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THE COST OF APARTMENT BUILDING DEFECTS

Summary

As Australia's population continues to grow, more and more of us are choosing to live in apartments. Large high-rise apartment towers are going up in our inner cities and outer urban centers, providing new places to live and call home. While new apartment construction has slowed from its peak in 2015-16, it continues to be an important source of economic activity, employment and residential construction (1). Almost fifty per cent of new residential dwellings are apartments. The total value of new apartment commencement in 2018-19 was \$31.7 billion, 14 per cent of the building and construction sector (1).

There has been a staggering increase in new apartment buildings, with new unit starts trebling from 38,400 during 2008/09 to 117,500 in 2015-16 (1). More than double the number of apartments were built in this decade compared to the previous decade.

There are now concerns, as a result of multiple high-profile building failures, such as Opal Tower at Olympic Park in Sydney, and revelations that many buildings have combustible cladding about the quality of these apartments. These concerns are supported by two studies of defects in apartment buildings that found that in excess of 70% of apartment buildings in Victoria, New South Wales and Queensland had defects.

The purpose of this paper is to estimate the total costs likely to result from building defects in apartments built in the last ten years. To do this Equity Economics has relied on publicly available information, used conservative costings and, where data was limited, applied a range to reflect the high level of uncertainty.



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Based on our analysis, we estimate the cost to building owners and State, Territory and Federal Governments of addressing the structural and safety defects in these buildings will approximate **\$6.2 billion (\$5.2-\$7.2 billion)**. This is a conservative estimate that excludes several potential costs including: legal costs; jurisdiction wide building audit schemes; and increases in insurance. In addition, it excludes the cost of defects for apartments built before 2009. The confidence interval around this estimate reflects that the scale of defects is not known and must be estimated using the available data. Our analysis highlights that the cost to Australia will be substantial.

The following sections provide a discussion of the modeling results, a sensitivity analysis and the rationale for the modelling inputs.

Modelling Results

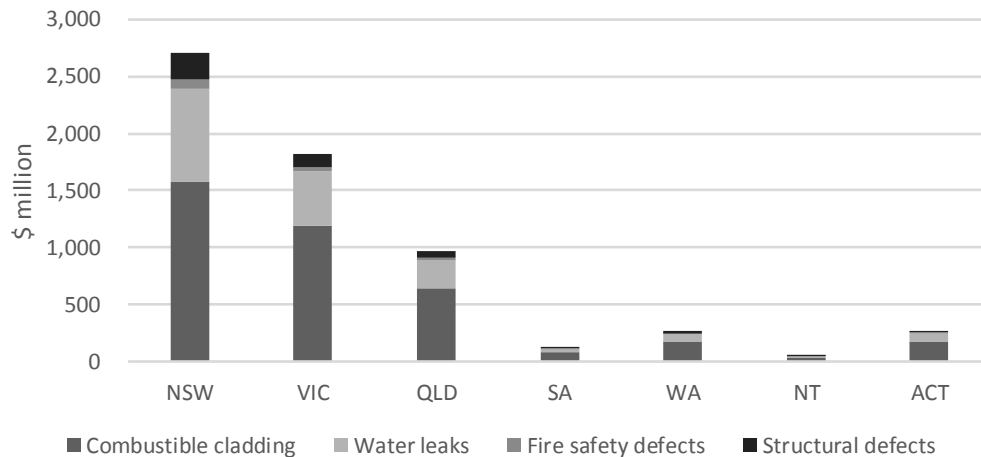
We estimate that building defects in Australian apartments built in the last ten years will ultimately cost approximate \$6.2 billion (\$5.2-\$7.2 billion). Most of these costs result from apartments built in New South Wales, Victoria and Queensland. Figure 1

Figure 1: Estimated cost per state and territory of residential apartment building defects – central estimate

breaks down the central cost estimate for building defects by state and territory.



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Note: Tasmania has been excluded due to low levels of apartment building activity.

While this cost is substantial, it has been developed using a conservative methodology and excludes several costs, including:

- The full range of building defects as sufficient information was only available to credibly calculate the costs of combustible cladding, water leaks, fire safety defects and structural defects.
- Increases in insurance premiums for building surveyors, builders and apartment owners. For example, it is reported that the insurance premiums of the owners of Anstey Square increased from \$29,000 to \$134,000 following the discovery of combustible cladding and their excess increased from \$1,000 to \$100,000.(2)
- State prescribed building audits such as the ones being undertaken in several states to assess the extent of combustible cladding.
- Legal expenses.
- Alternative accommodation costs when apartments or buildings are temporarily or permanently uninhabitable.



