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Determining Gaps in Evacuation Design Practice Affecting People with Disabilities

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Disclaimer

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Read and approved,

Ishaan Pathania
May 29, 2026

Table of Contents

Abbreviations

ADB	Approved Document B
ADM	Approved Document M
ADO	Automatic Door Operators
AS	Australian Standard
ASME	American Society of Mechanical Engineers
BFA	Hong Kong Design Manual: Barrier Free Access
BS	British Standards
CoA	Singapore Code on Accessibility in the Built Environment
CoP	Code of Practice
CSA	Canadian Standards Association
FLS	Fire and Life Safety
FSiB	Fire Safety in Buildings
FSI&E	Hong Kong Code of Practice for Minimum Fire Service Installation and Equipment
ICC	International Code Council
NBCC	National Building Code of Canada
NCC	National Construction Code
NFPA	National Fire Protection Association
NZS	New Zealand Standard
UAE	United Arab Emirates

Abstract

While accessibility in building design is now a widely adopted principle with the industry increasingly adopting inclusive practices, its integration into evacuation provisions remains limited and inconsistently applied across the world. This study examines gaps in evacuation design practices affecting occupants with disabilities through a comparative review of ten building codes and standards, supplemented by evaluation against existing scientific literature. Sixteen evacuation-related design features were assessed across key phases of evacuation. The findings conclude that although current codes and standards include some provisions aimed at inclusive evacuation design, their application remains limited compared to conventional design features based on normative assumptions of occupant ability. Widely implemented features such as audible alarms and exit signage stand in contrast to the limited and often conditional provisions addressing the needs of occupants with functional limitations, including visual alarms, communication systems, and mobility-related features. Significant gaps were identified in the prescribed notification systems, horizontal and vertical movement provisions, and the capacity and usability of areas of refuge. Overall, this uneven provision of design features results in an unequal level of safety for occupants with functional limitations. The study suggests that current practices could be improved through clearer performance criteria and broader application of existing accessibility provisions to include egress routes.

Keywords: Egressibility, Inclusive Design, Egress Provisions

1. Introduction

Toward the end of the 20th century, numerous initiatives were undertaken to create a more inclusive built environment by reducing barriers for people with mobility or other functional limitations. Along with this progress came the parallel concept of egressibility, a term introduced by Proulx and Yung [1], who noted that "*egressibility means that, in case of an emergency, the occupants have the ability to leave a building or to reach an area of safety unharmed.*" This was further studied and expanded upon in the work of Smedberg [2], who interpreted egressibility to mean "*accessibility to means of evacuation*".

Although meaningful strides have been made globally in accessibility, and in addition to the minimum code requirements, many building owners now pursue voluntary rating systems such as the Rick Hansen Foundation Accessibility Certification [3] to demonstrate the inclusiveness of their facilities. Similarly, tools like Housing Enabler [4] can be used to assess housing accessibility by comparing the functional limitations of an individual or group against the environmental barriers present in a house. However, the same level of progress has not been achieved for egressibility. Past studies [5], [6] indicates that during emergency evacuations, individuals with functional limitations often have to rely on assistance from others because building design does not provide adequate measures to support self-evacuation. This dependence directly contradicts the principle of independent living for people with functional limitations and undermines the possibilities such as aging in place.

This study follows the biopsychosocial model of disability as defined in the International Classification of Functioning, Disabilities and Health (ICF) [7], which considers disability in performing an activity (such as evacuation, which may be further broken down into constituent tasks) a result of interaction between the health condition or impairments in body function or structures (such as functional limitations) and contextual factors. Contextual factors are the environmental factors (such as building design features) and personal factors (such as age or gender).

The 2011 World Health Organization (WHO) report on disability [8] estimated that approximately 15% of the world's population live with some form of disability. Although the metrics used to quantify disability vary across surveys and countries, this proportion has likely increased over time or is at least being reported at higher levels regionally. Recent data from several countries included in this study indicate substantially higher rates, including Australia at 21.4% [9], Canada at 27% [10], New Zealand at 17% [11], the United Kingdom at 25% [12], and the United States at 28.7% [13]. Mobility-related disabilities alone were reported at levels exceeding 10% across all of these countries.

Recent estimates from National Fire Protection Association (NFPA) indicate that physical disability was likely a factor in 18% of home fire deaths [14]. In the study by Runefors et al. [6], which examined factors influencing survival and evacuation among older adults aged 65 years and above, found that at least 53% of the older adults in the reviewed dataset required assistance to evacuate. This assistance was provided by first responders, neighbors, or homecare personnel. The study further noted that airtightness and sound insulation of the buildings can influence the possibility of receiving assistance from neighbors due to potential absence of fire clues such as smoke alarm or fire noise, or smell of smoke.

The reliance on assistance from first responders or neighbors suggests that survival outcomes could have been notably different in situations involving delayed response by first responders or the absence

of assistance from neighbors. As noted in recent publication [15], a significant knowledge gap remains regarding egressibility, particularly related to building design features that create barriers to independent evacuation.

Although previous studies have examined specific functional limitations in relation to individual building design elements [16], [17], [18], [19] or other works that link evacuation activities to various functional limitation that are impacted [20], there remains a general lack of systematic connection between building design features mandated by codes and standards, or the absence of such features, and their impact on the independent evacuation ability of occupants with functional limitations.

2. Aim and Objectives

This research proposes to address the gap in existing literature by reviewing a selected set of building codes and standards from different jurisdictions worldwide. The primary objective is to determine whether current code-driven design practices may result in disproportionate impacts on individuals with functional limitations during emergency events. As discussed above, this population group may represent up to ~29% of the total population in some regions [13].

The aim of this study is to identify systematic gaps and differences across jurisdictions that may influence the ability of individuals with functional limitations to evacuate independently during emergency fire events. This study is specifically focused on self-evacuation and does not consider assisted evacuation by staff or emergency responders. The study does not intend to evaluate the quality of individual codes or standards in isolation, nor to propose best-practice solutions, rather the focus of the study is on understanding the current state of design practice. To achieve this aim, the following objectives have been identified.

1. Evacuation Provisions in Codes and Standards

   To determine the extent to which evacuation-related design features addressing the needs of people with functional limitations are represented within selected codes and standards.

2. Assessment of Equity in Evacuation Design Practices

   To assess whether current evacuation design practices provide comparable level of design features to support independent evacuation for individuals with functional limitations as those provided for able-bodied individuals.

3. Methodology

3.1. Scoping of Codes and Standards for Review

To inform the selection of the codes and standards for review, and to maintain the focus of this study on the evaluation of evacuation provisions, this research adopts as starting point the list of regions identified in a previous study by Xue [21] on phased evacuation. In that scoping review, seventeen countries and regions were initially identified based on economic influence and population size. Xue [21] subsequently reduced these to thirteen countries and regions based on the availability of current fire and life safety codes and standards in English and public accessibility. International best-

practice guides and standards were also included. Table 1 presents the list of countries and regions identified for initial scoping for this study.

Table 1: List of Countries Identified for Initial Scoping (adapted from Xue [21])

Europe	Asia	America	Oceania
United Kingdom	Republic of Singapore	United States of America	Commonwealth of Australia
Ireland	People's Republic of China	Canada	New Zealand
Italy	Hong Kong Special Administrative Region of the People's Republic of China		
Sweden			

Given that this study evaluates sixteen evacuation-related design features (see Section 4.1 for details), compared to a single focused element of the referenced work by Xue [21], the list of codes and standards was further narrowed down using the following criteria:

1. The code or standard should be written in English or have an official English translation available, and
2. Performance-based codes, standards, and handbooks are excluded from this study, as the scope of this study is limited to the typical code-based design features prescribed under conventional prescriptive framework. Performance-based design standards generally allow greater flexibility in application of best practice or novel design solutions, which limit the feasibility of direct comparison of typically used design features.

This selection process is illustrated in Figure 1.

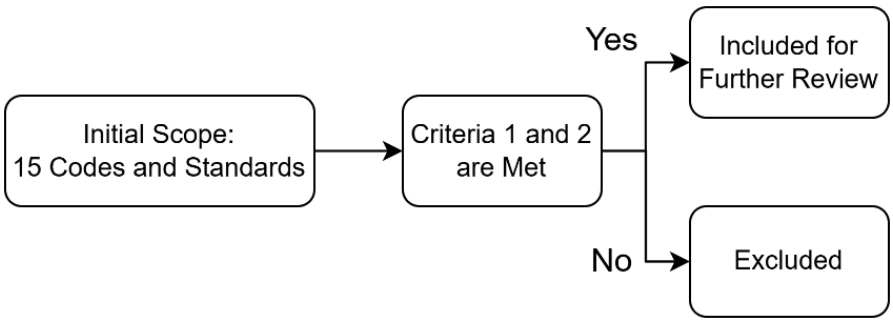

Figure 1: Scoping of Codes and Standards for Review

Applying the first criterion results in the exclusion of Italy, Sweden, and the People's Republic of China. Although Sweden has an official English translation of an earlier Building Regulation, the country is currently transitioning to a new Building Regulation that does not have an official English version available at the time of this study [22] .

For hybrid codes, such as those used in Australia and New Zealand, only the prescriptive provisions (deemed-to-satisfy solutions) are reviewed. Similarly, guidance documents, such as the Approved

Documents used in England, are reviewed in this study and treated as prescriptive requirements for the purposes of comparison.

In addition to the jurisdictions identified by Xue [21], the United Arab Emirates (UAE) Fire and Life Safety Code has been included in the review. This inclusion is made largely to broaden geographical representation.

Based on the scoping criteria described, the following codes and standards are reviewed against the sixteen key evacuation-related design features identified in Section 4.1.

1. NFPA 101, Life Safety Code [23]
2. NFPA 5000, Building Construction and Safety Co[24]
3. National Building Code of Canada [25]
4. United Arab Emirates Fire and Life Safety Code of Practice [26]
5. Approved Document B (ADB) Fire Safety Volume 1: Dwellings [27]
6. Approved Document B (ADB) Fire Safety Volume 2: Buildings other than dwellings [28]
7. Singapore Code of Practice for Fire Precautions in Buildings [29]
8. Hong Kong Code of Practice for Fire Safety in Buildings [30]
9. National Construction Code Volume One (Building Code of Australia) (Preview Draft) [31]
10. New Zealand Building Code [32], [33], [34]

3.2. Evacuation Provisions Review

The process used to review evacuation provisions is illustrated in Figure 2. The review begins with identifying typical design features prescribed by codes and standards to address various functional limitations associated with each evacuation activity. The coverage of these identified evacuation-related design features across the selected codes and standards is then evaluated. It is noted that many fire and life safety codes and standards reference separate accessibility standards or other complementary design standards, which were also reviewed for completeness.

It is important to note that in some instances this creates a circular dependency, where fire safety provisions defer to accessibility standards for accessibility related provisions and accessibility standards defer back to fire safety codes, without either document fully addressing the evacuation needs of individuals with functional limitations.

Where a specific design feature was not addressed in the primary code or standard, complementary accessibility standards or other relevant design standards were reviewed to determine whether coverage was provided elsewhere. In either case, the coverage status of those design features is noted in Table 3. Table 4 to Table 19 further identify whether coverage is provided within the primary code or standard, or within a complimentary code or standard. Coverage status is classified as follows:

- Addressed
- Not Addressed
- Addressed in Others (codes or standards)

In addition, the applicability category of each identified design feature was reviewed and documented in Table 4 to Table 19 using the following classifications:

- Not Required/Addressed
- Recommendation
- Mandatory
- Mandatory (Conditional) - mandatory in specific circumstances only, such as, if another requirement triggers, where a certain demographic group is present, or within accessible areas or routes.

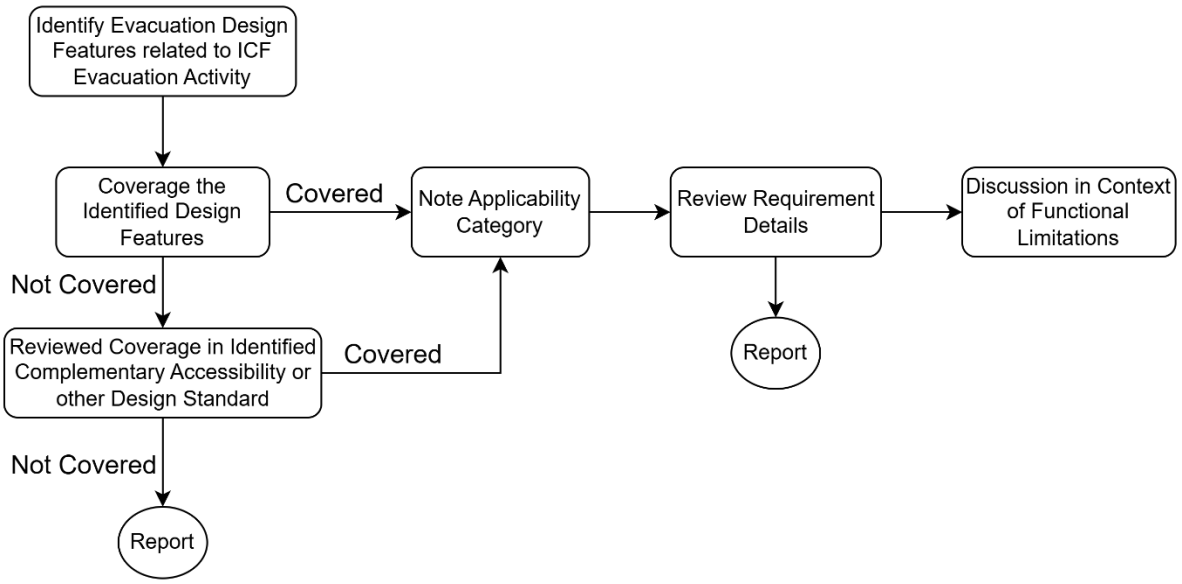

Figure 2: Methodology for the Evacuation Provisions Review and Discussion

A detailed summary of the requirements review is provided in Appendix A, presented in a tabular format for each code and standard. The Appendix documents the complementary accessibility or other design standard reviewed, summarizes the relevant requirements associated with each key design feature and references the applicable clauses. The results section presents a comparative assessment of the identified design features across the reviewed codes and standards.

Finally, the discussion section compares the identified code-based requirements for the specific evacuation design features with existing scientific knowledge to understand whether the current regulatory framework may result in disproportionate impacts on individuals with functional limitations.

4. Results on Evacuation Design Practices

4.1. Functional Limitations and Associated Evacuation Design Practices

Building upon the work of Bukvic et al. [20], who categorized functional limitations into six primary grouping, and linked evacuation activities to these six functional limitation groups and the International Classification of Functioning, Disabilities and Health (ICF) classification, this study further contextualizes the challenges faced by individuals with functional limitations during evacuation. This contextualization is carried out by examining how these challenges are addressed, or not addressed, through the provisions of applicable building codes and standards.

