Beyond Aesthetics: How Cabin Finishes Influence Lift Design

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Abstract. Modern lift cabin interiors have evolved into architecturally expressive spaces incorporating premium materials and integrated systems. While these finishes enhance perceived quality, they introduce significant engineering implications that are often overlooked during design. As lift-rated capacity and traffic analyses are typically based on bare cabin dimensions, the addition of interior finishes reduces the net usable area available to passengers, affecting passenger capacity, traffic performance and accessibility compliance.

This raises the critical questions:

Are traffic analyses based on accurate, real-world cabin conditions?

Do nominal car sizes continue to comply with accessibility standards once interior finishes are applied?

The paper identifies practical thresholds for assessing the impact of cabin finishes on lift design, highlighting the need to consider accessibility implications where finishes exceed 15 mm per wall and traffic performance implications where they exceed 25 mm per wall.

1 INTRODUCTION

Contemporary buildings increasingly prioritise interior aesthetics, with lift cabins evolving from purely functional enclosures into high-value architectural spaces. Finishes such as natural stone and composite panels are commonly incorporated to enhance user experience and align with design intent.

However, cabin finishes are often treated as architectural features rather than engineering design parameters. As lift-rated capacity, traffic performance, and accessibility assessments are typically based on bare-car dimensions, the resulting reduction in usable internal space may be overlooked. This can lead to overestimation of passenger capacity, reduced accessibility, and a gap between design assumptions and actual lift performance.

This paper evaluates the influence of cabin finishes on traffic performance and compliance with accessibility requirements. It argues that failing to consider finished internal car dimensions at the design stage can result in a consistent overestimation of lift performance.

To address this issue, the paper advocates early multidisciplinary coordination to ensure that interior design intent aligns with engineering performance requirements.

2 CONTEMPORARY TRENDS IN CABIN FINISHES

Modern lift design demonstrates a shift toward customisation and high-end finishes, including:

- Natural stone, engineered stone, composite panels
- Recessed handrails
- Concealed lighting systems in car walls

These solutions often require additional backing panels and support frames. As a result, wall build-ups can increase from 25–100 mm or more for premium installations. While visually appealing, the additional thickness reduces the lift's usable internal dimensions, affecting passenger capacity, traffic performance, and compliance with accessibility requirements.

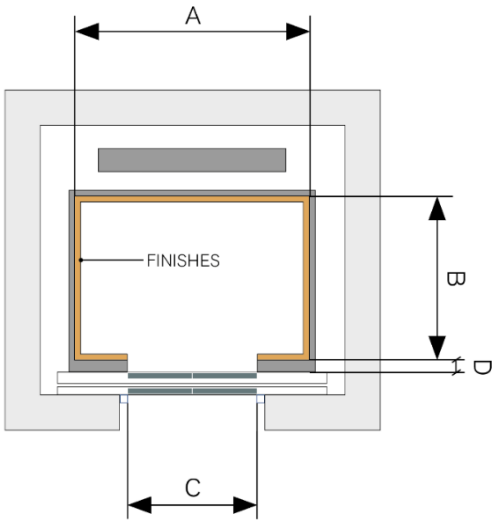
Figure 1 shows the interior of the office lifts at ICD Brookfield Place, Dubai, incorporating finish build-ups of approximately 80 mm on each side wall and 25 mm on the rear wall, together with a recessed handrail.



Figure 1 ICD Brookfield Place, Dubai

3 LIFT RATED LOAD DETERMINATION

BS EN 81-20 [1] defines the permissible relationship between the rated load of a lift and its car area, with the rated load determined based on the bare car dimensions, excluding any internal finishes.



Maximum available car area = A x B
If D>100mm,
Maximum available car area = (A x B) + (C x D)

A – Bare Cabin Width
B – Bare Cabin Depth
C – Clear Door Width
D – Front Return Panel Thickness

Figure 2 Car area calculation for rated load – BS EN 81-20 [1]

ASME A17.1-2022 / CSA B44 adopts a similar approach by relating rated load to the net internal platform area, with an allowance of up to a 5% increase to accommodate design variations. However, modern cabin finishes often exceed this allowance, reducing the effective usable area.