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In addition, the cost model has been rigorously sensitivity tested ensure the estimate is robust.

Sensitivity testing

There are several assumptions in this analysis that, given the uncertain nature of the issue being considered, may vary either side of the central estimate used. It is therefore important to sensitivity test these assumptions. Key assumptions that have sensitivity tests due to uncertainty are:

- Cost of the defects per apartment.
- Number of apartments per building with combustible cladding.

As Table 1 and 2 below demonstrate, even when the low estimates for these assumptions are applied, the overall cost of rectifying defects in these apartments the minimum cost exceeds \$3.5 billion in each instance.

Table 1: Sensitivity test – number of apartments per building with combustible cladding

	Low	Medium	High
Number of apartments per building	34	49	64
Estimate (million)	\$5,015	\$6,199	\$7,383

Table 2: Sensitivity test – cost of defect rectification per apartment

Cost per defect per apartment		Low	Central	High
Combustible cladding	Substantially effected	\$30,000	\$40,000	\$50,000
	Moderately effected	\$2,500	\$8,750	\$15,000
Water leaks	Substantially effected	\$15,000	\$25,000	\$35,000



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	Moderately effected	\$2,500	\$5,000	\$7,500
Fire safety defect	Substantially effected	\$4,000	\$9,000	\$14,000
Structural defect	Substantially effects	\$45,000	\$60,000	\$75,000
	Moderately effected	\$2,500	\$5,000	\$7,500
Estimate (million)		\$3,868	\$6,199	\$8,529

Monte Carlo Simulation

In addition to varying individual assumptions, a Monte Carlo simulation has been conducted. Monte Carlo simulation makes it possible to vary multiple assumptions simultaneously and explore the effect of their potential interactions on the final estimate of cost. It involves performing 20,000 simulations of the cost model using values for the assumptions that have been randomly selected from a defined range and distribution. This approach makes it possible to improve the robustness of the costing estimate.

Table 3, below, lists the assumptions varied during the Monte Carlo simulation. All assumptions were subject to a truncated normal distribution.

Table 3: Assumptions that were varied during the Monte Carlo simulation

Assumption	Minimum	Most likely	Maximum
Cost of combustible cladding rectification per apartment – substantially effected building	\$30,000	\$40,000	\$50,000
Cost of combustible cladding rectification per apartment – moderately effected building	\$2,500	\$8,750	\$15,000
Number of apartments per combustible cladding effected building	34	49	64
Cost of water leak rectification per	\$15,000	\$25,000	\$35,000



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apartment - substantially effected building			
Cost of water leak rectification per apartment - modestly effected building	\$2,500	\$5,000	\$7,500
Cost of fire safety defect - substantially effected building	\$4,000	\$9,000	\$14,000
Cost of structural defect - substantially effected building	\$45,000	\$60,000	\$75,000
Cost of structural defect - modestly effected building	\$2,500	\$5,000	\$7,500

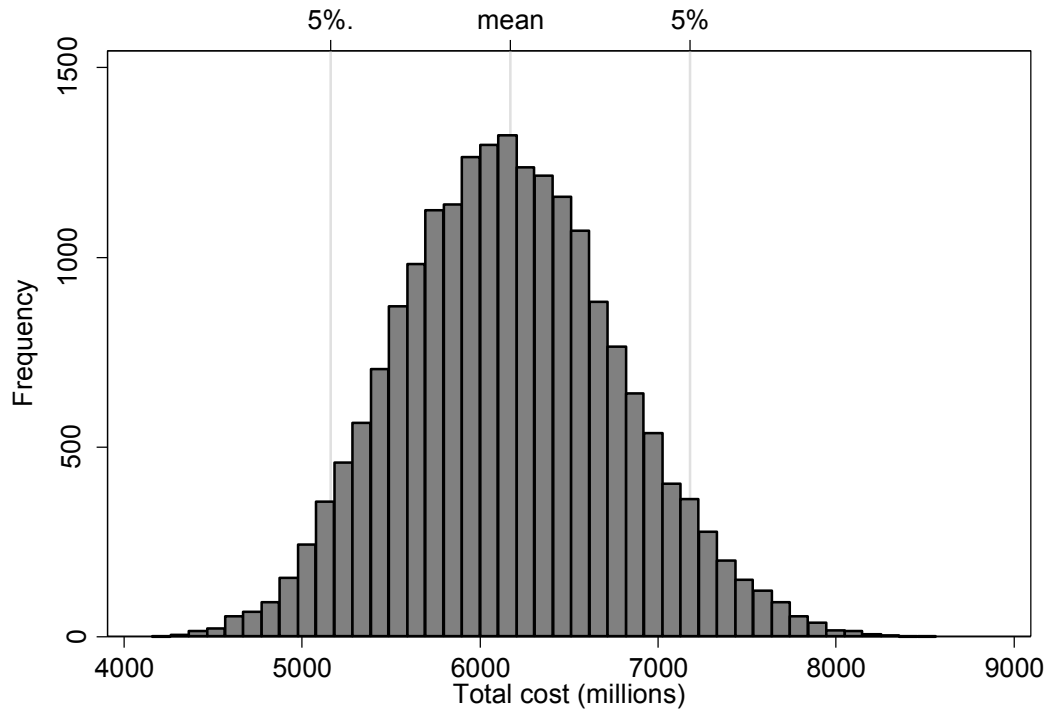
The Monte Carlo simulation found that the cost attributable to residential apartment defects ranged from \$4.2 to \$8.6 billion, with a 90% probability that the true cost was between \$5.2 and \$7.2 billion.