Table 2, adapted from Bukvic et al. [20], identifies key evacuation activities and links them to specific functional limitations that may be impacted at each stage of evacuation. This study extends the original table by adding a final column that identifies typical design features prescribed by codes and standards for each evacuation activity. These design features represent the commonly adopted means by which codes and standards attempt to address functional limitations during evacuation.

Through this comparative review, the following sixteen typical evacuation-related design features were identified as being referenced or required within codes and standards. A systematic review of all applicable codes and standards was not undertaken. Rather, based on practical experience with code application, each evacuation activity identified by Bukvic et al. [20] was associated with representative design features commonly found in building codes.

1. Audible Alarms
2. Visual Alarms
3. Pictogram Exit Signs
4. Tactile Signage – Braille and Tactile Characters
5. Tactile Signage – Elevators
6. Tactile Attention Indicators
7. Tactile Direction Indicators
8. Two-Way Emergency Communication – Audible and Visual
9. Mobility – Self-Evacuation Elevators
10. Mobility – Emergency Descent Device
11. Mobility – Corridor Width
12. Mobility – Turning and Passing
13. Mobility – Obstructions
14. Opening Doors – Dexterity
15. Opening Doors – Automatic Door Operators (ADO)
16. Area of Refuge

These design features form the basis for the systematic comparison of evacuation provisions across the selected codes and standards presented in the following sections.

Table 2: Mapping of Typical Code-Based Design Features Addressing Functional Limitations Across Evacuation Activities (adapted from Bukvic et al. [20])

Evacuation Activity[1, 2]	Visual Limitation	Hearing Limitation	Mobility Limitation	Upper Extremities Limitation	Cognitive Limitation	Other Functional Limitations	Typical Design Feature / Addressed By
Hearing Alarm (A,P)		**X**					Visual alarms
Smelling Emergency Clues (A,P)						Research Gap	Audible and visual alarm
Seeing Emergency Clues (A,P,T[3])	**X**						Audible alarms for initial notification; not addressed during travel
Locating Exit Signs (P,T)	**X**				**X** Difficulty in interpreting information		Visual and cognitive limitations not addressed Pictogram exit signs for difficulty in interpreting information.
Orientation (A,P,T)	**X**				**X**		Braille and tactile character signage and tactile direction indicators for visual limitation. Cognitive limitations not addressed
Maintaining/Changing Direction (A,P,T)	**X**		**X[4]**				Minimization of obstructions in means of egress for visual limitation. Corridors with adequate width, passing and turning spaces at regular intervals for mobility limitation.
Finding Arch. Elements (A,P,T)	**X**			Research Gap			Braille and tactile character signage, tactile attention indicators, and tactile maps for visual limitation.
Communication with Others/Rescue Services (P)		**X**			Research Gap	Speech Impairment	Audible and visual two-way emergency communication systems
Using Stairs (T)	**X**		**X** Issues with stamina / breathing/ fatigue	**X**			Braille and tactile character signage, and handrails for visual limitation. Emergency stair descent devices, self-evacuation elevators, and area of refuge for mobility limitations.
Using Evacuation Elevators (T)	**X[5]**		**X**	**X**	Dementia of Alzheimer's type		Braille and tactile character on controls for visual limitation. Corridors with adequate width, passing and turning spaces at regular intervals for mobility limitation. Upper extremities and cognitive limitations not addressed.

Evacuation Activity[1, 2]	Visual Limitation	Hearing Limitation	Mobility Limitation	Upper Extremities Limitation	Cognitive Limitation	Other Functional Limitations	Typical Design Feature / Addressed By
Opening Doors (A,P,T)	**X**		**X**	**X**			Braille and tactile character signage for unusual hardware identification for visual limitation. Reduced-dexterity hardware, automatic door operators, and push bar hardware for mobility and upper extremities limitations.

Table Notes:

1. (A) = during alarm (P) = during pre-evacuation (T) = during travel

2. Bukvic et al. [20] also identified additional evacuation activities primarily related to mobility limitations, such as getting out of bed, moving to wheelchair, or moving to escape mattress. These activities have been excluded from this study, as they are generally addressed through personal mobility aids or caregiver assistance rather than through building design features.

3. The travel phase (T) is introduced in addition to the phases identified by Bukvic et al. [20] for evacuation activity of seeing evacuation clues to capture situations in which occupants perceive evacuation cues while already moving toward an exit.

4. Mobility limitation is incorporated beyond those identified by Bukvic et al. [20] for the evacuation activity of maintaining or changing direction during evacuation. This addition accounts for the challenges individuals with mobility limitations may face when maneuvering in constrained spaces, such as narrow corridors. Although occupants are generally expected to move in a single direction toward an exit, evolving fire conditions or blocked routes may require occupants to navigate toward alternate exits, making directional changes a relevant evacuation consideration.

5. Visual limitation is incorporated beyond those identified by Bukvic et al. [20] for the use of evacuation elevators. This accounts for challenges associated with identifying controls and floor levels during elevator operation.

4.2. Evacuation Provisions in Codes and Standards

Table 3 summarizes the coverage status of the sixteen identified evacuation-related design features across the reviewed codes and standards. It indicates whether each design feature is addressed or not in the referenced code or standard or in the identified complementary code or standard. Similarly, Figure 3 provides a graphical representation of the distribution of evacuation provisions across the reviewed codes and standards, their complimentary codes and standards, or missing provisions.

The identified design features are compared across various codes and standards in the subsequent subsections.

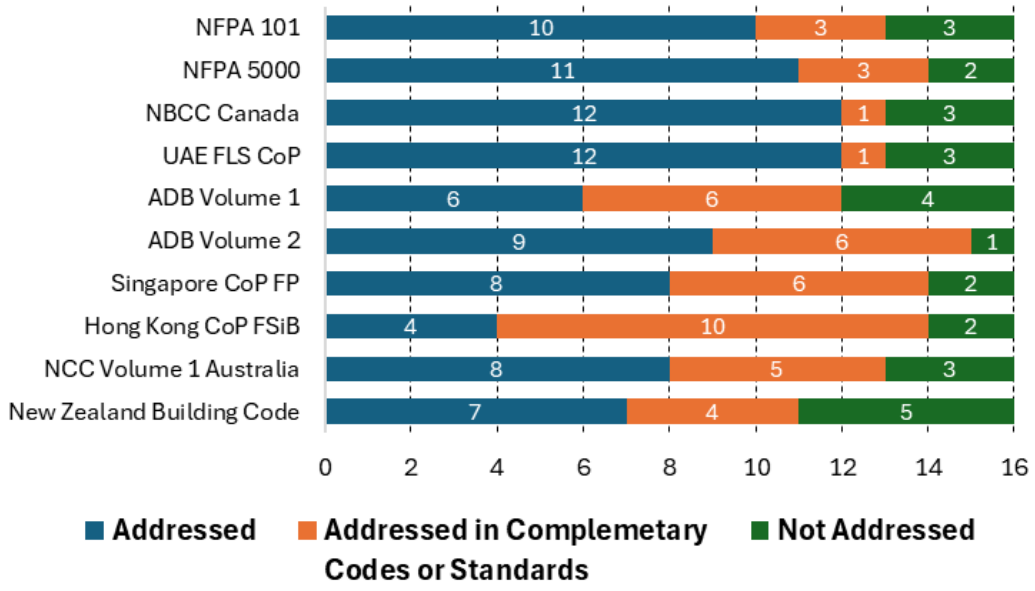

Figure 3: Distribution of Evacuation Provisions Between Primary Building Codes or Standards, Complementary Codes or Standards, and Unaddressed Features

Table 3: Coverage of Identified Code-Based Design Features Across Reviewed Codes and Standards

	NFPA 101	NFPA 5000	NBCC Canada	UAE FLS CoP	ADB Volume 1	ADB Volume 2	Singapore CoP FP	Hong Kong CoP FSiB	NCC Volume 1 Australia	New Zealand Building Code
Audible Alarms	✓	✓	✓	✓	✓	✓	✓	◐	✓	✓
Visual Alarms	✓	✓	✓	✓	◐	✓,◐	✓	◐	◐	◐
Exit Signs	✓	✓	✓	✓	✓	✓	✓	◐	✓	✓
Tactile Signage	◐	◐	✓	✓,◐	◐	◐	◐	◐	✓	✓
Tactile Signage – Elevator	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
Tactile Attention Indicator	✗	✗	✓	✓	✗	◐	◐	◐	✓	◐
Tactile Direction Indicator	✗	✗	✗	✗	✗	◐	✗	◐	✗	✗
Two Way Emergency Comm. Systems	✓	✓	✓	✓	✗	✓	✓	✓	◐	✗
Mobility – Self-Evacuation Elevators	✓	✓	✗	✗	✓	✓	✗	✗	✓	✗
Mobility – Emergency Stair Descent Device	✓	✓	✗	✓	◐	◐	✓	✗	✗	✗
Mobility – Width	✓,◐	✓,◐	✓	✓	✓,◐	✓,◐	✓	✓,◐	✓	✓,◐
Mobility – Turning and Passing	◐	◐	✓	✓	◐	◐	◐	◐	◐	◐
Mobility – Obstructions	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Opening Doors – Dexterity	✓	✓	✓	✓	◐	✓,◐	◐	◐	✓	✓
Opening Doors – ADO	✗	✓	✓	✗	✗	✗	◐	◐	◐	✓
Area of Refuge	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗

Table Notes: ✓ = Addressed in the referenced code or standard

◐ = Addressed in the identified complementary code or standard

✗ = Not Addressed

4.2.1. Audible Alarms

Across all regions reviewed, codes and standards [23], [24], [25], [26], [27], [28], [29], [31], [32], [35] consistently require audible alarm devices where a fire alarm system is provided. In such cases, fire detection systems with audible alarms may compensate for the occupant's inability to visually detect fire or smell combustion products.

Except ADB Volume 1 [27], the provision of audible alarm devices is contingent upon the requirement for a fire alarm system. In other words, where a fire alarm system is not mandated by the code, audible alarm devices are also not required. For example, a two-storey office building meeting certain maximum occupant load criteria may not require a fire alarm system under several codes and standards [23], [24], [25], [28], [31], [32]. Therefore, no audible alarm devices are required in such cases.

Table 4: Summary of Coverage Status and Applicability of Audible Alarm Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Addressed	Mandatory (Conditional)	Audible alarm devices are required when fire alarm system is required.
NFPA 5000 [24]	Addressed	Mandatory (Conditional)	Audible alarm devices are required when fire alarm system is required.
NBCC Canada [25]	Addressed	Mandatory (Conditional)	Audible alarm devices are required when fire alarm system is required.
UAE FLS CoP [26]	Addressed	Mandatory (Conditional)	Audible alarm devices are required when fire alarm system is required.
ADB Volume 1 [27]	Addressed	Mandatory	Audible alarm devices are required to be provided.
ADB Volume 2 [28]	Addressed	Mandatory (Conditional)	Audible alarm devices are required when fire alarm system is provided, except where the system is installed for property protection only.
Singapore CoP FP [29]	Addressed	Mandatory (Conditional)	Audible alarm devices are required when fire alarm system is required.
Hong Kong CoP FSiB [30][35]	Addressed in Others	Mandatory (Conditional)	Audible alarm devices are required when fire alarm system is required.
NCC Volume 1 Australia [31]	Addressed	Mandatory (Conditional)	Audible alarm devices are required when fire alarm system is required.
New Zealand Building Code [32]	Addressed	Mandatory (Conditional)	Audible alarm devices are required when fire alarm system is required.

4.2.2. Visual Alarms

The review of codes and standards reveals a common theme with respect to visual alarm requirements. All codes and standards reviewed [23], [24], [25], [26], [28], [29], [31], [32], [35], [36] include an initial requirement for the provision of visual alarms where a fire alarm system is installed. However, this requirement is often qualified by exemption statements that limit its application to

situations where occupants with hearing limitations may be isolated or are expected to be present. For example:

- "Areas not subject to occupancy by persons who are deaf or hard of hearing shall not be required . . ." [23], [24]
- "in buildings . . . intended for use primarily by persons with a hearing impairment" [25]
- "Where the system needs to warn a person who is Deaf or hard of hearing . . ." [36]
- "Where persons with hearing impairment can be isolated . . ." [37]
- "The provision of visual alarm shall not apply to . . . the following areas: areas not accessible to guests, areas accessible to staff only, . . ." [38]
- "Areas designated for persons with hearing impairments . . ."[39]

The codes and standards generally provide no further guidance or prescriptive criteria to define scenarios in which occupants with hearing impairments are not expected to be present or may be considered isolated. In certain cases, visual alarm devices explicitly omitted from residential occupancies where occupants with hearing limitations are frequently expected to be in isolation [25], [26], [37], [38].

Table 5: Summary of Coverage Status and Applicability of Visual Alarm Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Addressed	Mandatory (Conditional)	Unless the area is not subject to be occupied by persons with hearing limitations, visual alarm devices are required when fire alarm system is required.
NFPA 5000 [24]	Addressed	Mandatory (Conditional)	Unless the area is not subject to be occupied by persons with hearing limitations, visual alarm devices are required when fire alarm system is required.
NBCC Canada [25]	Addressed	Mandatory (Conditional)	Visual alarm devices are required in buildings intended primarily for persons with hearing limitations, in occupancies with high ambient noise levels, within corridors of most occupancies, in at least 10% of hotel guestrooms, and within washrooms except those located within dwelling suites.
UAE FLS CoP [26]	Addressed	Mandatory (Conditional)	Visual alarm devices are required only where audible alarms are not effective, not feasible to type of occupancy (such as noisy parking spaces or noisy environment like engine room), or in areas where audio alarm requires the aid of visual alarm. They may be required based on fire strategy for the building.
ADB Volume 1 [27]	Addressed in Others	Mandatory (Conditional)	BS 5839-6 [36] provides guidance on alarm system design and includes subjective recommendations for warning devices suitable for people with hearing limitations.

