Accessibility Systems Beyond Compliance:

Rethinking Braille Signage Through Standards Fragmentationand Engineering Translation

An LC Sign White Paper on System Translation,Lifecycle Execution, and Accessibility Infrastructure

Accessibility Systems Insight Report | May 2026

Contents

Key Insights

Global growth in the visually impaired population is shifting accessibility from a medical issue to a core infrastructure requirement in spatial and information systems. According to The Lancet Global Health, as of 2020, approximately 43.3 million people worldwide were blind. This number is projected to rise to 61 million by 2050, while the total number of people with some form of vision impairment is expected to reach 1.7 billion.[1] This trend indicates a sustained global demand for accessible environments.

However, braille and tactile signage systems still show a gap between compliance and usability, driven by fragmented regulatory standards (ISO[2], ADA[3], GB/T[4]) without unified engineering integration, along with execution inconsistencies across design, production, construction, and inspection.

Regional fragmentation further intensifies this gap. In the EU, accessibility remains sector-specific, with pharmaceutical packaging governed by ISO 17351[5], while building signage lacks a unified standard under development (prEN 18156[6]). In the

[1] International Agency for the Prevention of Blindness (IAPB). (2021). *Magnitude of Vision Loss – Vision Atlas Evidence Series*. Vision Atlas.Available at: https://www.iapb.org/wp-content/uploads/2021/02/Vision-Atlas_Evidence-Series_Magnitude-of-VIsion-Loss_24022021.pdf

[2] International Organization for Standardization. ISO 17049:2013 – Accessible design — Application of braille on signage, equipment and appliances. Available at: https://www.iso.org/obp/ui/#iso:std:iso:17049:ed-1:v1:en

[3] U.S. Access Board. 2010 ADA Standards for Accessible Design. Available at: https://www.ada.gov/law-and-regs/design-standards/2010-stds/

[4] State Administration for Market Regulation of China, Standardization Administration of China. *GB/T 39758-2021 "Accessible design — Application of braille on signage, equipment and appliances"*. 2021-03-09. Available at: https://std.samr.gov.cn/gb/search/gbDetailed?id=BD89DE8E07E53D08E05397BE0A0A4FAD

[5] International Organization for Standardization. ISO 17351:2013 – Packaging — Braille on packaging for medicinal products. Available at: https://www.iso.org/obp/ui/#iso:std:iso:17351:ed-1:v1:en

[6] CEN Draft Standard:prEN 18156 – Tactile

US, the ADA framework is shifting from compliance verification toward usability evaluation, reflecting a transition toward engineering hub logic.

This white paper uses LC Sign's "Touchpoint Initiative" and the Guangzhou Qiming School project as validation cases, demonstrating a pathway from compliance to usability. Through cross-standard engineering and ergonomic testing, LC Sign defines key parameters including a 1.1-meter tactile reading height, a 0.5 mm braille dot height, and high-contrast visual support systems. As accessibility becomes part of ESG[7] and sustainability frameworks, LC Sign positions itself as an end-to-end accessibility engineering provider enabling consistent execution across standards, scenarios, and materials, rather than fragmented delivery.

1 From Compliance to Infrastructure: The Systemic Shift of Global Information Accessibility in an Aging and Vision-Impaired World

According to The Lancet Global Health, as of 2020, approximately 43.3 million people worldwide were blind. This number is projected to rise to 61 million by 2050, while the total number of people with some form of vision impairment is expected to reach 1.7 billion,[1] making vision impairment a long-term global public health and accessibility challenge. It is increasingly shifting from a medical issue to a system-level constraint affecting mobility, spatial recognition, and public

lettering – Requirements on the presentation and application of Braille and raised characters at: https://standards.iteh.ai/catalog/standards/cen/be20c3e7-2df0-41d2-882a-d15c10662913/pren-18156