Figure 2 illustrates the results of the Monte Carlo Simulation and highlights the robust nature of the central estimate.



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Figure 2: Monte Carlo simulation of cost of apartment building defects for apartments built between 2009 and 2018



Reasonableness

Based on other publicly available information on costs, our estimate appears reasonable and sensible. For example:

- Geoff Hanmer, adjunct lecturer at UNSW, is quoted as estimating the cost of defective apartments will cost \$10 billion. The basis for this estimate, however, has not been provided. (3)
- Strata Community Association NSW \$1 billion to address combustible cladding in New South Wales. This is consistent with our central estimate of costs for NSW.(4)
- The Victorian Government has committed \$600 million to fund rectification works for buildings at extreme and high risk from combustible cladding.(5).



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This is an average of \$1.2 million per effected building. Our central estimate is higher – approximately \$1.7 million per building – for extreme and high risk buildings, however, \$1.2 million per building estimate is well within the range of values considered.

Modeling input

Forecasting the cost of building defects in residential apartment buildings built in Australia in the last 10 years relies on several assumptions because at this stage it is not known:

- How many apartments are effected
- What the defects are
- How much will it cost to rectify them
- How will demand for rectification works will affect the cost of the work

A scan of news reports on building failures provides some illustration on the extent of the problem. See Table 4, below.

Table 4: Reported apartment building defect costs

State or Territory	Name of building	Type of defect	Cost per dwelling	Source
NSW	Mascot Towers	Structural	\$75,000	(6)
	The Quay	Cladding	\$45,000	(7)
	Garland Lofts	Structural and fire safety Evacuated	\$165,000	(8)
	45 Bowman Street, Pymont	Cladding	\$35,000	(9)



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	Landmark building Charlestown	Defects levy	\$17,000	(10)
VIC	Lacrosse	Cladding led to fire	\$50,000	(11, 12)
	South Yarra apartment block	Cladding	\$55,000	(13)
	Brunswick apartment block	Water damage	\$41,000	(14)
	Neo200	Cladding led to fire	\$2700 (cladding replacement)	(15)
	St Kilda apartment block	Water damage	\$72,000	(16)
	Anstey Square, Brunswick	Cladding	\$19,000	(2)
ACT	Elara in Bruce	Structural and water damage	\$158,000	(17)

In order to forecast the cost of building defects in residential apartments built over the last ten years we estimated the cost of rectifying combustible cladding, water leaks, fire safety defects and structural defects nationwide.

Cost of combustible cladding

The cost of combustible cladding was estimated using the following formula:

number buildings effected x number of apartments per building x cost per apartment

How each of these inputs has been estimated is outlined below.



Number of effected buildings

In Victoria the Victorian Building Authority is leading an audit of residential buildings three stories and higher to identify which ones have combustible cladding. It has thus far identified more than 1000 private residential buildings with combustible cladding.(18) These buildings have been categorized based on the fire risk posed by the cladding.

Table 5: Results of the Victorian combustible cladding audit

Fire risk	Extreme	High	Medium	Low
Number of residential buildings identified	72	409	388	200

Source: VBA

Despite being on-going, this is the most complete data on the extent of combustible cladding use in the residential apartment building industry.