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
			Alternative notification devices such as vibrating pads for use under pillows or mattresses are also described. The extent of application of such guidance is unclear.
ADB Volume 22 [28]	Addressed & Addressed in Others	Mandatory (Conditional) & Recommend.	Visual alarm devices are required where occupants may be in relative isolation. Alternative systems, such as vibrating personal paging systems, may be used where the occupant population is managed. BS 5839-1 [40] also provides compliance pathways for additional devices such as vibrating pads (that can be used to wake people up) or portable pagers (that can be carried by users). The applicability of these systems depends on occupancy type and the fire safety strategy.
Singapore CoP FP [29]	Addressed	Mandatory (Conditional)	Visual alarm devices are required where persons with hearing limitations may be isolated, in car parks, in lift lobbies, and in places of entertainment. Visual alarms are not required within individual residential occupancies. Residential fire alarm devices may include optional features such as connections to visual alarms or vibrating pads.
Hong Kong CoP FSiB [30]	Addressed in Others	Mandatory (Conditional)	Except for residential occupancies, visual alarm devices are required in all occupancies where fire alarm systems are required. Staff-only areas or areas not open to visitors are exempt unless a person with hearing limitations is required to work alone.
NCC Volume 1 Australia [31]	Addressed in Others	Mandatory (Conditional)	Visual alarm devices are required in spaces designated for persons with hearing limitations and in spaces with high background noise levels.
New Zealand Building Code [32]	Addressed in Others	Mandatory (Conditional)	Visual alarm devices are required only along accessible routes and within accessible accommodation units. Within accommodation units, provision is limited to visibility from beds.

4.2.3. Pictograms in Exit Signs

Although exit signs in text format or pictogram form do not address the challenges faced by people with visual or cognitive limitations, pictogram exit signs are increasingly being adopted as a minimum requirement in many codes and standards. The transition toward pictogram exit signs is largely intended to address language barriers in an increasingly interconnected global environment, where unfamiliarity with the local language may hinder proper interpretation of exit information.

It is observed that all code and standards reviewed [23], [24], [25], [26], [27], [28], [29], [31], [32], [35] either require the use of pictogram exit signs or provide provisions that permit their use. In jurisdictions such as Singapore and Hong Kong [29], [35], either of the noted exit signs can be provided, making it difficult to identify a preferred or dominant approach. Similarly, NFPA Codes [23], [24] identify text exit signs as the default option, unless pictogram signs are permitted by the authority having jurisdiction. This may result in a broader application of text-based exit signs unless local bylaws explicitly promote or mandate pictogram signage. A review of such local regulatory requirements has not been undertaken as part of this study.

Table 6: Summary of Coverage Status and Applicability of Pictogram Exit Signs Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Addressed	Not required	Text-based EXIT signs are required unless graphical exit symbols are approved by the authority having jurisdiction.
NFPA 5000 [24]	Addressed	Not required	Text-based EXIT signs are required unless graphical exit symbols are approved by the authority having jurisdiction.
NBCC Canada [25]	Addressed	Mandatory	Exit signs are required to use pictograms.
UAE FLS CoP [26]	Addressed	Mandatory	Exit signage must be multilingual and include pictograms.
ADB Volume 1 [27]	Addressed	Mandatory	Exit signs are required to use pictograms. Not required if it is a regular use stair or door
ADB Volume 22 [28]	Addressed	Mandatory	Exit signs are required to use pictograms.
Singapore CoP FP [29]	Addressed	Recommend.	Exit signs may be pictogram or text based.
Hong Kong CoP FSiB [30]	Addressed in Others	Mandatory (Conditional)	Exit signs may be pictogram or text based. Text signs are required to be in both English and Chinese. Directional exit signs are required to be pictograms.
NCC Volume 1 Australia [31]	Addressed	Mandatory	Exit signs are required to use pictograms.
New Zealand Building Code [32]	Addressed	Mandatory	Exit signs are required to use pictograms.

4.2.4. Tactile Signage – Braille and Tactile Characters

Tactile signage, including braille and raised tactile characters, is typically required by all codes and standards reviewed [23], [24], [25], [26], [31], [32], [38], [41] to be installed adjacent to exit doors and at floor level identification within exit stairs. These measures are intended to assist individuals with visual limitations in locating architectural elements and maintaining orientation. Some jurisdictions [25], [31] also require tactile signage near doors equipped with unusual or non-standard door release hardware to assist occupants in operating such doors. Additional jurisdiction-specific locations include refuge area [23], [24] and crossover floor levels within exit stairs [25], both of which can support occupants with visual limitations in door operation and spatial orientation.

The tactile signage requirements in Hong Kong [38] stand out in this review. In addition to the commonly required tactile signage found in other codes and standards, Hong Kong requires braille and tactile information to be provided directly on handrails within exit stairways. It also mandates the provision of braille and tactile wayfinding fire exit maps in elevator lobbies and at the entrances to auditoriums. The inclusion of tactile wayfinding fire exit maps can be particularly beneficial for individuals with visual limitations by supporting orientation and identifying key architectural elements such as alternative exits.

Table 7: Summary of Coverage Status and Applicability of Tactile Signage – Braille and Tactile Characters Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Addressed in Others	Mandatory (Conditional)	Braille and tactile character exit signage required near exit doors, floor numbering for exit stairs, door to area of refuge.
NFPA 5000 [24]	Addressed in Others	Mandatory (Conditional)	Braille and tactile character exit signage required near exit doors, floor numbering for exit stairs, door to area of refuge.
NBCC Canada [25]	Addressed	Mandatory (Conditional)	Braille and tactile character exit signage required near exit doors, door for door release hardware such as maglock, crossover floors, floor and stair numbering for exit stairs.
UAE FLS CoP [26]	Addressed & Addressed in Others	Mandatory (Conditional)	Braille and tactile character exit signage required near exit doors and floor numbering for exit stairs.
ADB Volume 1 [27]	Addressed in Others	Recommend.	BS 8300-2 provides guidance on tactile way-finding and includes subjective recommendations. The extent of application of such guidance is unclear.
ADB Volume 22 [28]	Addressed in Others	Recommend.	BS 8300-2 provides guidance on tactile way-finding and includes subjective recommendations. The extent of application of such guidance is unclear.
Singapore CoP FP [29]	Addressed in Others	Mandatory (Conditional)	Braille and tactile character signage is required for ramps and stairs. No exit signage in tactile format.
Hong Kong CoP FSiB [30]	Addressed in Others	Mandatory (Conditional)	Braille and tactile fire exit maps are required in lift lobbies and at entrances to auditoriums. Braille and tactile character signage is required for floor numbers, directional, and other information in staircases. Exit information is required on handrails.
NCC Volume 1 Australia [31]	Addressed	Mandatory (Conditional)	Braille and tactile character signage is required to identify exit doors, floor and level information, and door latch operation where this information is not provided on the door leaf itself.

New Zealand Building Code [32]	Addressed	Mandatory (Conditional)	Braille signage for safety signs, exit signs, and fire related safety feature signs.

4.2.5. Tactile Signage – Elevators

Although the use of elevators during fire evacuation is discussed in Section 4.2.9 of this study, tactile signage and controls, including braille and raised tactile characters on elevator controls, are required by all codes and standards reviewed [37], [38], [42], [43], [44], [45], [46]. These provisions can assist individuals with visual limitations in the use of evacuation elevators, as well as elevators in general. All of the reviewed codes and standards rely on compliance with the applicable elevator or barrier-free standards to address these provisions.

Table 8: Summary of Coverage Status and Applicability of Tactile Signage – Elevators Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Addressed in Others	Mandatory	Braille and tactile character controls required.
NFPA 5000 [24]	Addressed in Others	Mandatory	Braille and tactile character controls required.
NBCC Canada [25]	Addressed in Others	Mandatory	Braille and tactile character controls required.
UAE FLS CoP [26]	Addressed in Others	Mandatory	Braille and tactile character controls required.
ADB Volume 1 [27]	Addressed in Others	Mandatory	Tactile controls which may include braille are required, along with floor numbering adjacent to lift call button.
ADB Volume 22 [28]	Addressed in Others	Mandatory	Tactile controls which may include braille are required.
Singapore CoP FP [29]	Addressed in Others	Mandatory	Braille and tactile character controls required.
Hong Kong CoP FSiB [30]	Addressed in Others	Mandatory	Braille and tactile character controls required.
NCC Volume 1 Australia [31]	Addressed in Others	Mandatory	Braille and tactile character controls required.
New Zealand Building Code [32]	Addressed in Others	Mandatory	Braille and tactile character controls required.

4.2.6. Tactile Attention Indicators

Tactile attention indicators, also referred to as tactile warning surface indicators, are standardized textured or raised walking surfaces, typically consisting of truncated domes arranged in a grid pattern, may be used to convey hazard-related information to people with visual limitations. The use of tactile attention indicators was found to be limited across the codes and standards reviewed. These indicators are typically used to identify architectural elements where changes in elevation may present a safety concern for people with visual limitations.

It was noted that most codes and standards do not explicitly address requirements for tactile attention indicators within their primary provisions and instead may rely on separate accessibility codes to

establish such requirements. While Australia, Hong Kong, and Singapore [31], [37], [38] require tactile attention indicators at locations involving changes in elevation and other similar hazards, other jurisdictions, including Canada and New Zealand [25], [46] generally limit their requirements to locations near stairways only. This approach overlooks comparable hazards and architectural elements such as escalators and moving walks.

Table 9: Summary of Coverage Status and Applicability of Tactile Attention Indicators Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Not Addressed	Not Addressed	Not covered by NFPA 101, typically governed by other standards.
NFPA 5000 [24]	Not Addressed	Not Addressed	Not covered by NFPA 5000, typically governed by other standards.
NBCC Canada [25]	Addressed	Mandatory (Conditional)	Tactile attention indicators are required at the top of stairs that are unenclosed.
UAE FLS CoP [26]	Addressed	Mandatory (Conditional)	"Detectable warning" is required only for rail platforms.
ADB Volume 1 [27]	Not Addressed	Not Addressed	Not covered by ADB or Approved Document M (ADM) Volume 1.
ADB Volume 22 [28]	Addressed in Others	Recommend.	Tactile paving guidance applies only for exterior spaces and transit platforms.
Singapore CoP FP [29]	Addressed in Others	Mandatory	Warning Tactile Ground Surface Indicators are required at changes in elevation and other hazardous conditions.
Hong Kong CoP FSiB [30]	Addressed in Others	Mandatory	Tactile warning strips are required at top, bottom, and landings of staircases, ramps, and escalators.
NCC Volume 1 Australia [31]	Addressed	Mandatory	Tactile Ground Surface Indicators (TGSI) are required at the approach to stairways, escalators, moving walks, and ramps.
New Zealand Building Code [32]	Addressed in Others	Mandatory (Conditional)	Change in color and texture of surface is required at top and bottom of stairs.

4.2.7. Tactile Direction Indicators

Although tactile direction indicators can be provided to support orientation and navigation, such as maintaining and changing direction for people with visual limitations, the codes and standards reviewed generally do not require their provision within buildings. Hong Kong [38] is the sole exception identified in this review. Across the reviewed codes and standards, the use of tactile direction indicators is generally more common in exterior environments and transit stations rather than within buildings.

In Hong Kong [38], tactile direction indicators are required in various types of public occupancy buildings, such as shopping complexes, cinemas, schools, and sports complexes. However, these requirements are intended to support general accessibility and are not required to lead to exits.

Table 10: Summary of Coverage Status and Applicability of Tactile Direction Indicators Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Not Addressed	Not Addressed	Not covered by NFPA 101, typically governed by other standards.
NFPA 5000 [24]	Not Addressed	Not Addressed	Not covered by NFPA 5000, typically governed by other standards.
NBCC Canada [25]	Not Addressed	Not Addressed	Not required by NBCC.
UAE FLS CoP [26]	Not Addressed	Not Addressed	Not covered by UAE FLS Code.
ADB Volume 1 [27]	Not Addressed	Not Addressed	Not covered by ADB or ADM Volume 1.
ADB Volume 22 [28]	Addressed in Others	Recommend.	Tactile paving guidance applies only for exterior and transit spaces.
Singapore CoP FP [29]	Not Addressed	Not Addressed	Not addressed.
Hong Kong CoP FSiB [30]	Addressed in Others	Mandatory (Conditional)	Directional tactile strips are required for various public occupancy buildings such as shopping complex, cinema, schools, sports complex. They are not required to provide direction to exits.
NCC Volume 1 Australia [31]	Not Addressed	Not Addressed	Not covered by Building Code of Australia.
New Zealand Building Code [32]	Not Addressed	Not Addressed	The concept of tactile directional indicators is introduced; however, no specific requirements are provided.

4.2.8. Two-Way Emergency Communication – Audible and Visual

The requirements for two-way emergency communication systems vary significantly among the codes and standards reviewed. NFPA and UAE Codes [23], [24], [26] require the provision of both audible and visual two-way emergency communication systems within areas of refuge or associated locations. In contrast, Canadian [25] requirements are limited to audible two-way emergency communication systems and are generally applicable near exit stairs of high buildings only.

Under ADB Volume 2 [28], an audible two-way emergency communication system is required in areas of refuge. However, these may be required in other locations as part of a fire engineering approach under ADB Volume 2 and New Zealand regulations. New Zealand [32] does not provide a clear deemed-to-satisfy requirement for two-way emergency communication systems.

Singapore [29] requires the provision of a distress button or voice communication system at persons with disabilities holding points. In addition, for tall buildings or buildings with high occupant loads, audible two-way emergency communication systems are required in fire lift lobbies, areas of refuge, and other locations housing firefighting-related mechanical equipment. These provisions appear to be primarily intended for firefighter use rather than for communication by building occupants.

Hong Kong [30] has a unique requirement, mandating the provision of closed-circuit television (CCTV) monitoring for areas of refuge in addition to an audible two-way emergency communication system.

Table 11: Summary of Coverage Status and Applicability of Two-Way Emergency Communication Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Addressed	Mandatory (Conditional)	Audible and visual two-way emergency communication systems are required for areas of refuge.
NFPA 5000 [24]	Addressed	Mandatory (Conditional)	Audible and visual two-way emergency communication systems are required for areas of refuge.
NBCC Canada [25]	Addressed	Mandatory (Conditional)	Audible two-way emergency communication systems are required only for high buildings in exits and elevators.
UAE FLS CoP [26]	Addressed	Mandatory (Conditional)	Audible and visual two-way emergency communication systems are required for elevator landings associated with area of refuge only.
ADB Volume 1 [27]	Not Addressed	Not Addressed	Not covered by ADB or ADM Volume 1.
ADB Volume 22 [28]	Addressed	Mandatory (Conditional)	Audible two-way emergency communication systems are recommended for refuge areas only.
Singapore CoP FP [29]	Addressed	Mandatory (Conditional)	Audible two-way emergency communication systems are required in buildings with high occupant load or tall buildings, typically within fire lift lobbies and areas of refuge. When considering the additional spaces identified for these systems, their provision appears to be primarily intended to support firefighter operations. Distress buttons or voice communication systems are required at holding points for persons with disabilities.
Hong Kong CoP FSiB [30]	Addressed	Mandatory (Conditional)	Closed-circuit television (CCTV) and intercom two-way emergency communication are required between temporary refuge spaces and management office.
NCC Volume 1 Australia [31]	Addressed in Others	Mandatory (Conditional)	Intercom system is required in compliance with AS 1670.4. Unclear whether the system is required to provide both audible and visual communication, or audible communication only, due to access limitation to the latest published version of the standard.
New Zealand Building Code [32]	Not Addressed	Not Addressed	May be required as part of a fire engineering approach. There are no clear deemed-to-satisfy provisions.