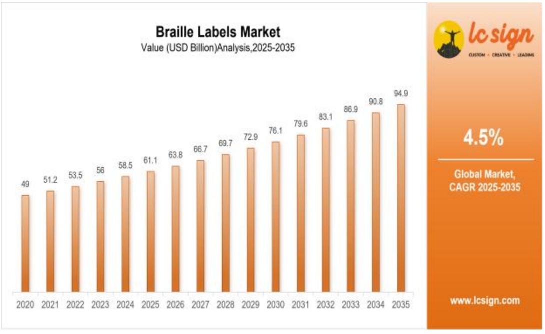
7 TechTarget. What is ESG (Environmental, Social, and Governance)？Available at: https://www.techtarget.com/whatis/definition/environmental-social-and-governance-ESG

participation, where information accessibility capability is becoming more critical than visual capability. As a result, accessibility systems are evolving from medical concern to spatial design requirement and ultimately to information infrastructure, becoming essential components of built environments. This evolution is reshaping accessibility requirements across spatial and information systems.

Despite global progress, accessibility implementation remains fragmented, with inconsistent standards and limited real-world usability, resulting in many systems being "compliant but unusable," highlighting the gap between regulatory compliance and actual user experience in tactile and spatial information systems.

The global braille labels market is projected to grow from USD 61.1 billion in 2025 to USD 94.9 billion in 2035 (CAGR ~4.5%), driven by accessibility shifting toward brand trust, aging populations, and digital tactile technologies such as QR and NFC integration. [8]

FIGURE1 Global Braille Labels Market Size Analysis：2020 – 2035 Growth Trend



Overview：The market is projected to reach USD 94.9 billion by 2035 with a 4.5% CAGR, fueled by the rising necessity for inclusive packaging.

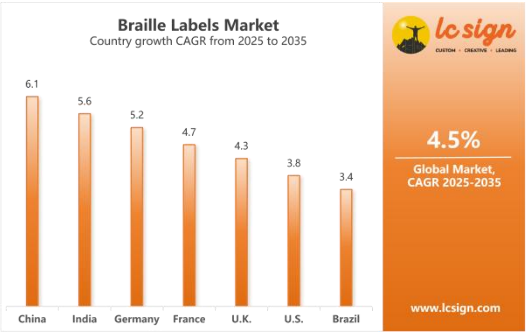
Based on regional segmentation, the Braille labels market is divided into seven regions: North America, Latin America, Eastern Europe, Western Europe, Asia-Pacific, the Middle East & Africa, and Japan.

North America and Europe dominate the market due to their advanced

[8] Future Market Insights. Braille Labels Market Report. 2025. Available at: https://www.futuremarketinsights.com/reports/braille-labels-market

technologies and the strong emphasis placed by end-user companies on providing convenient packaging solutions for people of all age groups, including individuals with disabilities.

FIGURE 2 Braille Labels Market Growth by Country：2025 – 2035 CAGR Forecast



Overview：Global demand for braille labels is surging as accessibility regulations tighten across commercial, public, and healthcare sectors

However, the industry still faces structural bottlenecks, including lack of unified standards, high deployment costs, and a persistent gap between design assumptions and real user behavior, confirming that information accessibility is becoming a core system capability rather than an optional feature.

2 Global Regulatory Systems and the Structural Compliance Shift in Information Accessibility

As information accessibility shifts from an auxiliary design feature to a core infrastructure capability, global regulatory systems are becoming the primary driver of industry structure. According to LC Sign’s engineering hub analysis, this shift is not only a compliance issue but also a structural driver reshaping the entire accessibility value chain.

2.1 EU System: Product Safety-Driven Mandatory Integration

In the EU, accessibility is embedded into product safety and industrial regulation systems. Under Directive 2001/83/EC (amended by 2004/27/EC[9]), all medicinal packaging must include braille identification of product names, standardized through ISO 17351:2013. This transforms braille from optional labeling into a mandatory production requirement.

However, in building and signage systems, the EU still lacks a fully harmonized standard, with prEN 18156[6] still under development, leaving a fragmentation gap across member states.