Although this paper references the EN 81 series of standards, the issue is globally applicable. Lift performance is generally assessed using nominal dimensions, whereas actual performance is governed by finished internal conditions.

A lift may be capacity-compliant but still fail in accessibility or operational performance due to reductions caused by cabin finishes - "*Compliance ≠ usability.*"

4 FINISHES INFLUENCE ON TRAFFIC PERFORMANCE

Research by Dr Gina Barney [2] demonstrated that lift cars rarely achieve the theoretical passenger capacity implied by their rated load, as passenger accommodation is constrained by available floor area and personal space requirements rather than by mass alone. In practice, passenger capacity is therefore limited using an assumed area per person, typically 0.21 m². Dr Richard Peters' research paper [3] recommends addressing variability in passenger characteristics by adjusting the assumed area per person (e.g. 0.21 m² for offices and 0.3 m² for residential use, as recommended in CIBSE Guide D) [4], rather than by modifying loading thresholds.

The introduction of cabin finishes exacerbates this issue by reducing net usable internal area, thereby lowering effective passenger capacity, and increasing the divergence between predicted and actual performance. Consequently, reliance on nominal car area results in systematic overestimation of lift system capability.

Table 1 and Figure 3 illustrate the impact of cabin finishes on net usable car area and passenger capacity for a 1600 kg lift with car dimensions of 2100 mm (W) × 1600 mm (D), in accordance with ISO 8100-30:2019 [5]. The capacity reductions presented are specific to the car dimensions considered and will differ for other lift sizes.

Table 1 Impact of finishes thickness on passenger capacity

Scenario	Finishes thickness per car wall	Net usable car width	Net usable car depth	Net usable car area[1]	Maximum number of passengers per car[2]	Reduction in Capacity[3]
	[mm]	[mm]	[mm]	[m²]	Persons	
1	Nil	2100	1600	3.36	16	0%
2	15	2070	1570	3.25	15	6%
3	25	2050	1550	3.18	15	6%
4	50	2000	1500	3.00	14	13%
5	80	1940	1440	2.79	13	19%
6	100	1900	1400	2.66	12	25%

[1]Assuming same finish thickness on all four sides of the car wall.