4.2.9. Mobility – Self-Evacuation Elevators

Elevators are one of the primary building features that provide barrier-free access between different levels; however, the same cannot be said for their role in evacuation. Several codes and standards [25], [30] explicitly exclude elevators from being used as a means of egress. Although UAE [16] requires the provision of "evacuation elevators", they cannot be used without the assistance of facility management or first responders, and therefore they do not function as self-evacuation elevators.

NFPA Codes [23], [24] include provisions that allow elevators to be used for self-evacuation under specific conditions; however, they do not contain prescriptive requirements mandating their installation. The provision of evacuation elevators is not incentivized, rather it is subject to restrictive conditions. Such evacuation elevators must meet stringent criteria to be considered a second means of egress. For example, for an elevator to be considered a second means of egress in towers, several requirements, including but not limited to the following apply:

- the entire building is required to be sprinklered throughout,
- the occupant load of the building is limited to 90 persons,
- no high hazard content areas allowed anywhere in the building,
- the alternative means of egress is required to be designed to accommodate 100% of the occupant load independently of the elevator,
- the building is not permitted to be used by the general public.

Where an elevator is designed for use by the general public, it is not credited to satisfy any of the means of egress requirements such as the required number, capacity, or arrangement of means of egress.

ADB Volumes 1 and 2 [27], [28] provide guidance that permits the use of elevators for evacuation purposes; however, they do not include recommendations on when such elevators should be provided. Similarly, the Australian and New Zealand building codes [31], [32] do not offer deemed-to-satisfy provisions for the use of elevators as self-evacuation systems.

Table 12: Summary of Coverage Status and Applicability of Self-Evacuation Elevators Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Addressed	Not required	Provisions permit the use of self-evacuation elevators under restrictive design requirements but do not mandate their provision. Very restrictive criteria apply for elevators to qualify as a second means of egress. Does not provide any incentive for its provision.
NFPA 5000 [24]	Addressed	Not required	Provisions permit the use of self-evacuation elevators under restrictive design requirements but do not mandate their provision. Very restrictive criteria apply for elevators to qualify as a second means of egress.

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
			Does not provide any incentive for its provision.
NBCC Canada [25]	Not Addressed	Not required	No prescriptive provision for the use of self-evacuation elevator. The Code specifically states elevators are not intended for use by persons with disability even in unsprinklered buildings without firefighter assistance. Recent edition of elevator standard contains provisions for the use of elevators for self-evacuation, but the NBCC does not provide a compliance pathway for their use.
UAE FLS CoP [26]	Not Addressed	Not required	Requirements are provided for "evacuation elevators," which may be required as part of the fire strategy. They cannot be used for self-evacuation without assistance of facility management and Civil Defense Rescue team.
ADB Volume 1 [27]	Addressed	Not required	Guidance is provided for design of self-evacuation lifts. No recommendation is provided on when self-evacuation lifts should be installed.
ADB Volume 22 [28]	Addressed	Not required	Guidance is provided for design and provision of self-evacuation lifts only where they form part of management plan for evacuating people. No recommendation is provided on when self-evacuation lifts should be installed.
Singapore CoP FP [29]	Not Addressed	Not required	Requirements are provided for "evacuation lifts," in buildings taller than 24 m in height, except residential. They cannot be used for self-evacuation without assistance of firefighters.
Hong Kong CoP FSiB [30]	Not Addressed	Not required	Lifts are explicitly excluded from the definition of an exit route.
NCC Volume 1 Australia [31]	Addressed	Not required	Lifts may be provided to assist occupants to evacuate a building; however, no deemed-to-satisfy provisions are provided.
New Zealand Building Code [32]	Not Addressed	Not required	Not covered by New Zealand Building Code deemed-to-satisfy provisions.

4.2.10. Mobility – Emergency Descent Device

Occupants with mobility limitations, including reduced stamina, breathing difficulties, or fatigue, may use emergency stair descent devices as an alternative to descending stairs on foot during evacuation. Despite their potential use for people with mobility limitations, half of the codes and standards reviewed [25], [26], [31], [32], [35] do not include any provisions addressing the use of such devices.

NFPA Codes [23], [24] establish requirements that an emergency stair descent device must meet; however, their installation is not mandated, and no incentives are provided to encourage their

installation. ADB Volumes 1 and 2 [27], [28] do not include guidance on when or where such devices should be provided. Limited guidance is referenced through BS 8300-2 [47], where it is limited to situations where the use of conventional lifts is not feasible.

Singapore [29] allows the voluntary provision of stairlifts within stairways; however, it requires that such installations must not encroach upon the required egress width. This requirement appears onerous from a design and integration perspective and may significantly limit the practical application and widespread adoption of such devices.

Table 13: Summary of Coverage Status and Applicability of Emergency Descent Device Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Addressed	Not required	Includes requirements for devices where provided; the provision of such devices is not mandated and no incentives are included.
NFPA 5000 [24]	Addressed	Not required	Includes requirements for devices where provided; the provision of such devices is not mandated and no incentives are included.
NBCC Canada [25]	Not Addressed	Not required	No provisions included.
UAE FLS CoP [26]	Addressed	Not required	No provisions are included. They can be part of fire strategy.
ADB Volume 1 [27]	Addressed in Others	Not required	Guidance in BS 8300-2 allows their use in existing buildings where conventional lifts are not feasible. No guidance is provided for new construction.
ADB Volume 22 [28]	Addressed in Others	Not required	Guidance in BS 8300-2 allows their use in existing buildings where conventional lifts are not feasible. No guidance is provided for new construction.
Singapore CoP FP [29]	Addressed	Not required	Such devices are not required. Wheelchair stairlifts may be provided within exits but must not encroach upon the required escape path.
Hong Kong CoP FSiB [30]	Not Addressed	Not required	No provisions included.
NCC Volume 1 Australia [31]	Not Addressed	Not required	Not covered by Building Code of Australia.
New Zealand Building Code [32]	Not Addressed	Not required	Not covered by New Zealand Building Code deemed-to-satisfy provisions.

4.2.11. Mobility – Corridor Width

A wide range of minimum corridor widths was identified across the codes and standards reviewed, ranging from 750 mm [28] to 1,200 mm [29]. The minimum corridor width can impact occupants with mobility limitations that use mobility aids such as wheelchairs. It is notable that some codes that permit corridor or egress route width less than 1,000 mm require wider accessible routes.

For example, ADB Volume 2 [28] specifies a minimum corridor width of 750 mm, with a note indicating that greater widths may be required to comply with the guidance provided in ADM Volume 2 [44]. ADM requires a minimum corridor width of 1,200 mm for accessible routes. However, ADM also states in its introductory section that its scope is limited to access provisions and does not extend to means of escape during a fire event. This suggests that circulation corridors intended for general access may be required to be 1,200 mm wide, while corridors forming part of the means of egress may be permitted to remain narrower.

A similar distinction exists in New Zealand, where a minimum corridor width of 850 mm applies to escape routes [32], while a width of 1,200 mm is required for accessible routes [34]. This is further reflected in some jurisdictions, where the minimum widths prescribed for accessible routes are themselves limited, such as UAE [26] and NFPA Codes [23], [24], both of which require a minimum corridor width of 915 mm for accessible routes [41].

Table 14: Summary of Coverage Status and Applicability of Corridor Width Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Addressed & Addressed in Others	Mandatory	Minimum corridor width of 915 mm.
NFPA 5000 [24]	Addressed & Addressed in Others	Mandatory	Minimum corridor width of 915 mm.
NBCC Canada [25]	Addressed	Mandatory	Minimum corridor width of 1,000 mm.
UAE FLS CoP [26]	Addressed	Mandatory	Minimum corridor width of 915 mm.
ADB Volume 1 [27]	Addressed & Addressed in Others	Not required	ADB provides no specific dimensional guidance, stating that an acceptable width for everyday use will be sufficient. Accessible routes are required to be 1,200 mm minimum.
ADB Volume 22 [28]	Addressed & Addressed in Others	Mandatory	Minimum corridor width of 750 mm. Table 2.3 notes that widths may need to be increased to align with ADM Volume 2 guidance. ADM Volume 2 states that means of escape is outside its scope and should be addressed through ADB. Accessible routes are required to be 1,200 mm minimum.
Singapore CoP FP [29]	Addressed	Mandatory	Minimum corridor width of 1,200 mm.
Hong Kong CoP FSiB [30]	Addressed & Addressed in Others	Mandatory	Minimum corridor width of 1,050 mm.
NCC Volume 1 Australia [31]	Addressed	Mandatory	Minimum corridor width of 1,000 mm.

New Zealand Building Code [32]	Addressed & Addressed in Others	Mandatory	Minimum corridor width of 850 mm. Minimum corridor width of 1,200 mm for accessible route.

4.2.12. Mobility – Turning and Passing

Compared to corridor width requirements, a relatively narrower range was observed for clear spaces associated with wheelchair turning diameters and passing widths, generally ranging from ~ 1,500 mm [26], [41], [46] to 1,800 mm [37], [44], [46], [48]. In contrast, significant variation was noted in the prescribed intervals at which passing spaces must be provided along corridors. These distances range from every 10 m [43] to every 61 m [26], [41], depending on the code or standard. Some referenced codes and standards [38], [44], [46] do not specify any maximum distance intervals for the provision of passing spaces.

Table 15: Summary of Coverage Status and Applicability of Turning and Passing Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Addressed in Others	Mandatory (Conditional)	Turning diameter of 1,700 mm. Passing spaces of 1,525 mm × 1,525 mm required at maximum intervals of 61 m. These requirements do not apply to exit access corridors or exit enclosures.
NFPA 5000 [24]	Addressed in Others	Mandatory (Conditional)	Turning diameter of 1,700 mm. Passing spaces of 1,525 mm × 1,525 mm required at maximum intervals of 61 m. These requirements do not apply to exit access corridors or exit enclosures.
NBCC Canada [25]	Addressed	Mandatory (Conditional)	Turning diameter of 1,700 mm. Passing spaces of 1,700 mm × 1,700 mm required at maximum intervals of 24 m. These requirements do not apply to exit access corridors or exit enclosures.
UAE FLS CoP [26]	Addressed	Mandatory (Conditional)	Turning diameter of 1,525 mm. Passing spaces of 1,525 mm × 1,525 mm required at maximum intervals of 61 m. These requirements do not necessarily apply to exit access corridors or exit enclosures. May be required as part of fire strategy.
ADB Volume 1 [27]	Addressed in Others	Mandatory (Conditional)	Passing and turning spaces of 1,500 mm × 1,500 mm required at maximum intervals of 10 m. These requirements do not apply to exit access corridors or exit enclosures.
ADB Volume 22 [28]	Addressed in Others	Mandatory (Conditional)	Passing and turning spaces of 1,800 mm × 1,800 mm required at reasonable intervals. These requirements do not apply to exit access corridors or exit enclosures.
Singapore CoP FP [29]	Addressed in Others	Mandatory (Conditional)	Passing spaces of 1,800 mm × 1,800 mm required at maximum intervals of 25 m. These requirements do not apply to exit access corridors or exit enclosures.

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
Hong Kong CoP FSiB [30]	Addressed in Others	Recommend.	Turning space of 1,500 x 1,500 mm is recommended in front of lift. Corridor passing width of 1,500 mm is recommended, with no specified interval for passing spaces. These requirements do not apply to exit access corridors or exit enclosures.
NCC Volume 1 Australia [31]	Addressed in Others	Mandatory (Conditional)	Turning spaces of at least 1,500 mm × 1,500 mm required at maximum intervals of 20 m. Passing spaces of 1,800 mm × 2,000 mm required at maximum intervals of 20 m. These requirements do not apply to exit access corridors or exit enclosures.
New Zealand Building Code [32]	Addressed in Others	Mandatory (Conditional)	Turning diameter of 1,500 mm. Passing spaces of 1,800 mm × 2,000 mm required, with no specified interval for passing spaces. These requirements do not apply to exit access corridors or exit enclosures.

4.2.13. Mobility – Obstructions

All reviewed codes and standards [23], [24], [25], [26], [27], [28], [29], [30], [31], [32] include some level of restrictions on obstructions within egress routes. These restrictions can support people with visual or mobility limitations by facilitating clear paths of travel and aiding in maintaining or changing direction, as appropriate.

Table 16: Summary of Coverage Status and Applicability of Obstructions Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Addressed	Mandatory	Restrictions on projections and obstructions within means of egress.
NFPA 5000 [24]			
NBCC Canada [25]			
UAE FLS CoP [26]			
ADB Volume 1 [27]			
ADB Volume 22 [28]			
Singapore CoP FP [29]			
Hong Kong CoP FSiB [30]			
NCC Volume 1 Australia [31]			
New Zealand Building Code [32]			

4.2.14. Opening Doors – Dexterity

Most of the codes and standards [23], [24], [25], [28], [31], [32], [47] require egress doors to be operable with one hand and typically specify the use of lever hardware or similar mechanisms. These requirements are generally framed to ensure that doors can be operated without the need for tight

grasping, pinching, or twisting of the wrist, thereby supporting occupants with limited upper extremity strength or dexterity limitations. Hong Kong, Singapore, and UAE [26], [37], [38] limit the application of this requirement to accessible routes only.

However, these provisions may not be sufficient to address the needs of people with more severe upper extremity limitations, including people with missing limbs or significantly reduced hand function. In such cases, alternative hardware such as push bar hardware or automatic door operators may provide more effective door operation. Across the reviewed codes and standards, the requirement for push bar hardware is typically limited to spaces with high occupant loads [23], [24], [25], [26], [28], [29], [31], [32], and the broader application of such devices to improve egressibility is generally not considered.