2.2 US System: Civil Rights-Based Enforcement Model

The US system is built on the Americans with Disabilities Act (ADA)[3], where accessibility is treated as a civil rights obligation rather than a design option.

The ADA Standards[4] for Accessible Design define requirements for tactile characters, braille signage, installation height, and critical space identification.

Unlike the EU, enforcement in the US relies on an ex-post legal mechanism, meaning compliance is often driven by complaints and litigation.

In the US, accessibility is not a design guideline—it is a legal risk framework..

2.3 Structural Transition: From Compliance Risk to System-Level Performance

Although the EU and US follow different regulatory paths, both are converging toward a shared structural shift: accessibility is increasingly treated not only as a design requirement, but as a system-level risk factor spanning compliance and operational performance.

LC Sign interprets this transition as a move toward execution reliability at system scale.

9 European Parliament & Council. *Directive 2001/83/EC of the European Parliament and of the Council of 6 November 2001 on the Community code relating to medicinal products for human use* (as amended by Directive 2004/27/EC). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32001L0083

This evolution is driving a new set of system requirements, where accessibility solutions must be functionally usable in real-world environments, consistently transferable across the design-to-execution chain, and verifiable under multi-layer regulatory and operational conditions.

Within this context, accessibility systems are increasingly evaluated not only by compliance status, but also by their demonstrated usability in real environments and their measurable functional performance.

3 Fragmented Global Standards: Why Accessibility Systems Fail to Scale

According to analysis from LC Sign Engineering Strategy Lab, global braille standards are not missing—they are fragmented across parallel systems.As accessibility shifts from compliance to infrastructure capability, this fragmentation is creating a structural execution gap: standards exist, but systems do not operate consistently.

3.1 Multi-Centric Standards System: Parallel and Overlapping Rule Systems

Global braille and tactile signage standards are not unified, but organized as a multi-centric and partially overlapping rule network. This structure creates cross-region inconsistency in design interpretation and execution logic.

International Standards System (ISO)[2]: Provides a technical framework for cross-border use, but its specifications focus mainly on material and symbol-level definitions, lacking systematic coverage of complete usage scenarios.

US Regulatory System (ADA[3] + Access Board[10]): Provides mandatory requirements for accessible sign installation height and tactile character usage, but implementation details rely on the discretionary space of local regulatory agencies.Industry Organization Standards (e.g., BANA)[11]: Though not mandatory by law, widely recognized and adopted across the industry to supplement application details not covered by the regulatory system.

EU Sectoral Standards: ISO 17351:2013[5](mandatory for pharmaceuticals); building environment signage lacking a harmonized standard (prEN 18156[6]in development).

Global braille standards are not a single system, but a distributed regulatory network with overlapping jurisdictions and inconsistent execution logic.

3.2 Execution Chain Break: Design → Manufacturing → Acceptance

Standards fragmentation is not theoretical —it breaks at execution level:

TABLE1 Design and Compliance Challenges in the Braille Labels Lifecycle

Link	Problem
design	multi-standard interpretation
manufacturing	material/process adaptation loss
installation	site constraint deviation
acceptance	local compliance-only logic

Overview: Implementation is hindered by complexities in multi-standard interpretation, manufacturing processes, and site-specific compliance constraints.

Resulting system failure pattern:

- Compliant but not reproducible
- Manufactured correctly but not installable
- Installed but not usable
- Compliance does not guarantee usability.

The system failure occurs at the translation layer, not at the standard layer.

[10] U.S. Access Board / ADA. ADA Standards & Guidelines Overview. Available at: https://www.ada.gov/law-and-regs/design-standards/standards-guidance/
[11] Braille Authority of North America (BANA). Signage Guidelines. Available at: https://www.brailleauthority.org/signage/index.html

3.3 Market Expansion, Structural Contradiction

The global braille label market is projected to grow from USD 61.1B (2025) to USD 94.9B (2035)[8], yet fragmentation persists. LC Sign observes a structural contradiction:

Demand is standardizing, but supply systems remain fragmented.