To estimate the total stock of residential apartment buildings in Australia with combustible cladding, it was assumed that:

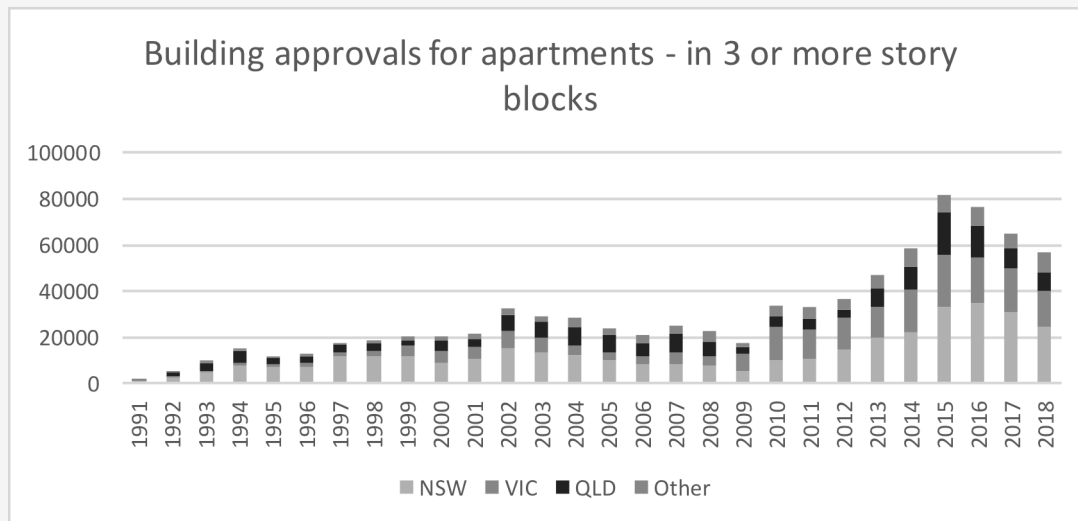
- All buildings with combustible cladding in Victoria had been identified.
- Combustible cladding use in other jurisdictions matches Victoria's.



- Total apartment approvals between 2009 and 2018 are an appropriate proxy to scale the results of the Victorian audit to reflect the stock of buildings with combustible cladding in other jurisdictions. Figure 3 below summarizes the extent of residential apartment building activity and illustrates the distribution

Figure 3: Apartment building activity in Australia

In the ten years from the start of 2009 to the end of 2018, building approvals have been issued for more than 500,000 new apartments in blocks three stories or higher.(1) Up from less than 250,000 for the previous ten years. As Figure below illustrates, most these apartments have been built in Victoria, New South Wales and Queensland.



by jurisdiction.



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As summarized in Table 6, below, using this approach, we estimate that there are over 3400 buildings nationwide with combustibile cladding.

Table 6: Estimated number of residential apartment buildings in Australia with combustibile cladding

Jurisdiction	Extreme	High	Medium	Low	Total
NSW	95	540	512	264	1411
VIC	72	409	388	200	1069
QLD	38	218	207	107	570
SA	5	26	25	13	69
WA	10	59	56	29	154
NT	2	12	11	6	31
ACT	11	60	57	29	157
Total	233	1324	1256	648	3461

Note: Tasmania has been excluded as only 250 apartments in 3 stories or more high complexes have been built over the last ten years.

Based on other published estimates these estimates are reasonable. For example:

- The Australian Society of Building Consultants (NSW) has estimated that there are 2700 buildings in Sydney alone with ACM. (19)
- NSW cladding taskforce had identified 222 high priority residential buildings, including 83 which are 8 stories or higher.(20)
- The Daily Telegraph estimated the number of cladding-affected buildings in NSW was 1500, while the Strata Community Association NSW president Chris Duggan estimated it would be closer to 2000. (21)
- Nearly 600 private residential buildings in Queensland have been identified as needing an inspection and more than 400 more have not provided enough information to determine if an inspection is required. (22)
- Western Australia’s State-Wide Cladding Audit has identified 46 residential apartment buildings where remediation is required. (23)



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Cost per apartment

The Deakin University study reported that the cost of cladding remediation cost between \$2500 and \$15,000 per apartment for low to medium risk buildings; and between \$20,000 and \$60,000 per apartment for high to extreme risk buildings. Similarly, the AFR reported that the average cost of replacing cladding on a high rise buildings was between \$40,000 and \$60,000 per unit.(24) Based on news stories reporting where it has been possible to estimate the cost per apartment, the cost per high to extreme risk apartment appears a bit high (See Table 4 Above). These costs are likely to be at the upper end of the costs borne by apartment owners to rectify combustible cladding. Therefore, we have adopted a conservative approach and applied the following estimates:

- \$40,000 per extreme or high fire risk apartment, sensitivity testing at \$30,000 and \$50,000.
- \$8,625 per medium and low fire risk apartment, sensitivity testing at \$2,500 and \$15,000.

Currently jurisdictions are applying different criteria to determine a building's risk of fire and hence requirements for remediation are also variable. However, in jurisdictions where remediation works are less onerous, it is anticipated that this will impact on sale price to an extent at least equivalent to the avoided remediation costs.