Table 17: Summary of Coverage Status and Applicability of Dexterity Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Addressed	Operability – Mandatory Push Bar – Mandatory (Conditional)	Egress doors must be operable with one hand and not require tight grasping, pinching, or twisting of the wrist. Push bar exit hardware required only for specific occupancies with high occupant loads.
NFPA 5000 [24]	Addressed	Operability – Mandatory Push Bar – Mandatory (Conditional)	Egress doors must be operable with one hand and not require tight grasping, pinching, or twisting of the wrist. Push bar exit hardware required only for specific occupancies with high occupant loads.
NBCC Canada [25]	Addressed	Operability – Mandatory Push Bar – Mandatory (Conditional)	Exit doors must be operable with one hand in closed fist position, without requiring tight grasping, pinching with fingers, or twisting of the wrist. Push bar exit hardware is required only in high occupant load spaces.
UAE FLS CoP [26]	Addressed	Operability – Mandatory (Conditional) Push Bar – Mandatory (Conditional)	Door hardware on accessible routes must have a shape that is easy to grasp with one hand and does not require tight grasping, pinching, or twisting of the wrist to operate. Push bar exit hardware required only for specific occupancies with high occupant loads.
ADB Volume 1 [27]	Addressed in Others	Operability – Mandatory Push Bar – Not addressed	Should be possible to open one-handed, without the need to grasp or twist. No recommendation for push bar exit hardware.
ADB Volume 22 [28]	Addressed & Addressed in Others	Operability – Mandatory	Door hardware is recommended to be such that it should be possible to open

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
		Push Bar – Mandatory (Conditional)	one-handed, without the need to grasp or twist. Push bar exit hardware required only for specific occupancies with high occupant loads.
Singapore CoP FP [29]	Addressed in Others	Mandatory (Conditional)	Doors must be operable by one hand, not requiring fine finger control, tight grasping, pinching, or twisting of the wrist. These requirements generally apply to accessible routes and may not necessarily apply to exit doors. Push bar exit hardware is required only for high occupant load occupancies.
Hong Kong CoP FSiB [30]	Addressed in Others	Operability – Recommend. Push Bar – Not addressed	Lever-type door handles are recommended. No deemed-to-satisfy provisions are provided that require push bar exit hardware.
NCC Volume 1 Australia [31]	Addressed	Operability – Mandatory Push Bar – Mandatory (Conditional)	Door latching mechanisms must be operable by a single downward action or a single pushing action, on a single device. The design must allow operation by a person who cannot grip, without the hand slipping during latch operation. Push bar exit hardware is required only for high occupant load spaces.
New Zealand Building Code [32]	Addressed	Operability – Mandatory Push Bar – Mandatory (Conditional)	Door latches must be operable using a single hand and incorporate lever action. Push bar exit hardware required only for specific occupancies with high occupant loads.

4.2.15. Opening Doors – Automatic Door Operators

In addition to serving as an effective alternative to conventional door release hardware for occupants with severe upper-extremity functional limitations, as discussed in the previous section, automatic door operators can also assist occupants with mobility limitations by addressing reach-related challenges when using mobility aids.

Across the reviewed codes and standards, the use of automatic door operators is even more limited than that of push bar hardware. Their application is generally limited to accessible routes to satisfy usability criteria, such as the provision of required clear spaces in front of doors [25], [29] or is limited only to principal building entrances [24], [25], [37], [38]. This indicates that automatic door operators are currently not being used as component of evacuation design features.

Table 18: Summary of Coverage Status and Applicability of Automatic Door Operators Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Not Addressed	Not Addressed	Not covered by NFPA 101, typically governed by other standards.
NFPA 5000 [24]	Addressed	Mandatory (Conditional)	Only required at public entrances where occupant load exceeds the prescribed threshold; not required for exit doors.
NBCC Canada [25]	Addressed	Mandatory (Conditional)	Automatic door operators are required at entrances and may also be required to meet door usability requirement. They are not required for exits.
UAE FLS CoP [26]	Not Addressed	Not Addressed	Not covered by UAE FLS Code.
ADB Volume 1 [27]	Not Addressed	Not Addressed	No recommendation for their provision in ADB or ADM Volume 1.
ADB Volume 2 [28]	Not Addressed	Not Addressed	No recommendation for their provision in ADB or ADM Volume 2.
Singapore CoP FP [29]	Addressed in Others	Recommend.	Automatic door operators are recommended only for the entrance doors. They may also be required where door clearance requirements are not met. Applicable only to accessible routes and not to exits.
Hong Kong CoP FSiB [30]	Addressed in Others	Recommend.	Automatic door operators are recommended only for the entrance doors.
NCC Volume 1 Australia [31]	Addressed in Others	Mandatory (Conditional)	Automatic door operators may be required to satisfy AS 1428.1 usability criteria, but are not required for exit doors.
New Zealand Building Code [32]	Addressed	Mandatory (Conditional)	Automatic door operators may be required to satisfy usability criteria but are not required for exit doors.

4.2.16. Area of Refuge

Australia and New Zealand [31], [32] do not include requirements for areas of refuge. While UAE [26] introduces requirements for areas of refuge, it leaves their application to be determined as part of the overall fire strategy. As an alternative to providing an accessible means of egress to the exterior of a building, NFPA codes [23], [24] permit the provision of areas of refuge. In Canada [25], areas of refuge are required only in unsprinklered buildings.

Where areas of refuge are assumed to function as an accessible means of egress, as is the case under NFPA through reliance on fire department for rescue, the reviewed codes and standards either do not provide the minimum space requirement within an area of refuge [27], [28] or prescribe capacities that may be insufficient. For example, NFPA [23], [24] and the UAE [26] require refuge space to accommodate 0.5% of the building occupants, while Canada [25] requires space for approximately 1% to 2% of occupants, and Singapore [29] requires the provision of two Persons with Disabilities holding points regardless of building area or total occupant load.

Table 19: Summary of Coverage Status and Applicability of Area of Refuge Requirement

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
NFPA 101 [23]	Addressed	Mandatory (Conditional)	One wheelchair space required for every 200 occupants, where an accessible means of egress is not otherwise provided. Areas of refuge are treated as an accessible means of egress.
NFPA 5000 [24]	Addressed	Mandatory (Conditional)	One wheelchair space required for every 200 occupants, where an accessible means of egress is not otherwise provided. Areas of refuge are treated as an accessible means of egress.
NBCC Canada [25]	Addressed	Mandatory (Conditional)	Areas of refuge are required only in unsprinklered buildings. Space must be provided for 1% to 2% percent of occupants. No two-way emergency communication system is required within areas of refuge.
UAE FLS CoP [26]	Addressed	Mandatory (Conditional)	The area of refuge may be required as part of fire strategy. One wheelchair space required for every 200 occupants.
ADB Volume 1 [27]	Addressed	Mandatory	Provisions support a “stay put” evacuation strategy for flats, rather than designated areas of refuge.
ADB Volume 22 [28]	Addressed	Mandatory	Refuges are recommended on each storey in or adjacent to a protected stairway and form part of the building management plan. Minimum refuge size is 900 mm by 1,400 mm. No capacity guidance is provided.
Singapore CoP FP [29]	Addressed	Mandatory	Two persons with disabilities holding points are required on all storeys to allow occupants to wait for assistance. Each holding point is required to accommodate a minimum of one wheelchair with a clear space of 900 mm x 1,400 mm. Area of refuge may be used in lieu of full exit capacity for all occupants, with an occupant load capacity factor provided. Refuge floors are additionally required in super high-rise residential buildings exceeding 40 storeys.
Hong Kong CoP FSiB [30]	Addressed	Mandatory (Conditional)	A refuge area of 0.5 m² per person is required on the roof for buildings over 13 m in height with only one staircase. Refuge floors are required for buildings exceeding 25 storeys at intervals of 20 to 25 storeys depending on occupancy. Refuge areas are not required for residential buildings up to 40 storeys. A clear space of 1,500 mm by

Codes/Standard	Design Feature Coverage Status	Applicability Category	Details
			1,500 mm is required within protected exits or fireman's lift lobby.
NCC Volume 1 Australia [31]	Not Addressed	Not Addressed	Not covered by Building Code of Australia deemed-to-satisfy provisions.
New Zealand Building Code [32]	Not Addressed	Not Addressed	Not covered by New Zealand Building Code deemed-to-satisfy provisions.

5. Discussion

5.1. Notification Phase

All reviewed codes and standards require audible alarm systems where a fire alarm system is required. At a high level, this suggests a comparable level of provision for occupants with and without visual limitations. However, in sprinklered buildings, codes and standards may rely on sprinkler system activation as the primary means of detection [23], [24], [25], [26], [28], [29], [32]. The reliance on sprinkler activation can introduce delays, including flow switch activation times of up to 90 seconds before signaling the fire alarm system [49]. This reliance on delayed detection may disproportionately affect occupants with visual limitations who cannot readily detect fire or products of combustion, particularly when they are in close proximity to a fire and require earlier warning.

These concerns are further amplified by the fact that fire alarm systems themselves are not universally required in all buildings. While all reviewed codes and standards include requirements for automatic detection and audible alarms in residential occupancies, similar provisions are not consistently required across other occupancy types. This gap is particularly relevant in occupancies where individuals may be alone and may need to evacuate independently. For example, a two-storey office meeting certain occupant load criteria may not require a fire alarm system [23], [24], [25], [28], [31], [32]. In such cases, reliance on manual notification, e.g., the use of megaphones or door-to-door alerts, can introduce significant delays and may fail to provide effective early notification for occupants with hearing limitations.

In contrast to the broadly applied audible alarm requirements, visual alarm provisions are subject to more restrictive and subjective application criteria, typically requiring their use only where occupants with hearing impairments are known or expected to be present, as discussed in Section 4.2.2. For instance, auditable requirements may state that "Audible signal devices . . . shall be installed in a building so that alarm signals are clearly audible throughout the floor area" [25], whereas, visual device requirements are worded such that ". . . visible signal devices shall be provided in addition to alarm signal devices in buildings or portions thereof intended for use primarily by persons with a hearing impairment" [25]. In some cases, provisions may state that "Areas not subject to occupancy by persons who are deaf or hard of hearing shall not be required . . ." [23], [24]. However, these codes do not provide any prescriptive guidance or requirements on how to determine whether a space would not be occupied by persons with hearing limitations.

Across all reviewed codes and standards, such provisions are expressed in similarly vague terms, with no guidance on where they may be excluded or how to determine occupant characteristics. Although

this could be interpreted to imply that visual alarms are required universally unless an exemption explicitly applies, the absence of an objective criteria, together with the contrast in how audible alarm requirements are defined, likely encourages the adoption on a less onerous and cheaper interpretation of the requirement, that is audible alarms only.

Visual alarms are also required in environments where high ambient noise levels may render audible alarms ineffective. The criteria triggering their use vary between codes, typically ranging from ~90 dBA [25], [50] to ~105 dBA [26], [49], while some codes provide only general descriptors, such as dance halls or gaming venues [29]. This approach introduces an additional gap, as it does not address the needs of occupants with visual limitations, who may lack an effective means of receiving alarm signals in environments where audible notification is ineffective.

Previous studies [51], [52] have also concluded that the use of audible and visual alarm devices may not be effective in notifying sleeping occupants with hearing limitations. Recent work by Smedberg et al. [53], [54] identified a range of alternative technologies with varying degrees of effectiveness for these occupants, including air movement devices, bed or pillow shakers, pagers, mobile phones, and olfactory alarms. However, there remains a general lack of requirements for such alternative notification methods within the reviewed codes and standards. Limited recommendations were noted for the use of vibratory alerters/pads for beds and radio pagers [29], [36], [40] and none of the alternative technologies identified in the literature are explicitly required by any of the codes and standards reviewed.

5.2. Travel Phase

5.2.1. Wayfinding

From a wayfinding perspective, the increasing adoption of pictogram exit signs, required by six out of the ten codes and standards reviewed and permitted by the remaining four, represents progress in addressing language barriers. All reviewed codes and standards also require exit signage to include directional indicators to guide occupants along egress routes toward exit doors and support wayfinding.

All reviewed codes and standards require tactile and Braille signage to address visual limitations. However, unlike conventional exit signage, these features are required only at limited locations, such as adjacent to exit doors, within exit stairways, or at elevators. While these provisions support local identification, existing literature [55] indicates that they are insufficient for wayfinding, not just for evacuation but also for accessibility. This limitation is partly attributed to the absence of clear requirements specifying where wayfinding signage should be located.

The literature further identifies wayfinding as a critical concern for individuals with visual impairments [56], [57]. Despite this, nine out of ten reviewed codes and standards do not require broader wayfinding features such as tactile directional signage or tactile direction indicators. Hong Kong is a notable exception [30], [38], mandating tactile direction indicators and tactile wayfinding maps. However, their application is limited to certain public occupancies, and the tactile directional indicators are not required to lead to exits.

Smartphone applications are increasingly being adopted by people with functional limitations to help mitigate barriers they encounter in the built environment. For example, individuals with visual

impairments may use such applications for navigation and wayfinding [58]. With ongoing advancements in artificial intelligence, these applications are becoming more capable, and emerging technologies such as smart eyewear are expanding functional capabilities for users [59]. As a result, the use of these assistive technologies is expected to become increasingly common.

However, building codes and standards cannot reasonably rely on such personal wearable technologies as part of building design and life safety features. This limitation arises from several challenges, including the inability of codes to control the type, availability, or affordability of technologies used by occupants. In addition, enforcing requirements that depend on user-provided devices would be impractical, particularly in terms of compliance verification, testing standards, and defining consistent performance criteria. Therefore, while these technologies may offer relatively low-cost and easily implementable solutions at an individual level, it is unlikely that they will be formally incorporated into codes and standards or relied upon as primary life safety measures in building design.

5.2.2. Communication

Although the importance of two-way emergency communication systems has been established in several studies [60], [61], [62], five of the eight codes that mandate provision of two-way communication system, require only audible two-way functionality. This creates additional barriers for occupants with hearing or speech limitations. The provision of communication system may even be further limited with one of the codes reviewed permitting the use of a distress button that provides only a visual indication that the distress signal has been relayed. For people with hearing or speech limitations, such approaches do not address the key end-user concerns identified in previous studies [60], [61], [62], particularly the lack of information regarding response actions, availability of assistance, and expected waiting times before assistance may arrive.

Existing research evaluating two-way communication systems in practice has also identified accessibility concerns. One study reported that ~ 40% of installed systems were located in positions inaccessible to occupants with limited mobility, further reducing their effectiveness [63].

5.2.3. Vertical Movement

Self-evacuation elevators and emergency descent devices are two building design features intended to address vertical evacuation challenges for occupants with mobility limitations. The inclusion of provisions permitting the use of self-evacuation elevators in four of the ten reviewed codes and standards represents a relatively recent development, indicating a gradual shift toward their acceptance within the industry. However, their adoption remains limited, as none of the reviewed codes mandate their provision.

Where permitted, the implementation of self-evacuation elevators is constrained by restrictive requirements and a general lack of any incentives. In addition to construction and emergency power requirements, their use is typically conditional on other factors such as buildings cannot be open to general public, full building sprinkler protection, limited occupant loads, and alternative means of egress be designed to accommodate 100% of the occupant load independently.

