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Cost Benefit Analysis of Acoustic Treatments for Entertainment Venues

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Fortitude Valley in Brisbane City, Australia is an inner city area with a vibrant mix of retail, commercial, residential, and entertainment uses. It has been the starting place for several major Australian bands. To address the increase in apartments in the Valley, the Brisbane City Council has developed a noise policy (The Valley Music Harmony Plan) identifying entertainment precincts with specific noise criteria, to allow informed decisions to be made regarding future development while minimizing potential conflicts. A previous paper by the author addressed the ambient noise mapping undertaken for the Valley, and this paper presents the results of the cost benefit study undertaken into the acoustic treatment of selected entertainment venues. The purpose of this work was to provide Council with information on both the feasibility of treating the entertainment venues to reduce noise emissions and the order of cost of the treatments. The study of four venues found that attenuation of 3 – 22dB(A) or 1 – 17dB(C) could be achieved with associated costs ranging from $30,000AUD to over $700,0000AUD (2003 rates). The costing work provided invaluable knowledge for Council in the development of the Valley Music Harmony Plan.

1 Introduction

Fortitude Valley is home to a wide range of uses, including live entertainment venues, residential development, retail facilities, commercial and industrial development. The introduction of residential apartments raised concerns regarding the potential impact on the future of entertainment venues in the Valley. To address this, the Valley Music Harmony Plan (VMHP) was developed by the Brisbane City Council (BCC) in consultation with the Liquor Licensing Division, Environmental Protection Agency, entertainment industry, and community stakeholders. Development of the VMHP required an understanding of the existing noise climate in the Valley and the practicality of reducing venue noise levels.

To determine the existing noise climate, studies were undertaken by the author [1, 2, 3] to provide noise level information and noise contour maps for the Fortitude Valley Local Plan area. This ambient noise information was used as part of the VMHP to assist in the future development of the area, while minimising potential noise conflicts.

As part of the Valley Music Harmony Plan, the Brisbane City Council required information on the following:

- The feasibility of treating entertainment venues to reduce noise emissions ie. what improvement could be achieved; and
- The order of cost for treating the venues.

Studies were undertaken by the author to provide this information [4]. Four venues were selected by the VMHP committee for consideration in the study: The Tivoli, Jubilee Hotel, Ric's Cafe, and The Zoo. These venues were seen by the committee as key live music venues in the Valley that provided a cross section of the types of venues operating in the area. This paper discusses the methodology used to undertake the study and presents the results of the costing work.

2 Methodology

2.1 General approach

The general approach was to undertake an acoustic assessment to allow the design of indicative treatments, and then to use appropriate sub-consultants to estimate the costs for these treatments. The sub-consultants comprised: an architect, a quantity surveyor, and mechanical and electrical services engineers. It was agreed with BCC that while there may be other issues associated with the assessment of the costs for treating the buildings (eg. structural integrity, fire safety, heritage), the selected sub-consultants would have an understanding of these issues sufficient for the costing exercise, and that the engagement of additional sub-consultants was not appropriate for the study.

2.2 The venues

The venues were visited on several occasions, initially to inspect the buildings and meet the operators, then to undertake noise monitoring during the evenings when entertainment was being provided, and finally with the sub-consultants to discuss the proposed acoustic treatments.

2.3 Design of noise control measures

The approach to the design of noise control measures was to select various treatment options to reduce noise levels external to the venues. Treatments were grouped into two or three options for each venue that provided increases in noise reduction with increasing complexity and cost. Initial noise predictions for each venue were undertaken using noise levels measured inside the venues, and the existing venue constructions to predict existing external noise levels. These models were validated against the measured external noise levels. The models were then used to predict the noise attenuation that would result from the installation of various acoustic treatments and constructions. The noise attenuation levels are indicative and would vary depending on several factors including: type of music (see discussion below), location of band, location of external receptor, and final construction details. Noise attenuation levels were predicted using two standard frequency weightings, dB(A) and dB(C). Table 1 shows the indicative attenuation levels predicted for each venue and option.