This creates a shift from rule compliance to system integration capability.

4 System Failure Mechanisms: Why Accessibility Becomes Unreliable in Real Use

Across global deployments, accessibility systems often fail not at design level, but at translation and execution level. LC Sign identifies this as a missing "interpretation layer" between standards and real-world use.

4.1 Core Structural Gaps

1) Multi-Standard Fragmentation

Global accessibility systems operate across multiple independent regulatory frameworks, including ISO[2], ADA[3], EU sectoral standards (ISO 17351[5] for pharmaceuticals; prEN 18156[6] for building signage still in development), and regional building and product codes.

Due to differences in scope, enforcement logic, and technical interpretation, identical signage systems may follow different design and implementation rules across jurisdictions.

2) Conversion Loss in Execution

Standards define signage logic at the documentation level, but real-world implementation requires adjustments based on material constraints, site conditions, and cost structures.

Without a unified engineering interpretation layer, this translation process introduces systematic deviation between design intent and delivered outcome.

3) Missing Feedback Loop

Current evaluation systems are primarily concentrated on construction-phase compliance verification, while long-term usability data—such as recognition efficiency, behavioral interaction, and environmental adaptation—remains insufficiently structured.

As a result, optimization is driven by fragmented project experience rather than continuous system feedback.

4.2 Risk Landscape

TABLE 2 Core Operational Risks and Evaluation Metrics for Braille Information Systems

Risk Type	Manifestation
Compliance Risk	systems typically meet current regulatory requirements during construction, but over long-term operation, due to the accumulation of standard interpretation differences and execution deviations, system consistency may gradually decline.In the EU, the absence of a harmonized building signage standard increases compliance ambiguity.
Usability Risk	tactile or braille information exists physically, but due to inconsistent information structure or layout logic, users struggle to reliably recognize or use it in real-world environments.
Operational Risk	because systems rely on custom design and non-standardized construction pathways, later maintenance and replacement typically require higher cost inputs.
Reputational & ESG7 Risk	as accessibility capabilities are increasingly integrated into corporate social responsibility and ESG evaluation systems, the actual effectiveness of information accessibility systems is becoming an important external evaluation metric for public spaces and commercial facilities.

Overview: Compliance, usability, and long-term operational consistency are critical ESG metrics; structural failures pose significant operational and reputational risks.

Risk in accessibility systems is not isolated — it is systemic and cumulative across lifecycle stages.

5 4-Layer Accessibility Failure Model (LC Sign Framework)

Global accessibility failures are not caused by isolated technical issues, but by a four-layer structural misalignment across technology, cost, execution, and governance systems. These layers interact continuously, reinforcing systemic inconsistency between standards compliance and real-world usability.

5.1 Technology Layer — Standard-to-System Translation Gap

Current braille and tactile signage systems are still primarily based on text-based standards and static design specifications. However, in real engineering environments, there is no unified digital representation or systematic conversion tool.

This leads to three structural limitations:

- Standards cannot be consistently parsed into executable systems
- Cross-project reuse is difficult to achieve
- Design intent is easily lost during multi-step translation

From an industry evolution perspective, accessibility remains in a “specification-text driven stage” rather than a system-engineered stage.

5.2 Cost Layer — Precision vs Scalability Imbalance

Tactile accessibility systems require high precision in material processing and installation accuracy. However, most projects are still delivered in a custom, project-based model.

This creates a structural tension:

- Higher precision increases unit cost
- Scaling increases customization complexity
- Standardized production cannot fully cover real-world diversity

This contradiction is especially evident in pharmaceuticals, public infrastructure, and cross-regional deployments.

5.3 Execution Layer — Fragmentation Across the Delivery Chain

In real-world implementation, accessibility systems involve multiple stakeholders: design teams, manufacturers, and construction contractors. However, there is no unified data or interpretation standard across these actors.

This results in three common breakdowns:

- Design intent is reinterpreted during construction
- Manufacturing standards diverge from site conditions
- Maintenance lacks unified upgrade logic

As a result, system consistency depends more on project coordination capability than on the standards system itself.