Where self-evacuation elevators are provided for use by general public, they are not credited toward satisfying the minimum means of egress requirements [23], [24]. For example, the provision of an self-evacuation elevator is not considered to provide the required second or third means of egress.

Similarly, if a floor area is assigned an occupant load of 200 persons based on the egress capacity of exit stairs, the inclusion of an elevator does not contribute any additional occupant load capacity [23], [24]. This further reduces their value as an alternative/performance-based design solution, limiting their practical appeal, even in scenarios where they could offer clear benefits, such as addressing means of egress compliance challenges such as dead-end conditions or space constraints in existing or historic buildings.

In the real estate development and construction industry, which is often characterized by a tendency toward minimum compliance to control costs [64], [65], these constraints significantly hinder adoption. In the absence of regulatory requirements or meaningful economic or design incentives, developers are unlikely to incorporate self-evacuation elevators on a voluntary basis, particularly when doing so introduces additional cost and design complexity without corresponding benefits.

Similarly, the incorporation of mobility devices such as emergency stair descent devices remains limited, as none of the reviewed codes mandate their provision. At best, half of the reviewed codes leave their inclusion to the fire strategy, permitting the use of a range of devices without prescribing specific requirements.

Existing literature indicates that the choice of stair descent device can significantly influence evacuation performance and resource requirements. Reported evacuation speeds vary from approximately 0.21 m/s to 0.81 m/s depending on the device used [66] while the number of personnel required to assist can range from one to four individuals [67] depending on the device and training levels. Experimental studies have also identified usability concerns reported by firefighters during trials, including issues related to stability, control, lifting effort, device width, and construction of such devices [68], [69], [70]. In the absence of mandatory provisions or performance criteria within codes and standards, it remains unclear what minimum benchmarks these devices should meet to satisfy the intended level of performance [71].

5.2.4. Horizontal Movement

During the travel phase of evacuation, mobility-related provisions such as minimum corridor widths, turning and passing spaces, door operability requirements, and automatic door operators are generally limited to accessible routes.

In three of the ten codes and standards reviewed, egress routes are permitted to be narrower than accessible routes. Furthermore, six codes allow minimum egress widths between 850 mm and 915 mm. Based on the available anthropometric data for wheelchair users [72], a minimum clear width of approximately 860 mm is required to accommodate 95% of users. When typical encroachments into the clear width are considered, corridor widths below or close to this threshold will restrict wheelchair users from accessing a safe space.

Across all reviewed codes, turning and passing space requirements are treated as accessibility provisions and are typically limited to accessible routes leading from building entrances to points of service or suites, rather than along egress routes. While codes require multiple means of egress in medium to large buildings to address the risk of a blocked egress route [23], [24], [25], [26], [28], [29], [30], [31], [32], the absence of turning and passing spaces, combined with corridor widths ranging from 850 mm to 1,200 mm, effectively limits occupants using mobility aids such as wheelchairs to

unidirectional travel. This may prevent occupants from turning around or accessing alternative routes if hazards are encountered along the egress path [72].

Furthermore, even along accessible routes, provisions for turning or passing spaces are noted to be inadequate with respect to fire safety. Three of the reviewed codes do not specify maximum spacing between such features, while another three permit intervals of up to 61 m. Depending on the occupancy type, this distance may approach or exceed maximum permitted travel distances to an exit [23], [24], [26], potentially resulting in no intermediate passing or turning space along the route.

For example, NFPA and UAE provisions [23], [24], [26] generally limit travel distances to an exit in unsprinklered buildings to 61 m for assembly and certain healthcare occupancies, 46 m for educational and mercantile occupancies, and 30 m in apartment corridors. In this context, an allowable spacing of 61 m between turning or passing spaces is excessive, as it may leave occupants without any opportunity to change direction. This creates a situation where occupants may be required to travel excessive distances backward if a hazard, such as fire, smoke, or obstruction, blocks access to the exit or a designated safe space, without a suitable area to turn around.

All five codes and standards that address the use of automatic door operators require them to meet door clearance and usability requirements only. However, their application is limited to accessible routes and does not extend to egress doors. Based on user feedback [57] and available anthropometric data for wheelchair users [72], door operability is understood to be a building design obstacle and a push and pull side clearance of 1,525 mm is typically required to enable independent door operation. As the accessible route is not required to extend up to exits, none of the reviewed codes or standards mandate such clearance requirements for egress doors and consequently do not require the provision of automatic door operators in such locations.

Although research on occupants with upper extremity limitations, such as missing limbs, remains limited, automatic door operators and push-bar hardware represent design features that could improve door usability during evacuation. However, across the reviewed codes, the provision of automatic door operators remains restricted to accessible routes, while push-bar hardware is required only in occupancies with high occupant loads.

In the context of the identified gaps in horizontal movement provisions, a potential approach to address these limitations would be to extend the definition of accessible routes to explicitly include egress routes and exits. As many of the necessary provisions already exist within current codes, this approach could address key concerns related to maneuverability, door operation, and independent evacuation.

5.2.5. Area of Refuge

Where areas of refuge are permitted as an alternative to evacuation for occupants with mobility limitations, their requirements do not align with the principles governing exit systems. As noted earlier, medium to large buildings are typically required to provide two or more means of egress [23], [24], [25], [26], [28], [29], [30], [31], [32], yet areas of refuge were noted to be limited to a single location, with no requirement for redundancy.

As noted in Section 4.2.16, areas of refuge are generally designed to accommodate ~ 0.5% to 2% of the occupants. These provisions appear insufficient, given that the proportion of wheelchair users

alone has historically exceeded these thresholds [73], [74], and when broader mobility limitations are considered, this population can be closer to 10% of occupants [10], [75].

The effectiveness of areas of refuge has also been questioned in existing literature. A previous study examining end-user awareness found that fewer than 8% of occupants understood what an area of refuge is or how it functions [62], suggesting a high likelihood of ineffective use. Additionally, user willingness to utilize such spaces has been shown to depend heavily on design characteristics [60]. Factors such as inadequate information, poor lighting conditions, and concerns about being left behind resulted in more than 60% of participants expressing significant reluctance to use these spaces. Although a comprehensive review of such design features was not undertaken in this study, the overall requirements for areas of refuge were observed to be limited in scope.

5.3. Summary of Identified Gaps

This study identifies a number of systemic gaps in current evacuation design practice that collectively result in an unequal level of safety for occupants with functional limitations. These gaps are consistent across jurisdictions and occur throughout the key phases of evacuation. The following provides a synthesis of the key gaps identified across the notification and travel stages of evacuation, highlighting areas where current code-based practices fail to adequately support independent evacuation:

1. **Notification Phase:**
    a. Reliance of manual detection and notification methods, such as megaphones or door-to-door alerting, can introduce delays and may be ineffective for occupants with hearing limitations.
    b. Audible alarm systems that rely on sprinkler activation for fire detection may not provide sufficiently timely notification for occupants with visual limitations, particularly where the fire is in close proximity.
    c. The use of visual alarm systems as an alternative to audible alarm systems in high-noise environments creates gaps for occupants with visual limitations who rely on audible notification.
    d. Visual alarm requirements are typically conditional and defined using vague applicability criteria, leading to subjective interpretation and inconsistent implementation.

2. **Travel Phase:**
    a. Wayfinding toward exits is not adequately addressed for occupants with visual limitations. This is reflected in the following:
        i. Tactile wayfinding signage is generally limited to specific locations and does not include directional signage comparable to pictogram exit signage.
        ii. Tactile attention indicators are typically limited to stairs, while other hazards such as escalators, ramps, and moving walks are often not addressed.
        iii. Tactile directional indicators are rarely required, resulting in a lack of continuous guidance along egress routes.
    b. Two-way emergency communication systems that rely solely on audible communication do not adequately support occupants with hearing or speech limitations. Systems that rely only on visual indicators do not provide the level of information expected by occupants, particularly those using areas of refuge.

c. Self-evacuation elevators and emergency descent devices, which could support vertical movement for occupants with mobility limitations, are not required. As a result, occupants are not provided with design features that enable independent evacuation in multilevel buildings.
d. Minimum corridor width requirements and provisions for turning and passing are often insufficient to accommodate powered wheelchairs and other mobility aids, particularly along egress routes.
e. Door operability requirements do not adequately account for occupants with severe upper extremity limitations. Furthermore, automatic door operators, when provided to address usability requirements, are typically not required for exit doors.
f. Provisions for areas of refuge are not aligned with those for exits. While buildings may require multiple exits for redundancy, areas of refuge are often limited to a single location, resulting in a lack of equivalent redundancy.
g. The capacity of areas of refuge is insufficient relative to the proportion of occupants with mobility limitations.

6. Conclusion

The review of evacuation provisions across the codes and standards reviewed reveals substantial gaps in current design practices. Although building codes and standards acknowledge the need for certain features to support more equitable evacuation, they largely rely on normative assumptions about occupant abilities. When assessed across the phases of evacuation, a consistent pattern emerges in which provisions aligned with such assumptions are applied more extensively, while features addressing functional limitations are comparatively limited. As a result, current requirements often fail to provide an equivalent level of safety for occupants with functional limitations.

Codes and standards are shaped by past incidents and perceptions of risk; however, this risk is not always defined through quantitative measures and is more often than not informed by socially negotiated and contextual interpretations of safety [76]. In the context of a society where established fire safety concepts such as stay-put and phased evacuation policies are being re-evaluated [77], [78], and where design decisions such as the use of single-exit stairs are increasingly debated [79] due to a lack of confidence in construction quality and long-term maintenance practices, the evacuation provisions afforded to people with disabilities remain limited. Measures such as areas of refuge continue to be regarded as sufficient within codes, despite their reliance on the same systems and assumptions that are increasingly being questioned not only by the public, but also through technical, professional, and regulatory discourse.

6.1. Limitations and Future Work

This study demonstrates that meaningful insights can be derived through both quantitative and qualitative comparisons of evacuation provisions for occupants with functional limitations relative to those based on normative occupant assumptions. However, as with all research, the scope of the study was necessarily constrained to ensure completion within the timeframe of a Master's thesis. These constraints introduce several limitations that present opportunities for future work.

The key limitations are as follows:

- **Scope of design feature evaluation:** This study examined 16 design features across 10 codes and standards, resulting in approximately 160 points of comparison. Given this breadth, each design feature was not analyzed in detail at the level of its individual components. For example, while audible alarm systems were assessed in terms of their presence or absence, factors such as signal frequency and their differential impact on various user groups were not evaluated. Similarly, specific aspects such as door clearance dimensions or lighting conditions within areas of refuge were not examined in detail. Each of the identified design feature categories could form the basis of dedicated studies focused on performance and adequacy in comparison with existing literature.
- **Evidence-based review:** A key limitation of this study is the lack of an evidence-based review of past evacuation incidents involving occupants with disabilities. Only a small number of high-profile incidents, such as the Grenfell Tower fire [80], provide sufficient detail in publicly available information to examine the relationship between occupant functional limitations and building design. It is recognized that such data is likely collected for smaller incidents but not publicly available. Future research would benefit significantly from access to more comprehensive incident data to support evidence-based evaluation of evacuation provisions.

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Appendix A Evacuation Provisions in Codes and Standards

A.1. NFPA 101, Life Safety Code

In addition to the NFPA 101, Life Safety Code [23], relevant provisions of ICC A117.1, Accessible and Usable Buildings and Facilities [41] and ASME A17.1, Safety Code for Elevators and Escalators [42] are referenced in the following table where NFPA 101 defers to external standards or where other standards are commonly applied. All clause references are to NFPA 101 unless stated otherwise.

Design Feature	Reference	Details
Audible Alarms	9.6.3.6.	Audible alarm devices are required when fire alarm system is required.
Visual Alarms	9.6.3.6.1	Unless the area is not subject to be occupied by persons with hearing limitations, visual alarm devices are required when fire alarm system is required.
Exit Signs	7.10.3 and 7.2.2.5.5.8	Text-based EXIT signs are required unless graphical exit symbols are approved by the authority having jurisdiction.
Tactile Signage	7.2.2.5.4, 7.2.12.3.6, and 7.10.1.3, ICC A117.1 504.10 and 504.11	Braille and tactile character exit signage required near exit doors, floor numbering for exit stairs, door to area of refuge.
Tactile Signage – Elevator	ASME A17.1	Braille and tactile character controls required.
Tactile Attention Indicator	N/A	Not covered by NFPA 101, typically governed by other standards.
Tactile Direction Indicator	N/A	Not covered by NFPA 101, typically governed by other standards.
Two Way Emergency Communication Systems	7.2.12.1.1	Audible and visual two-way emergency communication systems are required for areas of refuge.
Mobility – Self-Evacuation Elevators	7.2.13 and 7.15	Provisions permit the use of self-evacuation elevators under restrictive design requirements but do not mandate their provision. Very restrictive criteria apply for elevators to qualify as a second means of egress. Does not provide any incentive for its provision.
Mobility – Emergency Stair Descent Device	7.16	Includes requirements for devices where provided; the provision of such devices is not mandated and no incentives are included.
Mobility – Width	7.3.4 ICC A117.1 403.5.1	Minimum corridor width of 915 mm.
Mobility – Turning and Passing	ICC A117.1 304.3 and 403.5.4.1	Turning diameter of 1,700 mm. Passing spaces of 1,525 mm × 1,525 mm required at maximum intervals of 61 m. These requirements do not apply to exit access corridors or exit enclosures.
Mobility – Obstructions	7.3.2	Restrictions on projections and obstructions within means of egress.

Design Feature	Reference	Details
Opening Doors – Dexterity	7.2.1.5.3.3	Egress doors must be operable with one hand and not require tight grasping, pinching, or twisting of the wrist. Push bar exit hardware required only for specific occupancies with high occupant loads.
Opening Doors – ADO	N/A	Not covered by NFPA 101, typically governed by other standards.
Area of Refuge	7.2.12.3.1 and 7.5.4	One wheelchair space required for every 200 occupants, where an accessible means of egress is not otherwise provided. Areas of refuge are treated as an accessible means of egress.

A.2. NFPA 5000, Building Construction and Safety Code

In addition to the NFPA 5000, Building Construction and Safety Code [24], relevant provisions of ICC A117.1, Accessible and Usable Buildings and Facilities [41] and ASME A17.1, Safety Code for Elevators and Escalators [42] are referenced in the following table where NFPA 5000 defers to external standards or where other standards are commonly applied. All clause references are to NFPA 5000 unless stated otherwise. It was observed that NFPA 5000 requirements are almost identical to NFPA 101.