[2]Maximum passenger capacity based on a passenger area of 0.21 m² per person

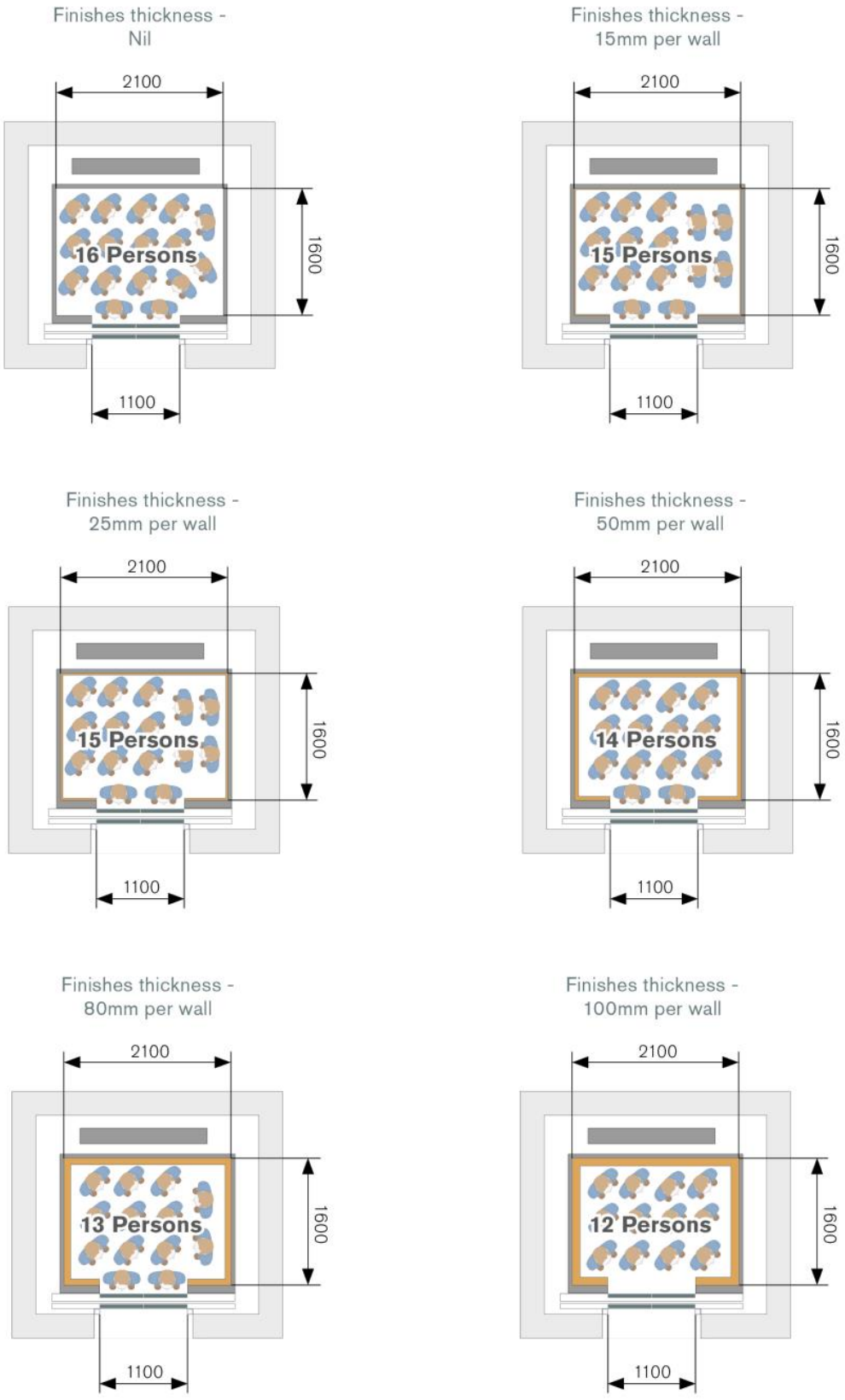


Figure 3 Maximum passenger capacity for a 1600kg lift with varying finish thickness.

The case study presented in this paper examines the impact of lift car finish thickness on traffic performance. The analysis considers a G+12 office building with a total population of 1,200 occupants, uniformly distributed at 100 per floor, with the ground floor serving as the main entrance level. The floor-to-floor height is 4.5 m.

Traffic performance was evaluated using a simplified simulation model under up-peak traffic conditions. The key modelling assumptions were as follows:

- Control system: Destination Control System (DCS)
- Passenger area allowance: 0.21 m²/person
- Capacity factor by mass: 100%
- Capacity factor by area: 100%
- Constant traffic demand over a one-hour simulation period

The lift system was assessed against the performance criteria specified in ISO 8100-32:2020 [6].

- Traffic condition: Up-peak (100% incoming traffic)
- Handling capacity in 5 minutes: 12%
- Average waiting time: 30 seconds

To evaluate the impact of cabin finishes on traffic performance, all building and lift parameters were kept constant, while the net usable car area was varied to reflect different finish thicknesses. Table 2 presents the traffic analysis results for each finish thickness scenario, including net usable car area, average capacity factor by area, average waiting time, and average time to destination. This enables a direct assessment of how reductions in usable car area, resulting from increased finish thickness, influence the overall performance of the lift system.

Table 2 Impact of finishes thickness on traffic performance

Lift Quantity	Lift Capacity	Lift Speed	Finishes thickness per car wall	Net Usable Car Area	Handling Capacity in 5 min	Average capacity factor by Area	Average Waiting Time	Average Time to Destination
	[kg]	[m/s]	[mm]	[m²]			[s]	[s]
5 Lifts	1600	2.5	Nil	3.36	12%	74%	29.1	80.4
5 Lifts	1600	2.5	15	3.25	12%	76.4%	29.6	81.0
5 Lifts	1600	2.5	25	3.18	12%	78.1%	29.6	81.0
5 Lifts	1600	2.5	50	3.00	12%	83.9%	31.7	83.8
5 Lifts	1600	2.5	80	2.79	12%	93.1%	129.9	188.1
5 Lifts	1600	2.5	100	2.66	12%	94.7%	651.8	738.5

The traffic analysis results show that the average waiting time remains within the design target of 30 seconds for finish thicknesses up to 25 mm. Beyond this point, performance begins to deteriorate. A significant non-linear increase in waiting time is observed at finish thicknesses of 80 mm and above, indicating that the lift system is approaching saturation.