The noise attenuation calculations were based on the internal noise levels measured at each of the venues during "typical loud" entertainment. The difference in dB(A) and dB(C) levels indicated the amount of low frequency noise audible external to the venue. Where the external entertainment noise was predominantly low frequency (eg. outside the Tivoli), the difference in dB(A) and dB(C) attenuation was small, where vocals and other mid frequency music was clearly audible the difference was

larger. It should be noted that the type of music would affect the predicted noise attenuation shown in Table 1. Music with a higher bass level is more difficult to attenuate than lighter music with the same overall volume. Hence the noise attenuation levels are indicative, and would vary depending on several factors (as noted above) including the type of music/ entertainment being provided. During monitoring the following entertainment was provided:

Ric's Café: Rock band downstairs, and disco upstairs.

The Zoo: Rock band.

The Tivoli: Dance party type disco with significant bass amplification.

Jubilee Hotel: Soloist downstairs bar, and "light" disco party in upstairs function room with relatively low bass amplification.

It was understood that these were typical of the type of entertainment provided in these venues, with the exception of the Tivoli which also hosted entertainment such as light live music accompanying a stage show, which would have significantly lower bass levels.

3 Acoustic treatments and cost

3.1 Venue inspections and treatment costs

During the site inspection of the four venues, the sub-consultants were provided with a list of the proposed acoustic treatment options. These treatments were reviewed and alternatives explored on site to develop the final treatment lists for each venue. The treatments were designed to provide practical solutions to reducing noise emissions from the premises, taking into account cost effectiveness and functional requirements. As noted in the architect's report: "*Take for example the balcony windows at Ric's café- these were detailed in a complex bay shape (expensive), because of the maximum usage of floor area which would need to be available. This was important for the small tenancy area: a loss of even a small floor space would mean loss of potential patronage. Other solutions have taken a more economical approach- for example the rear windows at the Zoo: since it is now required to be fully mechanically ventilated and since it is a night venue, windows have been blocked by a new wall construction rather than more expensive double glazing.*"

A similar approach was adopted for the services works where the type of system proposed took into account the use of the venue, space constraints for installation of the equipment, and cost effectiveness. For example, the proposed system for The Zoo used freestanding internally mounted air conditioners, rather than a fully ducted system which would be more expensive and would require large/ heavier outdoor units. The freestanding units would produce higher internal noise levels than a ducted system but the levels would be well below the internal levels in the venue with live bands. As with all design solutions, there were numerous alternatives that could be explored, however only the agreed options were investigated as the purpose of the work was to provide sufficient detail to allow indicative costs to be established. Costs included consideration of likely construction techniques and time frames. It should be noted that the construction time frames may vary considerably (eg. factor of x 2) from builder to builder. Noise and dust from the works may also impact on the adjacent premises, causing loss of income.

3.2 Ric's Cafe

Ric's Café is located on Brunswick Street Mall, as shown in Fig.1, and provides live entertainment in the ground floor bar and a disco on the first floor during the evening. Dining is provided on the mall outside the premises. The ground floor has ducted air conditioning (but doors are usually left open) and the first floor has a split air conditioning system (but the balcony is open to the outside).

Fig.1 Exterior view of Ric's Cafe.

Entertainment noise is audible on the Mall due to noise radiating via the open solid timber entry door and glass facade downstairs, and the open balcony to the disco upstairs. The building has masonry walls and plasterboard or timber ceilings with corrugated iron roof sheeting. As Ric's Café forms an important part of the streetscape on the mall, architectural changes were approached with minimum impact on the front facade (eg. glazed front balcony). The acoustic treatments were designed to treat the noise radiating through the ground floor facade, then via the first floor open balcony, and then via the roof and remaining (rear) facade elements. Table 1 summarises the proposed acoustic treatments and associated costs for Ric's Café.

It was suggested that structural checks be undertaken to confirm whether the additional weight of the ceiling system could be supported by the existing building roof structure. Initial visual inspection indicated existing ceiling members may be suitable.