Design Feature	Reference	Details
Audible Alarms	55.2.3.5	Audible alarm devices are required when fire alarm system is required.
Visual Alarms	55.2.3.5.1	Unless the area is not subject to be occupied by persons with hearing limitations, visual alarm devices are required when fire alarm system is required.
Exit Signs	11.10.3 and 11.10.6	Text-based EXIT signs are required unless graphical exit symbols are approved by the authority having jurisdiction.
Tactile Signage	11.2.2.6.1.10, 11.2.12.3.6, and 11.10.1.3, ICC A117.1 504.10 and 504.11	Braille and tactile character exit signage required near exit doors, floor numbering for exit stairs, door to area of refuge.
Tactile Signage – Elevator	ASME A17.1	Braille and tactile character controls required.
Tactile Attention Indicator	N/A	Not covered by NFPA 5000, typically governed by other standards.
Tactile Direction Indicator	N/A	Not covered by NFPA 5000, typically governed by other standards.
Two Way Emergency Communication Systems	11.2.12.1.1	Audible and visual two-way emergency communication systems are required for areas of refuge.
Mobility – Self-Evacuation Elevators	11.2.13 and 11.14.1	Provisions permit the use of self-evacuation elevators under restrictive design requirements but do not mandate their provision. Very restrictive

Design Feature	Reference	Details
		criteria apply for elevators to qualify as a second means of egress. Does not provide any incentive for its provision.
Mobility – Emergency Stair Descent Device	11.15	Includes requirements for devices where provided; the provision of such devices is not mandated and no incentives are included.
Mobility – Width	11.3.4 ICC A117.1 403.5.1	Minimum corridor width of 915 mm.
Mobility – Turning and Passing	ICC A117.1 304.3 and 403.5.4.1	Turning diameter of 1,700 mm. Passing spaces of 1,525 mm × 1,525 mm required at maximum intervals of 61 m. These requirements do not apply to exit access corridors or exit enclosures.
Mobility – Obstructions	11.3.2	Restrictions on projections and obstructions within means of egress.
Opening Doors – Dexterity	11.2.1.5.3.3	Egress doors must be operable with one hand and not require tight grasping, pinching, or twisting of the wrist. Push bar exit hardware required only for specific occupancies with high occupant loads.
Opening Doors – ADO	12.6.4.1.1	Only required at public entrances where occupant load exceeds the prescribed threshold; not required for exit doors.
Area of Refuge	11.2.12.3.1 and 11.5.4	One wheelchair space required for every 200 occupants, where an accessible means of egress is not otherwise provided. Areas of refuge are treated as an accessible means of egress.

A.3. National Building Code of Canada

In addition to the National Building Code of Canada (NBCC) [25], relevant provisions of CSA B44, Safety Code for Elevators and Escalators [42], are referenced in the following table where NBCC defers to external standards or where other standards are commonly applied. Unless otherwise noted, all clause references are to NBCC 2025 Division B.

Design Feature	Reference	Details
Audible Alarms	Article 3.2.4.18.	Audible alarm devices are required when fire alarm system is required.
Visual Alarms	Article 3.2.4.19.	Visual alarm devices are required in buildings intended primarily for persons with hearing limitations, in occupancies with high ambient noise levels, within corridors of most occupancies, in at least 10% of hotel guestrooms, and within washrooms except those located within dwelling suites.
Exit Signs	Article 3.4.5.1.	Exit signs are required to use pictograms.
Tactile Signage	Articles 3.4.5.2., 3.4.6.16., 3.4.6.18., and 3.4.6.19.	Braille and tactile character exit signage required near exit doors, door for door release hardware such as maglock, crossover floors, floor and stair numbering for exit stairs.

Design Feature	Reference	Details
Tactile Signage – Elevator	CSA B44	Braille and tactile character controls required.
Tactile Attention Indicator	Article 3.3.1.19.	Tactile attention indicators are required at the top of stairs that are unenclosed.
Tactile Direction Indicator	N/A	Not required by NBCC.
Two Way Emergency Communication Systems	Articles 3.2.6.8. and 3.2.4.22	Audible two-way emergency communication systems are required only for high buildings in exits and elevators.
Mobility – Self-Evacuation Elevators	Appendix A-3.3.1.7.(1)	No prescriptive provision for the use of self-evacuation elevator. The Code specifically states elevators are not intended for use by persons with disability even in unsprinklered buildings without firefighter assistance. Recent edition of elevator standard contains provisions for the use of elevators for self-evacuation, but the NBCC does not provide a compliance pathway for their use.
Mobility – Emergency Stair Descent Device	N/A	No provisions included.
Mobility – Width	Article 3.3.1.9. and 3.8.3.2.	Minimum corridor width of 1,000 mm.
Mobility – Turning and Passing	Article 3.8.3.2.	Turning diameter of 1,700 mm. Passing spaces of 1,700 mm × 1,700 mm required at maximum intervals of 24 m. These requirements do not apply to exit access corridors or exit enclosures.
Mobility – Obstructions	Articles 3.3.1.8. and 3.4.3.4.	Restrictions on projections and obstructions within means of egress.
Opening Doors – Dexterity	Articles 3.3.1.13., 3.4.6.16., and 3.8.3.8.	Exit doors must be operable with one hand in closed fist position, without requiring tight grasping, pinching with fingers, or twisting of the wrist. Push bar exit hardware is required only in high occupant load spaces.
Opening Doors – ADO	Articles 3.8.2.7. and 3.8.3.6.	Automatic door operators are required at entrances and may also be required to meet door usability requirement. They are not required for exits.
Area of Refuge	Article 3.3.1.7., Table 3.8.2.3., and Article 3.2.4.22.	Areas of refuge are required only in unsprinklered buildings. Space must be provided for 1% to 2% percent of occupants. No two-way emergency communication system is required within areas of refuge.

A.4. UAE Fire and Life Safety Code of Practice

In addition to the UAE Fire and Life Safety Code of Practice [26], relevant provisions of ICC A117.1, Accessible and Usable Buildings and Facilities [41] and ASME A17.1, Safety Code for Elevators and Escalators [42] are referenced in the following table where UAE Fire and Life Safety Code of Practice

defers to external standards or where other standards are commonly applied. All clause references are to UAE Fire and Life Safety Code of Practice unless stated otherwise. It was observed that UAE Fire and Life Safety Code of Practice requirements are quite similar to that of NFPA 101 and NFPA 5000.

Chapter 15 Section 5 of UAE Fire and Life Safety Code of Practice includes emergency evacuation strategies for people with various functional limitations. However, these provisions are largely guidance-based, and their application is understood to be limited and subject to interpretation through the project-specific fire strategy.

Design Feature	Reference	Details
Audible Alarms	Table 8.1 Item 16	Audible alarm devices are required when fire alarm system is required. Required in most buildings.
Visual Alarms	Table 8.1 Items 16 and 17	Visual alarm devices are required only where audible alarms are not effective, not feasible to type of occupancy (such as noisy parking spaces or noisy environment like engine room), or in areas where audio alarm requires the aid of visual alarm. They may be required based on fire strategy for the building.
Exit Signs	Table 5.1 Item 1	Exit signage must be multilingual and include pictograms.
Tactile Signage	Table 5.1 Item 3, Table 5.3 ICC A117.1 Clause 504.10 and 504.11	Braille and tactile character exit signage required near exit doors and floor numbering for exit stairs.
Tactile Signage – Elevator	ASME A17.1	Braille and tactile character controls required.
Tactile Attention Indicator	Table 15.5 Item 4	“Detectable warning” is required only for rail platforms.
Tactile Direction Indicator	N/A	Not covered by UAE FLS Code.
Two Way Emergency Communication Systems	Table 3.10 Item 5 Table 15.4 Item 5	Audible and visual two-way emergency communication systems are required for elevator landings associated with area of refuge only.
Mobility – Self-Evacuation Elevators	Table 3.11 Item 1	Requirements are provided for “evacuation elevators,” which may be required as part of the fire strategy. They cannot be used for self-evacuation without assistance of facility management and Civil Defense Rescue team.
Mobility – Emergency Stair Descent Device	Chapter 15 Clause 5.2.	No provisions are included. They can be part of fire strategy.
Mobility – Width	Table 15.1 Item 4	Minimum corridor width of 915 mm.
Mobility – Turning and Passing	Table 15.1 Items 2 and 4	Turning diameter of 1,525 mm. Passing spaces of 1,525 mm × 1,525 mm required at maximum intervals of 61 m. These requirements do not necessarily apply to exit access corridors or exit enclosures. May be required as part of fire strategy.

Design Feature	Reference	Details
Mobility – Obstructions	Table 3.1 Table 15.1 Item 3	Restrictions on projections and obstructions within means of egress.
Opening Doors – Dexterity	Table 15.1 Item 6 Chapter 3	Door hardware on accessible routes must have a shape that is easy to grasp with one hand and does not require tight grasping, pinching, or twisting of the wrist to operate. Push bar exit hardware required only for specific occupancies with high occupant loads.
Opening Doors – ADO	N/A	Not covered by UAE FLS Code.
Area of Refuge	Table 3.10 Item 4	The area of refuge may be required as part of fire strategy. One wheelchair space required for every 200 occupants.

A.5. Approved Document B (ADB) Fire Safety Volume 1: Dwellings

In addition to Approved Document B (ADB) Volume 1 [27], relevant provisions of BS 5839-6 [36], BS 8300-2 [47], and Approved Document M (ADM) Volume 1 [43] are referenced in the following table where ADB Volume 1 defers to external standards or where other standards are commonly applied. Unless stated otherwise, all clause references are to ADB Volume 1.

Approved Documents are understood to be guidance documents rather than mandatory requirements. However, for the purposes of this study, their provisions are treated as prescriptive requirements.

Design Feature	Reference	Details
Audible Alarms	Clause 1.1	Audible alarm devices are required to be provided.
Visual Alarms	BS 5839-6 Section 14	BS 5839-6 provides guidance on alarm system design and includes subjective recommendations for warning devices suitable for people with hearing limitations. Alternative notification devices such as vibrating pads for use under pillows or mattresses are also described. The extent of application of such guidance is unclear.
Exit Signs	Clause 3.45	Exit signs are required to use pictograms. Not required if it is a regular use stair or door.
Tactile Signage	BS 8300-2 12.1.3	BS 8300-2 provides guidance on tactile way-finding and includes subjective recommendations. The extent of application of such guidance is unclear.
Tactile Signage – Elevator	ADM Vol 1 Clause 1.11	Tactile controls which may include braille are required, along with floor numbering adjacent to lift call button.
Tactile Attention Indicator	N/A	Not covered by ADB or ADM Volume 1.
Tactile Direction Indicator	N/A	Not covered by ADB or ADM Volume 1.

Design Feature	Reference	Details
Two Way Emergency Communication Systems	N/A	Not covered by ADB or ADM Volume 1.
Mobility – Self-Evacuation Elevators	Clauses 3.29 and 3.53	Guidance is provided for design of self-evacuation lifts. No recommendation is provided on when self-evacuation lifts should be installed.
Mobility – Emergency Stair Descent Device	BS 8300-2 10.5.1	Guidance in BS 8300-2 allows their use in existing buildings where conventional lifts are not feasible. No guidance is provided for new construction.
Mobility – Width	Clause 3.60 ADM Vol 1 Clause 3.9	ADB provides no specific dimensional guidance, stating that an acceptable width for everyday use will be sufficient. Accessible routes are required to be 1,200 mm minimum.
Mobility – Turning and Passing	ADM Vol 1 Clause 3.9	Passing and turning spaces of 1,500 mm × 1,500 mm required at maximum intervals of 10 m. These requirements do not apply to exit access corridors or exit enclosures.
Mobility – Obstructions	Clause 3.38	Restrictions on projections and obstructions within means of egress.
Opening Doors – Dexterity	BS 8300-2 Clause 8.4.1	Should be possible to open one-handed, without the need to grasp or twist. No recommendation for push bar exit hardware.
Opening Doors – ADO	ADB and ADM	No recommendation for their provision in ADB or ADM Volume 1.
Area of Refuge	Clause 3.3	Provisions support a “stay put” evacuation strategy for flats, rather than designated areas of refuge.

A.6. Approved Document B (ADB) Fire Safety Volume 2: Buildings other than Dwellings

In addition to Approved Document B (ADB) Volume 2 [28], relevant provisions of BS 5839-1 [40], BS 8300-2 [47], and Approved Document M (ADM) Volume 2 [44] are referenced in the following table where ADB Volume 2 defers to external standards or where other standards are commonly applied. Unless stated otherwise, all clause references are to ADB Volume 2.

Approved Documents are understood to be guidance documents rather than mandatory requirements. However, for the purposes of this study, their provisions are treated as prescriptive requirements.

Design Feature	Reference	Details
Audible Alarms	Clause 1.7 BS 5839-1 Section 15 and Table A.1	Audible alarm devices are required when fire alarm system is provided, except where the system is installed for property protection only.
Visual Alarms	Clause 1.15 BS 5839-1 Section 17	Visual alarm devices are required where occupants may be in relative isolation. Alternative systems, such as vibrating personal paging systems, may be used where the occupant population is managed.

Design Feature	Reference	Details
		BS 5839-1 also provides compliance pathways for additional devices such as vibrating pads (that can be used to wake people up) or portable pagers (that can be carried by users). The applicability of these systems depends on occupancy type and the fire safety strategy.
Exit Signs	Clause 5.28	Exit signs are required to use pictograms.
Tactile Signage	BS 8300-2 12.1.3	BS 8300-2 provides guidance on tactile way-finding and includes subjective recommendations. The extent of application of such guidance is unclear.
Tactile Signage – Elevator	ADM Vol 2 Clause 3.28	Tactile controls which may include braille are required.
Tactile Attention Indicator	ADM Vol 2 Clause 1.13 BS 8300-2 Clause 20.2.7	Tactile paving guidance applies only for exterior spaces and transit platforms.
Tactile Direction Indicator	BS 8300-2 Clause 20.2.7	Tactile paving guidance applies only for exterior and transit spaces.
Two Way Emergency Communication Systems	Clause 3.7	Audible two-way emergency communication systems are recommended for refuge areas only.
Mobility – Self-Evacuation Elevators	Clause 5.32	Guidance is provided for design and provision of self-evacuation lifts only where they form part of management plan for evacuating people. No recommendation is provided on when self-evacuation lifts should be installed.
Mobility – Emergency Stair Descent Device	BS 8300-2 10.5.1	Guidance in BS 8300-2 allows their use in existing buildings where conventional lifts are not feasible. No guidance is provided for new construction.
Mobility – Width	Table 2.3 ADM Vol 2 Clause 3.14	Minimum corridor width of 750 mm. Table 2.3 notes that widths may need to be increased to align with ADM Volume 2 guidance. ADM Volume 2 states that means of escape is outside its scope and should be addressed through ADB. Accessible routes are required to be 1,200 mm minimum.
Mobility – Turning and Passing	ADM Vol 2 Clause 3.14 BS 8300-2 Clause 9.1.2	Passing and turning spaces of 1,800 mm × 1,800 mm required at reasonable intervals. These requirements do not apply to exit access corridors or exit enclosures.
Mobility – Obstructions	Clause 5.16	Restrictions on projections and obstructions within means of egress.
Opening Doors – Dexterity	Clause 5.9 BS 8300-2 Clause 8.4.1	Door hardware is recommended to be such that it should be possible to open one-handed, without the need to grasp or twist. Push bar exit hardware required only for specific occupancies with high occupant loads.
Opening Doors – ADO	ADB and ADM	No recommendation for their provision in ADB or ADM Volume 2.