Post-analysis assessment shows that average car loading exceeds the commonly accepted 80% occupancy threshold when the finish thickness exceeds 25 mm. Consistent with the observations of Dr Richard Peters [3], increasing waiting times indicate that the lift system is operating closer to saturation and is less resilient to variations in passenger demand.

The magnitude of this effect is not determined by finish thickness alone and will vary depending on factors such as lift capacity, building arrangement, control strategy, and traffic patterns. Nevertheless, the underlying principle remains the same: reducing the net usable car area reduces the effective carrying capacity of the lift system.

(Recommendation) Therefore, traffic analysis should always be based on the net usable internal car area to ensure a reliable and realistic assessment of lift system performance.

5 FINISHES INFLUENCE ON ACCESSIBILITY

BS EN 81-70 [7] is widely adopted as a global benchmark for lift accessibility, particularly in regions influenced by European engineering practices or lacking comprehensive local standards. The standard defines the minimum technical requirements for accessible passenger lifts.

It establishes baseline provisions to support independent access for a wide range of users, including those with mobility or sensory impairments, with the key principle that lifts shall be usable without assistance.

However, a compliance-versus-usability gap can arise in practice, as the application of cabin finishes may reduce usable internal space and limit the intended level of accessibility under real operating conditions.

Lift car design is therefore critical, as it directly determines:

- Wheelchair access
- Physical support and stability during travel
- Reachability of controls
- Effectiveness of sensory performance (visual, auditory)

For lift consultants and designers, the critical question is "*Can a diverse range of users enter, use, and exit the lift independently and confidently?"*

(Design risk) Failure to adequately coordinate architectural and lift design requirements can introduce significant risks, including accessibility non-compliance, reduced operational performance, and costly modifications or retrofitting following installation.

5.1 Wheelchair access

Finished internal dimensions play a critical role in ensuring that lifts are genuinely accessible in practice. The introduction of car finishes can significantly reduce usable space, thereby affecting accessibility by limiting wheelchair access and manoeuvrability.

BS EN 81-70 specifies the minimum lift car dimensions for different levels of accessibility. Type 2 lift cars (rated load of 630 kg) with internal dimensions of 1100 mm (W) × 1400 mm (D) represent the minimum accessible lift size for new buildings.

BS EN 81-70 further states that decorative finishes up to 15 mm thick on each wall may be disregarded when assessing accessibility compliance. However, thicker finishes reduce the usable car dimensions and may affect compliance with the minimum accessibility requirements.

Figure 4 illustrates the effect of 25 mm wall finishes on a Type 5 lift car (1275 kg rated load) with internal dimensions of 2000 mm (W) × 1400 mm (D). This lift type is commonly adopted as the minimum practical solution for accommodating Class A, B, and C electrically powered wheelchairs, as defined in EN 12184. The finishes reduce the clear internal dimensions, resulting in an effective car depth of less than 1400 mm. Consequently, the lift cannot be considered an accessible lift solution for a new building.