Operational costs for mechanical services were difficult to estimate due to the wide range of operating times and occupancy levels, however the following was given as a guide:

- Electrical running cost for First Floor system only: Summer with full occupancy $1.30AUD/hr
- Maintenance: Annual Routine $400.00AUD, Average annual breakdown over life of plant $500.00AUD per annum.

Based on discussions with the architect and services engineers, it was expected that the acoustic treatments could be installed with minimal disruption to the operation of the premises, provided a suitably experienced and

resourced builder was used for the works. It was envisaged that each option would require around 1 to 2 weeks on site, with works being undertaken during the day and left in a safe manner during the evening. Option 1 treatments would be undertaken with parts of the bar closed off during works (eg. solid timber entry door, and then the glass doors). Alternatively the construction time could be shortened by complete closure of areas while works were carried out.

3.3 The Zoo

The Zoo is located on the first floor of a building on the corner of Ann and Winn Streets, with entry via stairs from Ann Street, as shown in Fig.2. Shops are located under the Zoo on the ground floor.

Fig.2 Exterior view of The Zoo.

The Zoo provides live entertainment during the evening. The space is naturally ventilated and noise radiates to the exterior via open windows and doors to Ann and Winn Streets and to the rear of the building. The existing building has masonry walls on three sides, a light weight verandah to the rear alley, light weight plywood ceiling and steel roof sheeting. The Zoo has a relationship with the Valley Heart and is a navigation point for people on Ann Street. Hence the external appearance was to remain unchanged. The acoustic treatments were designed to initially treat the noise radiating through the open windows and doors (which is relatively straightforward architecturally), then via the roof/ ceiling (significantly more involved work) and finally by upgrading the window and door performance. Table 1 summarises the proposed treatments and associated costs for The Zoo.

It was suggested that structural checks be undertaken to confirm whether the significant weight of the new ceiling system could be supported by the existing building roof structure. Initial visual inspection through openings in the existing ceiling indicated the roof structure was light weight and it was doubtful that it would support the new ceiling.

Operational costs for mechanical services were difficult to estimate due to the wide range of operating times and occupancy levels, however the following were given as a guide:

- Electrical running cost for new system: Summer with full occupancy $7.50AUD/hr.
- Maintenance: Annual Routine $1,800.00AUD, Average annual breakdown over life of plant $2,000.00AUD per annum.

Based on discussions with the architect and services engineers, it was expected that the Option 1 acoustic treatments and air conditioning could be installed with minimal disruption to the operation of the premises, provided a suitably experienced and resourced builder was used for the works. It was envisaged that Option 1 would require around 4 weeks on site, with works being undertaken during the day and left in a safe manner during the evening. Option 2 works would be difficult to undertake during day time only, and it was expected that the premises would need to be closed for 2 to 4 weeks. Option 3 works could be undertaken at the same time as Option 2 works, but with a larger crew of tradesmen.

3.4 The Tivoli

The Tivoli is located on Costin Street, opposite the Brisbane Exhibition Grounds, as shown in Fig.3.

Fig.3 Exterior view of The Tivoli.

The Tivoli provides live entertainment during the evening, ranging from soloists, small jazz groups, musicals, to rock bands and discos. The space has ducted air conditioning and noise radiates to the exterior primarily via the roof and fly tower, and also the stage doors. The existing building has masonry walls, original timber raked ceilings with roof sheeting directly fixed to the ceiling. A fly tower has been added to the original building comprising steel sheeting backed with thermal insulation. As the acoustic treatments were primarily to the roof and fly tower, they had little impact on the exterior appearance of the building. However treating the roof and fly tower was a significant undertaking. Given the rope systems in the fly tower and the character of the internal timber ceilings and beams, the acoustic treatments were to be applied from the exterior. The acoustic treatments were designed to initially treat the noise radiating through the doors and fly tower, and then via the roof/ ceiling and ducting. Table 1 summarises the proposed treatments and associated costs for The Tivoli.