Design Feature	Reference	Details
Area of Refuge	Clause 3.4 and 3.6	Refuges are recommended on each storey in or adjacent to a protected stairway and form part of the building management plan. Minimum refuge size is 900 mm by 1,400 mm. No capacity guidance is provided.

A.7. Singapore Code of Practice for Fire Precautions in Buildings

In addition to Singapore Code of Practice for Fire Precautions in Buildings [29], relevant provisions of Singapore Code on Accessibility in the Built Environment (CoA) [37] are referenced in the following table where Singapore Code of Practice for Fire Precautions in Buildings defers to external standards or where other standards are commonly applied. Unless stated otherwise, all clause references are to Singapore Code of Practice for Fire Precautions in Buildings.

Design Feature	Reference	Details
Audible Alarms	Clause 6.3.5b	Audible alarm devices are required when fire alarm system is required.
Visual Alarms	Clause 6.3.5c and 6.3.6b	Visual alarm devices are required where persons with hearing limitations may be isolated, in car parks, in lift lobbies, and in places of entertainment. Visual alarms are not required within individual residential occupancies. Residential fire alarm devices may include optional features such as connections to visual alarms or vibrating pads.
Exit Signs	Clause 8.1.7	Exit signs may be pictogram or text based.
Tactile Signage	CoA Table 1	Braille and tactile character signage is required for ramps and stairs. No exit signage in tactile format.
Tactile Signage – Elevator	CoA Clause 4.8.2.2	Braille and tactile character controls required.
Tactile Attention Indicator	CoA Clause 4.7.4	Warning Tactile Ground Surface Indicators are required at changes in elevation and other hazardous conditions.
Tactile Direction Indicator	N/A	Not addressed.
Two Way Emergency Communication Systems	Clause 8.2.2 and 2.4.3.	Audible two-way emergency communication systems are required in buildings with high occupant load or tall buildings, typically within fire lift lobbies and areas of refuge. When considering the additional spaces identified for these systems, their provision appears to be primarily intended to support firefighter operations. Distress buttons or voice communication systems are required at holding points for persons with disabilities.
Mobility – Self-Evacuation Elevators	Clause 6.6.5 and Appendix 02 Item 4.7	Requirements are provided for “evacuation lifts,” in buildings taller than 24 m in height, except

Design Feature	Reference	Details
		residential. They cannot be used for self-evacuation without assistance of firefighters.
Mobility – Emergency Stair Descent Device	Clause 2.4.6b	Such devices are not required. Wheelchair stairlifts may be provided within exits but must not encroach upon the required escape path.
Mobility – Width	Table 2.2A	Minimum corridor width of 1,200 mm.
Mobility – Turning and Passing	CoA Clause 4.2.1.2.	Passing spaces of 1,800 mm × 1,800 mm required at maximum intervals of 25 m. These requirements do not apply to exit access corridors or exit enclosures.
Mobility – Obstructions	Clause 2.3.3d and CoA Clause 4.3.1	Restrictions on projections and obstructions within means of egress.
Opening Doors – Dexterity	CoA Clause 4.4.8 Clause 2.3.9i	Doors must be operable by one hand, not requiring fine finger control, tight grasping, pinching, or twisting of the wrist. These requirements generally apply to accessible routes and may not necessarily apply to exit doors. Push bar exit hardware is required only for high occupant load occupancies.
Opening Doors – ADO	CoA Clauses 4.4.1.4. and 4.4.6	Automatic door operators are recommended only for the entrance doors. They may also be required where door clearance requirements are not met. Applicable only to accessible routes and not to exits.
Area of Refuge	Clause 2.4.2 Clause 2.2.15, 9.2.2, and 9.3.2	Two persons with disabilities holding points are required on all storeys to allow occupants to wait for assistance. Each holding point is required to accommodate a minimum of one wheelchair with a clear space of 900 mm x 1,400 mm. Area of refuge may be used in lieu of full exit capacity for all occupants, with an occupant load capacity factor provided. Refuge floors are additionally required in super high-rise residential buildings exceeding 40 storeys.

A.8. Hong Kong Code of Practice for Fire Safety in Buildings

In addition to Hong Kong Code of Practice for Fire Safety in Buildings [30], relevant provisions of Hong Kong Design Manual: Barrier Free Access (BFA) [38], Hong Kong Code of Practice for Minimum Fire Service Installation and Equipment (FSI&E) [35], and are referenced in the following table where Hong Kong Code of Practice for Fire Safety in Buildings defers to external standards or where other standards are commonly applied. Unless stated otherwise, all clause references are to Hong Kong Code of Practice for Fire Safety in Buildings.

Design Feature	Reference	Details
Audible Alarms	FSI&E Section 5.11 and 5.13	Audible alarm devices are required when fire alarm system or fire detection system is required.

Design Feature	Reference	Details
Visual Alarms	FSI&E Section 5.11 and 5.13 BFA Chapter 5 Clause 5.2.3	Except for residential occupancies, visual alarm devices are required in all occupancies where fire alarm systems are required. Staff-only areas or areas not open to visitors are exempt unless a person with hearing limitations is required to work alone.
Exit Signs	FSI&E Section 5.10	Exit signs may be pictogram or text based. Text signs are required to be in both English and Chinese. Directional exit signs are required to be pictograms.
Tactile Signage	BFA Chapter 4 Div 1 Clause 6, Div 7 Clause 26, Div 8 Clause 30, and Div 14 Clause 68 and Figure 32	Braille and tactile fire exit maps are required in lift lobbies and at entrances to auditoriums. Braille and tactile character signage is required for floor numbers, directional, and other information in staircases. Exit information is required on handrails.
Tactile Signage – Elevator	BFA Chapter 4 Division 19 Clause 80 and 81	Braille and tactile character controls required.
Tactile Attention Indicator	BFA Chapter 4 Div 1 Clause 6 Division 5 Clause 18 Div 7 Clause 26 Division 20 Clause 85	Tactile warning strips are required at top, bottom, and landings of staircases, ramps, and escalators.
Tactile Direction Indicator	BFA Table 2 and Chapter 4 Div 4 Clause 13	Directional tactile strips are required for various public occupancy buildings such as shopping complex, cinema, schools, sports complex. They are not required to provide direction to exits.
Two Way Emergency Communication Systems	Clause B30.4	Closed-circuit television (CCTV) and intercom two-way emergency communication are required between temporary refuge spaces and management office.
Mobility – Self-Evacuation Elevators	Section 3	Lifts are explicitly excluded from the definition of an exit route.
Mobility – Emergency Stair Descent Device	N/A	No provisions included.
Mobility – Width	Table B2 BFA Chapter 4 Div 4 Clause 12	Minimum corridor width of 1,050 mm.
Mobility – Turning and Passing	BFA Chapter 4 Div 9 Recomm. B(a) and Div 19 Recomm. B(e)	Turning space of 1,500 x 1,500 mm is recommended in front of lift. Corridor passing width of 1,500 mm is recommended, with no specified interval for passing spaces. These requirements do not apply to exit access corridors or exit enclosures.
Mobility – Obstructions	Table B2 Note 3 BFA Chapter 4 Div 7 Clause 26	Restrictions on projections and obstructions within means of egress.

Design Feature	Reference	Details
Opening Doors – Dexterity	BFA Chapter 4 Div 10 Recomm. B(b)	Lever-type door handles are recommended. No deemed-to-satisfy provisions are provided that require push bar exit hardware.
Opening Doors – ADO	BFA Chapter 4 Div 10 Recomm. B(d)	Automatic door operators are recommended only for the entrance doors.
Area of Refuge	Clauses B6.1, B18.1, B18.5, B30.1	A refuge area of 0.5 m² per person is required on the roof for buildings over 13 m in height with only one staircase. Refuge floors are required for buildings exceeding 25 storeys at intervals of 20 to 25 storeys depending on occupancy. Refuge areas are not required for residential buildings up to 40 storeys. A clear space of 1,500 mm by 1,500 mm is required within protected exits or fireman's lift lobby.

A.9. National Construction Code Volume One (Building Code of Australia) (Preview Draft)

In addition to National Construction Code Volume One (Building Code of Australia) (Preview Draft) [31] relevant provisions of AS 1670 Fire Detection, Warning, Control and Intercom Systems - System Design, Installation and Commissioning [39], [81], AS 1735.12 Lifts, Escalators and Moving Walks, Part 12: Facilities for Persons with Disabilities [45], and AS 1428.1 Design for access and mobility, Part 1: General Requirements for Access - New Building Work [48] are referenced in the following table where National Construction Code Volume One defers to external standards or where other standards are commonly applied. Unless stated otherwise, all clause references are to National Construction Code Volume One.

Design Feature	Reference	Details
Audible Alarms	S20C7, E4D9	Audible alarm devices are required when fire alarm system is required.
Visual Alarms	S20C7 AS 1670.1 Clause 3.17.4	Visual alarm devices are required in spaces designated for persons with hearing limitations and in spaces with high background noise levels.
Exit Signs	E4D8	Exit signs are required to use pictograms.
Tactile Signage	D3D26, D4D7	Braille and tactile character signage is required to identify exit doors, floor and level information, and door latch operation where this information is not provided on the door leaf itself.
Tactile Signage – Elevator	AS 1735.12 Clause 5.4.3	Braille and tactile character controls required.
Tactile Attention Indicator	D4D9	Tactile Ground Surface Indicators (TGSI) are required at the approach to stairways, escalators, moving walks, and ramps.
Tactile Direction Indicator	N/A	Not covered by Building Code of Australia.

Design Feature	Reference	Details
Two Way Emergency Communication Systems	E4D9 AS 1670.4	Intercom system is required in compliance with AS 1670.4. Unclear whether the system is required to provide both audible and visual communication, or audible communication only, due to access limitation to the latest published version of the standard.
Mobility – Self-Evacuation Elevators	D1P7, D2D1 Notes	Lifts may be provided to assist occupants to evacuate a building; however, no deemed-to-satisfy provisions are provided.
Mobility – Emergency Stair Descent Device	N/A	Not covered by Building Code of Australia.
Mobility – Width	D2D8	Minimum corridor width of 1,000 mm.
Mobility – Turning and Passing	D4D4 AS 1428.1 Clause 3.4	Turning spaces of at least 1,500 mm × 1,500 mm required at maximum intervals of 20 m. Passing spaces of 1,800 mm × 2,000 mm required at maximum intervals of 20 m. These requirements do not apply to exit access corridors or exit enclosures.
Mobility – Obstructions	D2D7	Restrictions on obstructions within means of egress.
Opening Doors – Dexterity	D3D26	Door latching mechanisms must be operable by a single downward action or a single pushing action, on a single device. The design must allow operation by a person who cannot grip, without the hand slipping during latch operation. Push bar exit hardware is required only for high occupant load spaces.
Opening Doors – ADO	N/A	Automatic door operators may be required to satisfy AS 1428.1 usability criteria, but are not required for exit doors.
Area of Refuge	N/A	Not covered by Building Code of Australia deemed-to-satisfy provisions.

A.10. New Zealand Building Code

Multiple Acceptable Solution documents are used in combination to achieve deemed-to-satisfy compliance with the New Zealand Building Code. The following documents are referenced in this section:

- C/AS2 Protection from Fire - Acceptable Solution for Buildings other than Risk Group SH [32]
- F8/AS1 Signs [33]
- D1/AS1 Access Routes[34]

Additionally, NZS 4121 Design for Access and Mobility – Buildings and Associated Facilities [46] is also referenced.

Design Feature	Reference	Details
Audible Alarms	C/AS2 Subsection 2.2.8 and Appendix C	Audible alarm devices are required when fire alarm system is required.
Visual Alarms	NZS-4121 Section 4.12, 4.13, 14.6.6	Visual alarm devices are required only along accessible routes and within accessible accommodation units. Within accommodation units, provision is limited to visibility from beds.
Exit Signs	F8/AS1 Clause 4.0	Exit signs are required to use pictograms.
Tactile Signage	F8/AS1 Clause 2.0	Braille signage for safety signs, exit signs, and fire related safety feature signs.
Tactile Signage – Elevator	NZS 4121 Clause 9.2.4	Braille and tactile character controls required.
Tactile Attention Indicator	NZS 4121 Clause 8.1.2	Change in color and texture of surface is required at top and bottom of stairs.
Tactile Direction Indicator	NZS 4121 Clause 4.7	The concept of tactile directional indicators is introduced; however, no specific requirements are provided.
Two Way Emergency Communication Systems	N/A	May be required as part of a fire engineering approach. There are no clear deemed-to-satisfy provisions.
Mobility – Self-Evacuation Elevators	N/A	Not covered by New Zealand Building Code deemed-to-satisfy provisions.
Mobility – Emergency Stair Descent Device	N/A	Not covered by New Zealand Building Code deemed-to-satisfy provisions.
Mobility – Width	C/AS2 Paragraph 3.2.2.3 D1/AS1 Clause 2.2.1	Minimum corridor width of 850 mm. Minimum corridor width of 1,200 mm for accessible route.
Mobility – Turning and Passing	NZS 4121 Clause Appendix D3.3.4.1	Turning diameter of 1,500 mm. Passing spaces of 1,800 mm × 2,000 mm required, with no specified interval for passing spaces. These requirements do not apply to exit access corridors or exit enclosures.
Mobility – Obstructions	C/AS2 Subsection 3.2.4	Restrictions on projections and obstructions within means of egress.
Opening Doors – Dexterity	C/AS2 Paragraph 3.9.1.7. and 3.9.8.2. D1/AS1 Clause 7.0.5	Door latches must be operable using a single hand and incorporate lever action. Push bar exit hardware required only for specific occupancies with high occupant loads.
Opening Doors – ADO	D1/AS1 Clause 7.0.5	Automatic door operators may be required to satisfy usability criteria but are not required for exit doors.
Area of Refuge	N/A	Not covered by New Zealand Building Code deemed-to-satisfy provisions.