Number of apartments per complex

It has been estimated that on average there will be 49 apartments per effected building. This is based on the average number of apartments per building in the Melbourne City Council area in complexes with at least three apartments.(25) This estimate has been sensitivity tested at 34 and 64.



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Cost of other building defects

There is significantly less data on the extent and cost of other defects in residential apartment buildings.

There are two relevant studies of the extent of defects in residential apartments in Australia. These indicate that apartment buildings are more likely than not to have defects:

- A survey of more than 1100 apartment owners in 2012 by UNSW City Futures Research Centre found that more than 75% of respondents reported knowledge of one or more defects. (26)
- A review of 212 audit reports across New South Wales, Queensland and Victoria by researchers at Deakin and Griffith Universities found that 97% of buildings in New South Wales, 71% in Queensland and 74% in Victoria had at least 1 defect across multiple locations. (27)

These findings support the growing concern and the frequent news reports, see Table 4, above, that the problems with combustible cladding represent only a small proportion of the total costs to apartment owners of substandard building practices.

We have estimated the likely costs of water leaks, fire safety defects and structural defects.

The cost of each type of defect are calculated using the following formula:

$$\% \text{ with defect} \times \text{cost of fixing the defect} \times \text{number of apartments}$$

Defects are further broken down as either minor or major defects. How the inputs for each class of defects has been estimated is outlined below.



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Water leaks

There are several estimates of the extent water leaks in residential buildings:

- The Australian Institute of Architects found that 4% of buildings inspected between 2010 and 2015 in Australia (9% in NSW) had a major water problem and a further 34% had a minor water problem.(28)
- UNSW City Futures Research Centre's survey found that 42% of respondents reported internal leaks and 40% reported water penetration from outside.(26)
- Deakin University's study of building audits found that of the more than 3000 defects identified in the audits of 212 buildings, 11% were waterproofing defects, 13% were cladding defects that led to water ingress and 9% were roof and guttering defects.(27)

We have chosen to apply the Australian Institute of Architects estimates for water leaks. It is a more conservative estimate than the UNSW survey and it provides a split between minor and major defect rates.

Data on the cost to rectify water leaks and the damage they cause is sparse. In Canada, the leaky condo crisis, resulted in 31,000 individual housing units built between 1980s and early 2000, being damaged by water. The average repair cost per apartment was \$25,000 (\$CA 23,000).(29) This estimate is much smaller than the estimates for specific buildings published in the news, however, these are likely to be the most extreme cases. In addition, it has been reported that the cost of fixing leaking bathrooms in apartment buildings costs \$12,000-\$15,000.(30) We have, therefore, applied the following estimates:

- \$25,000 per apartment with a major water problem, sensitivity tested at \$15,000 and \$35,000.



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- \$5,000 per apartment with a minor water problem, sensitivity tested at \$2,500 and \$7,500.

Fire safety defects

Estimates of buildings with fire safety defects by the UNSW and Deakin University studies are very similar, 15% and 13% respectively.(26, 27) We have used the UNSW estimate because the UNSW estimate is per apartment whereas the Deakin estimate is a proportion of total defects. In the absence of more relevant information, we have assumed that the ratio of major to minor defects is consistent with the reported ratio for water leaks. Therefore 20% of fire safety defects in NSW are classed as major as are 10% in all other state and territories.

A Noble Park apartment building was required to spend \$500,000 on rectification works to ensure it met fire safety requirements after it was revealed that it did not have adequate fire safety measures. This is equivalent to \$9,000 per apartment.(31) This figure has been used as central estimate for a major fire safety defect and has been sensitivity tested at \$4000 and \$14,000. A minor defect assumed to be \$1,000 per apartment.

Structural defects

The Deakin University study reports that 7% of the defects in the audit reports were classed as structural.(27) We have used this to estimate the prevalence of structural defects in apartment buildings. However, it is not known if these defects were spread uniformly through the buildings audited or concentrated in a few specific buildings. As such, this estimate may overstate the number of effected buildings.

In the absence of more relevant information, we have assumed that the ratio of major to minor defects is consistent with the reported ratio for water leaks.



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Therefore 20% of structural defects in NSW are classed as major as are 10% in all other state and territories.

The cost of fixing Mascot Towers is estimated to exceed \$10 million.(6) This is equivalent to \$75,000 per apartment. We have applied a more conservative cost of \$60,000 as a This figure has been used as central estimate for a major structural defect and sensitivity tested at \$45,000 and \$75,000. A minor defect has assumed to be \$5,000 per apartment and has been sensitivity tested at \$2,500 and \$7,500.



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