It was suggested that structural checks be undertaken to confirm the additional weight of the ceiling and wall treatments to the roof and fly tower could be supported by the existing building wall and roof structure. Operational and maintenance costs for mechanical services would not

be changed by the proposed treatments, however the added roof insulation would reduce the heat load during the day.

Based on discussions with the architect and services engineers, it was expected that both Option 1 and Option 2 treatments could be installed during the day with minimal disruption to the operation of the premises at night provided a suitably experienced and resourced builder was used for the works. It was envisaged that Option 1 would require around 6 weeks on site, with works being undertaken during the day and left in a safe manner during the evening. Option 2 works could be undertaken at the same time as Option 1 works, in a similar period of around 6 weeks on site, but with a larger crew of tradesmen.

3.5 Jubilee Hotel

The Jubilee Hotel is located on the corner of St Paul's Terrace and Constance Street, as shown in Fig.4. Live entertainment is provided during the evening in the ground floor bar, function room on the first floor, and beer garden at the rear of the premises. The ground floor bar has air conditioning (but doors are usually left open), whilst the first floor function room is naturally ventilated.

Fig.4 Exterior view of the Jubilee Hotel.

Entertainment noise radiates to the exterior via the open doors, and from the open beer garden. The building has masonry walls and plaster ceilings with corrugated iron roof sheeting. This building has significant heritage character and is recognised under the Brisbane City Plan 2000 [5]. Hence both internal and external architectural acoustic treatments were designed to have minimal impact on the fabric of the building. The proposed new ceiling to the upstairs function room would cover the existing ceilings without interfering with them.

The purpose of treatments to the upstairs function room was to contain entertainment noise within the function room, bar and corridor. Access to the verandah was provided via two rooms along the hall, which acted as sound locks. Option 1 addressed the door and window treatments, and air conditioning was required as these elements were acoustically sealed. Option 2 allowed for treatment of the roof/ ceiling. Option 3 involved treating the downstairs bar to contain entertainment noise within the original masonry building structure (ie. rather than allowing it to spread into the new light weight "courtyard" area). No improvements were proposed for the beer garden at the rear of the premises.

Table 1 summarises the proposed treatments and associated costs for the Jubilee Hotel.

It was suggested that structural checks be undertaken to confirm the additional weight of the ceiling system could be supported by the existing building structure. Initial visual inspection indicated the walls may be suitable to support a new 'C channel' structure for the proposed ceiling.

Operational costs for mechanical services were difficult to estimate due to the wide range of operating times and occupancy levels, however the following was given as a guide:

- Electrical running cost for First Floor system only: Summer with full occupancy $1.30AUD/hr
- Maintenance: Annual Routine $400.00AUD, Average annual breakdown over life of plant $500.00AUD per annum.

Based on discussions with the architect and services engineers, it was expected that Option 1, 2 and 3 treatments could be installed during the day with minimal disruption to the operation of the premises provided a suitably experienced and resourced builder was used for the works. It was envisaged that Option 1 would require around 6 weeks on site, with works being undertaken during the day and left in a safe manner during the evening. Option 2 works could be undertaken in a period of around 4 weeks on site, but with a larger crew of tradesmen. Option 3 works could be undertaken in a period of around 6 weeks on site, with parts of the bar (eg. a door and window at a time) closed off during works.

4 Conclusions

The method employed to undertake the costing work successfully provided indicative costs for a range of acoustic treatments for the four venues. Based on the acoustic treatments designed, the indicative costs for architectural and services works can be summarised as shown in Table 1.

The study revealed a wide range of potential costs to treat the venues due to the variable nature of the building structures, ventilation and entertainment. The age of the buildings and their heritage character also contributed to the relatively high costs of treatments, particularly treatment of the roof and ceiling construction.

The costing work provided invaluable knowledge for Council in the development of the Valley Music Harmony Plan.