5.4 Management Layer — Lifecycle Governance Gap

From an industry governance perspective, accessibility systems are still primarily managed at the construction and compliance acceptance stage, with limited focus on long-term operational performance.

Key missing mechanisms include:

- Continuous usage-based evaluation systems
- Cross-project consistency governance
- Data-driven optimization loops

This keeps accessibility infrastructure in a "completion equals end-state" model rather than a continuously evolving system model.Without lifecycle governance, accessibility systems remain incomplete infrastructure.

6 Qiming School Case: From Standards Compliance to Usability Engineering Validation

The Guangzhou Qiming School project is the first large-scale implementation of LC Sign's "The Touchpoint Initiative", serving as a real-world validation of accessibility engineering hub beyond compliance requirements. This case demonstrates the gap between compliance-based design and usability-based engineering.

Through the deployment of 631 precision braille signage units, the project demonstrates a key structural transition: from "meeting standards" to "delivering usable environments."

6.1 Compliance vs Usability Gap (System Deviation in Real Environments)

Standard parameters such as braille dot height, spacing, and installation height are defined as compliance ranges. However, LC Sign field validation shows that these parameters require contextual optimization when applied to real users and environments.

For example, the installation height was optimized to 1.1 meters based on ergonomic observation of children at Qiming School, enabling natural tactile reading without posture adjustment.

Standards define compliance range; usability defines optimal range.

6.2 Dual-System Design: Tactile + Visual Redundancy Model

User populations are not homogeneous. Visually impaired groups include both totally blind users and low-vision users with different perception channels.

LC Sign implemented a dual-system accessibility structure:

- Tactile braille system → functional information for blind users
- High-contrast visual system → spatial guidance for low-vision users

Accessibility is not a single-channel system, but a layered perception architecture.

6.3 From Project Delivery to Engineering hub Model

Traditional accessibility projects are often treated as one-time installations. However, the Qiming School case reflects a pivotal shift toward a full lifecycle engineering model, where accessibility is managed as a continuously operating system rather than a fragmented delivery outcome.

MaaS™: Integrated Manufacturing-as-a-Service

Within this framework, LC Sign operates under a Manufacturing-as-a-Service™ (MaaS™) model, in which manufacturing is repositioned from a standalone production function into a continuous service system.

This system integrates design translation, engineering validation, production execution, quality assurance, and delivery coordination into a unified operational loop. Rather than managing these stages separately, LC Sign treats them as interconnected service nodes within a single controlled lifecycle.

Traceability Infrastructure (Operational Layer)

- Material & Batch Control: Integrates supplier records and batch identification to ensure upstream traceability.
- Process & QC Tracking: Records production steps, inspections, and key quality data for end-to-end visibility.
- Production & Delivery Coordination:

Aligns scheduling and delivery planning to ensure stable execution and on-time fulfillment.

Accessibility is a system to be operated, not a product to be installed.

7 LC Sign Standard Translation and Localized Adaptation Capabilities

Braille signage standards vary globally, creating a fragmented regulatory landscape. LC Sign's core strength lies in systematically translating complex international guidelines into actionable design and production specifications, balancing rigorous compliance with real-world usability.

LC Sign Engineering Strategy Lab maintains precise control over key parameters across major regulatory frameworks:

TABLE 3 International Technical Standards for Braille Labels: ISO, ADA & GB/T Comparison

Parameter Dimension	Braille Dot Height	Installation Height (center point)	Character-to-Braille Spacing
ISO 17049	0.3–0.7 mm	no unified value is specified; placement shall be at an accessible and reachable position.	no explicit text–Braille spacing is defined; a minimum 6 mm clear space is required around Braille cells or blocks.
ADA 2010	0.6–0.9 mm	1.220–1.525 m	≥9.5 mm
GB/T 39758-2021	0.3–0.7 mm	no unified value is specified; placement shall be at an accessible and reachable position.	no explicit text–Braille spacing is defined; a minimum 6 mm clear space is required around Braille cells or blocks.