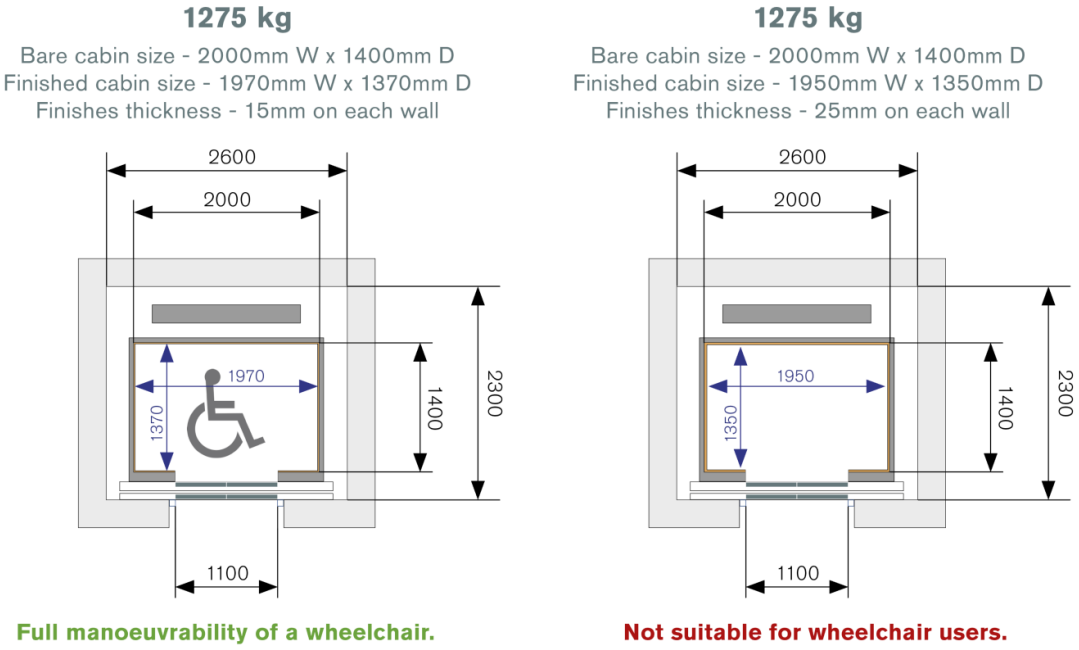


Figure 4 Finishes thickness impact on wheelchair compliance

(Recommendation) Accessibility assessments should be based on the finished internal cabin dimensions rather than the bare cabin dimensions. This ensures that the installed lift provides the required wheelchair accommodation and remains compliant with the accessibility requirements of BS EN 81-70.

5.2 Physical support and stability during travel

Handrails enhance safety and comfort not only for ambulant disabled users, but also for elderly passengers and others with reduced balance or mobility.

BS EN 81-70 requires a handrail to be provided on one side wall of the lift car, typically the wall containing the car operating panel. For lift car Types 4 and 5, a second handrail is required on either the opposite side wall or the rear wall (Code Requirement – BS EN 81-70). While providing handrails on all non-door walls is recommended as good practice, it is not a mandatory requirement of the standard.

Handrails are a key accessibility feature and must comply with specific dimensional criteria, including a graspable circular profile with a diameter of 30–45 mm and a minimum clearance of 35 mm between the handrail and the wall. These requirements are intended to ensure that passengers can maintain a secure and comfortable grip while travelling.

However, certain design solutions, such as recessed handrails or flat bar handrails (as shown in Figures 5 and 6), may not meet these requirements. These arrangements can restrict effective gripping space, reduce hand clearance, and make it difficult for users, particularly those with limited mobility, reduced dexterity, or visual impairments, to maintain a secure and continuous grip. This can compromise both safety and usability.

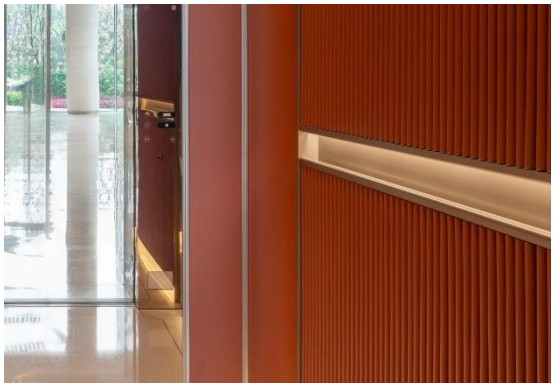


Figure 5 Recessed handrail



Figure 6 Flat bar handrail

5.3 Reachability of controls

BS EN 81-70 requires the car operating panel (COP) to be positioned on the side wall, enabling passengers, including wheelchair users, to access the controls directly after entering the lift car without the need for additional manoeuvring.

