopter noise at the NSRs. Steeper glide slope and larger take-off angle
was proposed to apply on the approaching and departure operations to increase the distance between the helicopter flight profile and the NSRs and hence to reduce the noise impact.

2.5.2 Quieter helicopter model

The GFS’s existing Super Puma AS332 L2 and Dauphin EC155 B1 helicopters will be replaced by medium-sized single-model helicopter Airbus H175. The Helicopter Replacement Programme has been implementing in phases from 2018 to 2019. The new helicopters would be equipped with more advanced engines and could facilitate quieter operations compared with the phased out ones. When the proposed helipad is put into operation in 2024, all the existing noisier GFS’s helicopters should have been phased out. Due to unavailability of noise data for the new helicopter model at the time of the EIA, the noise assessment adopted a conservative approach by assuming the noise levels of the new helicopter in non-lateral movement operations (e.g. hovering mode, lift off and touch down) with reference to those levels measured for the existing noisiest helicopter model.

2.5.3 Provision of noise barriers

Installation of noise barriers at the rooftop of the New Block as shown in Fig. 4 was proposed to reduce the direct line of sight of the NSRs on the helicopter during hovering, touchdown, lift-off and idling on the helipad. The helipad should be constructed according to GFS Helicopter Landing Site Specification Guidelines and thus a safety requirement for vertical clearance of 10m below the helicopter hovering position in the immediate vicinity of the helipad had to be observed for flight safety reasons. Besides, due to the building services design constraints, the height of noise barriers shall be kept not more than 4m in order to ensure effective operation of the essential ventilation plants on the roof. In the proposal on noise mitigation measures, the height of noise barriers had been maximized to satisfy all design, operation and safety requirements. In addition to maximizing the height of the noise barriers, provision of noise reducers at the top and edges of noise barriers were also proposed with a view to further enhancing the noise shielding effect. With the proposed noise mitigation measures in place, the predicted noise levels at all NSRs comply with the daytime helicopter noise standard of 85 dB(A) $L_{max}$.

Figure 4: Noise barriers and noise reducers at the roof of New Block (source: [2])
3. Discussion

Planning against noise from emergency helicopter operations in an environment mainly with residential uses is a great challenge. This paper illustrates how proactive and preventive planning helps address public concern and keep noise at bay. The helicopter noise impacts have been critically assessed through the statutory EIA process. The EIA report approved in March 2017 under the EIAO concluded that, with all the planning efforts, the potential environmental impacts of the proposed helipad for medical emergency services could meet the noise requirements of the EIAO-TM. The project proponent did not only ensure the compliance with the relevant daytime planning standard, but also demonstrated that all practical noise mitigation measures, including noise conscientious selection of the helipad site and location, careful design of flight sectors and flight paths, use of quieter helicopters and provision of noise barriers with noise reducer, have been adopted to minimise the noise impact for the helipad operation.

The successful and effective approach adopted for planning a hospital helipad against potential noise impact in this case can be applied to planning of similar helipad in Hong Kong in future.

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