Option #	Description of Acoustic Treatment	Indicative Noise Attenuation[1]	Indicative Cost $AUD[2]
	Ric's Café		
1	Ground Floor Front Façade facing Brunswick Street Mall (reduction to mall) – No attenuation of First Floor entertainment.	9 dB(A) 3 dB(C)	$30,300
2 + 1	First Floor Façade facing Brunswick Street Mall (reduction to mall) – Ground and First Floor entertainment attenuated.	17 dB(A) 9 dB(C)	$94,800
3 + 2 + 1	Roof Treatments and Rear Facade (reduction to receptor above roof)	13 dB(A)[3] 8 dB(C)	$131,900
	The Zoo		
1	Seal Existing Facade and Air Condition venue	11 dB(A) 4 dB(C)	$279,500
2 + 1	Ceiling Treatments	18 dB(A) 12 dB(C)	$382,900
3 + 2 + 1	Upgrade Façade	22 dB(A) 15 dB(C)	$436,100
	The Tivoli		
1	Treat Fly Tower and Doors	3 dB(A) 2 dB(C)	$233,100
2 + 1	Treat Roof and Ventilation Ducting	13 dB(A) 13 dB(C)	$716,600
	Jubilee Hotel		
1	Upstairs Function Room – Doors, Windows & Ventilation	6 dB(A)[5] 1 dB(C)	$120,400[4]
2 + 1	Upstairs Function Room – Roof/ Ceiling	14 dB(A)[5] 10 dB(C)	$162,200[4]
3 + 2 + 1	Ground Floor Bar – Doors, Windows & Basement	20 dB(A)[6] 17 dB(C)	$224,600[4]

1. The Indicative Noise Attenuation levels were based on the Options or combinations of options shown. Two weightings were used dB(A) and dB(C). The latter indicates the improvement in low frequency Noise Attenuation.
2. Costs were taken from the quantity surveyor's report, and the services consultant's report, for architectural and services treatments respectively. Costs include 10% Goods and Services Tax.
3. Attenuation for a receptor above the roof was less than the attenuation to a receptor on the Mall (Option 2+1).
4. Possible additional $12,000AUD for electrical upgrade – further investigation and load testing required.
5. This attenuation was based on the reduction in levels compared with a base case where the function room windows and doors were covered with plywood and insulation to reduce radiated noise levels.
6. Treatments for Option 3 would achieve 20dB(A) attenuation for the Ground Floor bar, while the Upstairs Function Room attenuation would remain at 14dB(A).

Table 1 Summary of Noise Attenuation Treatments and Costs for Venues

The above fees cover general building costs, but exclude the following: possible loss of revenue to the venues or nearby premises during construction; consequential redecorating works (ie. repainting an entire wall to match the new works); architectural enhancements to the acoustic treatments; cost of new roof and associated structures to support acoustic ceilings etc.; electrical system upgrades; additional costs to meet cultural heritage requirements; additional works required by fire/ licensing authorities; project management fees; design consultant fees; application fees to various authorities (eg. development application, building application, fire services, heritage, liquor licensing). Mechanical services upgrades have been sized for peak usage during the evening in summer (ie. no solar load), and an occupancy of 1 person/ m^2 of useable floor area. During the site inspections it was noted that The Zoo presently has a light-weight roof/ ceiling construction and is therefore likely to require significant structural upgrading to allow installation of the proposed acoustic ceiling treatments. The Tivoli may also require structural upgrading of the roof/ ceiling and the fly tower. All venues would require structural investigations, however these have not been undertaken as part of this study.

Acknowledgments

The author wishes to thank members of BCC, Harm Hollander Architect, Rider Hunt, and Drake Consulting Engineers involved in the VMHP work, for their interest and assistance during the venue work. On 1 July 2006 BCC created the Valley Special Entertainment Precinct. This is Australia's first legally designated entertainment precinct, and BCC has created specific noise laws and development control laws to govern the precinct. The VMHP is a BCC strategy which aims to manage the impacts of music noise on residents and businesses in an integrated way without compromising the viability of the music industry in the Valley or the vibrancy of the Valley. A paper was presented on the development of the VMHP [6] by Brisbane City Council.

References

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