Figure 7 illustrates an alternative COP arrangement, where the panel is located on the front return wall to achieve a cleaner architectural appearance on the side walls. This arrangement is commonly seen in older installations and in countries where BS EN 81-70 is not the governing accessibility standard. However, it can present accessibility challenges, as wheelchair users may need to reposition themselves within the car to reach the controls after entering. Consequently, the side-wall COP arrangement specified by BS EN 81-70 provides superior accessibility and ease of use.

It is also important to ensure that lift controls remain within the reach limits specified by BS EN 81-70 for wheelchair users. The standard recommends that car operating panel buttons are positioned between 850 mm and 1200 mm above the finished floor level.



Figure 7 COP on front walls (Emaar Square, Dubai)

5.4 Sensory Performance

5.4.1 Visual Performance

Reflective or uniform materials (e.g. polished metals, mirror stainless steel) may cause glare and reduce luminance contrast, making controls and signage harder to identify.

To maintain visual performance:

- Sufficient luminance contrast between controls, signage, and background surfaces in accordance with BS EN 81-70 / ISO 21542 [8] should be provided.
- Highly reflective finishes near the COP and indicators should be avoided.
- Transparent elements should be designed to minimise visual discomfort; in high-rise applications, their use may be limited where excessive exposure affects user comfort.

(Recommendation) Visual conditions should be verified on site, as lighting and reflections can reduce performance after installation.

5.4.2 Auditory Performance

Cabin finishes can degrade auditory performance by causing:

- Uneven induction loop signal
- Increased reverberation and reduced speech clarity

As a result, systems meeting design criteria may underperform after the installation of finishes.

(Recommendation) To ensure effective auditory performance, the induction loop field strength should be maintained at 400 mA/m (RMS) ±3 dB (283-566 mA/m) across the lift cabin in accordance with IEC 60118-4 [9] and verified on site following the installation of cabin finishes.

6 OTHER IMPACTS

Shaft Constraints: Increasing the bare cabin size to compensate for the finishes may require a larger lift shaft, which can be difficult to accommodate at later stages of the design process.

Additional Car Mass and Equipment Selection: Lift manufacturers typically allow an additional 300-800 kg for cabin finishes, depending on the rated load. Where the weight of cabin finishes exceeds the manufacturer's standard allowance, additional assessment may be required to verify the suitability of the lift equipment, safety components, and certification status [10].

Higher Electrical Demand: Excessive finish weight may increase motor size requirements and electrical power demand.

Fire Safety: BS EN 81-20 [1] requires the supporting structure of the lift car body to be non-flammable. Furthermore, materials used for the car walls, floor, and ceiling should comply with EN 13501 or relevant local fire performance requirements. Decorative finishes, laminates, composites, and adhesives can contribute to fire load, smoke generation, toxicity, and flame spread, and should therefore be carefully evaluated during material selection.

7 CONCLUSION

The key thresholds identified in this paper are 15 mm and 25 mm of decorative finishes per wall. BS EN 81-70 permits finishes of up to 15 mm per wall to be disregarded when assessing accessibility. Beyond 15 mm, the impact of finishes should be explicitly considered in accessibility assessments. Where the build-up exceeds 25 mm, the effects on traffic performance should also be assessed. These thresholds demonstrate that cabin finishes can no longer be regarded as purely architectural elements and must be considered as part of the lift design process.

A coordinated design approach is therefore essential, supported by the following key actions:

- Early definition – Define cabin finishes during the concept / schematic design stage.
- Space planning – Allow for finish thicknesses in initial space planning.
- Traffic analysis – Include finishes in the internal car area in traffic calculations.
- Accessibility compliance – Verify that the finished car dimensions remain suitable for wheelchair users and that handrail designs and car operating panel arrangements comply with accessibility requirements.
- System checks – Review impacts on lift equipment selection, electrical demand, and fire safety requirements.

While nominal car dimensions may guide early planning, actual lift performance depends on the finished internal dimensions available to passengers. By considering cabin finishes from the outset and coordinating them throughout the design process, project teams can ensure that lifts achieve their intended accessibility compliance and operational performance.

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BIOGRAPHICAL DETAILS



Vignesh Dhanapal is currently working as a Senior Vertical Transportation Engineer at Foster + Partners, London.

He began his career as an installation engineer in India and has over 10 years of experience in the Gulf region as a Vertical Transportation Consultant.

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