Note: GB/T 39758–2021 standard identically adopts the ISO international standard.

While these parameters establish the technical baseline, real-world implementation requires contextual engineering decisions based on spatial conditions, user groups, and environmental constraints. LC Sign translates these standards into deployable solutions through systematic engineering workflows validated across diverse global projects.

In the United States, LC Sign delivered 664 tactile signage units for a hotel project fully compliant with ADA standards[3]. The system integrated Braille, raised lettering, and refined visual layering across eight signage variants with black-and-white integrated layouts. Constructed using multi-layer acrylic structures, each sign ensured consistent tactile readability and regulatory compliance while maintaining a premium, architecturally integrated appearance. The modular design also enabled efficient installation within a high-end hospitality environment.

In Guangzhou, China, LC Sign completed 631 high-precision Braille door signs for Qiming School under an accessibility-first design framework. The system design was informed by on-site research and interviews with special education professionals, resulting in a hierarchical wayfinding logic aligned with student mobility patterns and cognitive mapping needs. Technically, 3 mm white acrylic substrates combined with 3D-printed Braille dots were adopted to ensure durability and tactile accuracy. A high-contrast visual system, including yellow edge accents, was implemented to support low-vision users and integrate with existing accessibility infrastructure. The final delivery achieved 100% installation accuracy and full compliance with GB/T 39758-2021[4] requirements for tactile and content standards.

In Serbia, LC Sign delivered 80 illuminated room signs with integrated Braille for a boutique hotel project. Each unit combined tactile Braille, raised numerals, and soft backlighting to enhance legibility in low-light corridor environments while maintaining compliance with ISO 17049[2] standards. A staged validation process—including prototype sampling and on-site testing—ensured consistency in tactile feedback, installation alignment, and architectural integration.

Collectively, these projects demonstrate LC Sign’s capability to bridge fragmented global standards through localized engineering execution. By integrating regulatory expertise, precision manufacturing, and user-centered design logic, LC Sign delivers signage systems that are not only compliant, but also durable, context-aware, and optimized for inclusive user experience across diverse built environments.

Conclusion

Accessibility is transitioning from compliance-based implementation to lifecycle system engineering. Across global markets, regulatory frameworks continue to expand, but execution remains structurally fragmented, resulting in a persistent gap between regulatory compliance and real-world usability.

The root issue not as a lack of standards, but as the absence of a unified engineering translation and lifecycle governance mechanism. Without system-level integration across design, manufacturing, installation, and validation, accessibility remains a fragmented delivery outcome rather than a continuous infrastructure capability.

From a engineering hub perspective, accessibility failure is primarily caused by cross-layer misalignment rather than single-point technical defects. This includes standard fragmentation, execution loss during translation, and insufficient lifecycle feedback mechanisms.

This structural condition is validated through LC Sign’s multi-region implementations, including:

- Guangzhou Qiming School (education environment, accessibility-first system validation)
- United States hotel project (commercial hospitality compliance-to-execution system)
- Serbia hotel project (low-light environment integrated tactile signage system)

These cases demonstrate a consistent shift from isolated signage delivery to integrated engineering systems, where accessibility is managed as a continuously controlled operational process rather than a static installation output.

Under the Manufacturing-as-a-Service™ (MaaS™) framework, LC Sign integrates design translation, engineering validation, production control, and traceability infrastructure into a unified lifecycle system. This enables repeatable execution across regions, standards, and application scenarios.

Ultimately, accessibility is evolving into a system-level infrastructure discipline. Its effectiveness is determined not only by compliance with standards, but by the integrity of its end-to-end engineering and operational lifecycle.

Contributors

This white paper was prepared by the LC Sign Engineering Strategy Lab, based on the "The Touchpoint Initiative" and the Guangzhou Qiming School project practice.

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The company works with designers, developers and global brands to shape modern commercial and public environments.

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