

Digital Billboard Design, Driver Visual Attention and Urban Visual Quality: A Literature Review

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Received: 8 August 2026; Accepted: 12 August 2026; Published: 18 August 2026

ABSTRACT

Digital billboards have become prominent components of metropolitan streetscapes, yet the same visual features that improve advertising visibility may also compete with road information and alter the perceived quality of urban environments. This article presents a structured narrative review of seventeen references previously assembled for research on evidence-based digital billboard design. The literature was organised through thematic synthesis into four areas: digital display characteristics, driver visual attention and road safety, urban visual quality and clutter, and spatial regulation and guideline development. The review indicates that luminance, animation, transition frequency, colour contrast, message complexity, display scale and location jointly determine the attention-capturing potential of digital billboards. Field, simulator and review studies consistently suggest that roadside advertising can influence glance allocation and driving-related information processing, although the severity of the effect depends on traffic complexity and placement context. Urban studies further show that colour content, cumulative advertising area and signage density shape streetscape coherence and perceived clutter. Spatial decision-support and regulatory studies provide useful approaches to location control, but they remain weakly connected to content-level design parameters. The review identifies a fragmented evidence base, limited Malaysian metropolitan research and an absence of integrated criteria linking design behaviour, driver safety and urban visual quality. It concludes that future guidelines should combine design controls, context-sensitive placement assessment, cumulative visual evaluation and multidisciplinary expert validation.

Keywords: Digital Billboard, Literature Review, Visual Attention, Urban Visual Quality, Road Safety.



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1 INTRODUCTION

Digital billboards represent a significant shift in outdoor advertising from fixed printed surfaces to programmable visual media. Unlike static signs, digital displays can rotate multiple messages, adjust brightness, use animated content and introduce transitions that change over time. These capabilities

increase commercial flexibility and allow advertisers to respond to location, schedule and audience conditions. They also make the billboard an active visual element within the urban environment rather than a passive surface. The design of a digital billboard therefore involves more than the arrangement of typography and images. It includes the timing, intensity and movement of visual information in a setting where attention is already divided among vehicles, pedestrians, traffic signals, road signs and surrounding architecture.

The central concern in the literature is not that every digital billboard automatically causes unsafe driving or poor urban quality. Rather, digital billboards can create additional visual demand when their design characteristics and placement compete with information that is more important to road users. Early work on roadside advertising framed this issue as a conflict between commercial attention capture and the limited attentional resources available for driving (Young et al., 2009). Subsequent simulator, field and review studies have examined how advertising may affect glance behaviour, response to traffic information and broader driving performance (Belyusar et al., 2016; Edquist et al., 2011; Meuleners et al., 2020; Oviedo-Trespalacios et al., 2019). More recent literature extends the discussion to digital-specific variables, including luminance, display density and dynamic content (Kim & Choi, 2024; Lee & Park, 2024; Wang et al., 2023).

A second body of literature considers billboards as components of the built environment. From this perspective, the key issue is not only whether an advertisement is visible, but whether its colour, scale, brightness and cumulative presence remain compatible with the character and legibility of the streetscape. Studies focused on urban visual quality show that colour content and the total area occupied by outdoor advertising can shape public evaluation of urban scenes (Adam et al., 2022; Rahman et al., 2022). Research on spatial decision support and billboard location further demonstrates that visual pollution cannot be managed by content design alone; it also requires coordinated planning, locational analysis and multi-stakeholder governance (Abdullahi et al., 2025; Wakil et al., 2021; Zhang et al., 2023).

The existing evidence is distributed across road safety, ergonomics, visual communication, urban design and planning. This disciplinary separation makes it difficult to translate findings into a coherent set of design guidelines. A road safety study may identify distraction-related effects without addressing streetscape quality, while an urban visual study may evaluate clutter without considering the moment-to-moment demands of driving. The purpose of this article is therefore to synthesise the existing reference corpus into a focused account of what is known, where the findings converge and which gaps remain. The review specifically examines the relationship among digital billboard design characteristics, driver visual attention, urban visual quality and regulatory implementation in metropolitan environments.

2 REVIEW METHOD

2.1 Review Scope and Source Corpus

This article uses a structured narrative review rather than a new systematic database search. The review corpus was restricted to the seventeen references listed in the preceding conceptual article on evidence-based digital billboard design. The sources span the period from 2006 to 2025 and include field studies, driving simulation studies, systematic or critical reviews, urban visual quality research, spatial planning studies and methodological references. This fixed-corpus approach ensures continuity with the earlier article while allowing the literature component to be examined in greater depth.

The corpus includes seven sources directly concerned with driver attention, distraction or road safety; four sources concerned with urban visual quality, visual pollution, signage density or billboard location; two sources concerned with regulation and smart-city governance; and four methodological sources relevant to qualitative synthesis, purposive expert selection, thematic analysis and consensus development. Some references contribute to more than one category. For example, systematic reviews

of roadside advertising combine safety evidence with recommendations for regulation, while spatial decision-support studies combine visual quality concerns with implementation mechanisms.

2.2 Analytical Procedure

The review followed an interpretive thematic process informed by qualitative research design principles (Creswell & Creswell, 2018) and the staged logic of thematic analysis described by Braun and Clarke (2006). Each reference was examined according to its principal problem, design variables, setting, method, stated contribution and implication for guideline development. The resulting observations were compared and grouped into four themes: visual characteristics of digital billboards; driver visual attention and road safety; urban visual quality and visual clutter; and spatial regulation and evidence-based implementation.

The analysis emphasised patterns of agreement and unresolved relationships rather than statistical effect sizes because the corpus contains heterogeneous research designs. Field observation, simulation, systematic review, GIS-based decision support and conceptual regulation studies cannot be combined as though they measured the same outcome. The synthesis therefore asks how the different forms of evidence complement one another and where they remain disconnected. Methodological sources on purposive sampling and Delphi consensus were reviewed as supporting literature for the later validation of guidelines rather than as evidence about billboard effects themselves (Hsu & Sandford, 2007; Palinkas et al., 2015).

2.3 Limitations of the Review

The review has three limitations. First, the reference list was predetermined and is not claimed to represent every publication on digital billboards. Second, several studies focus on roadside advertising generally rather than on digital billboards alone, requiring careful interpretation when applying their findings to animated LED displays. Third, the corpus contains different geographic and regulatory contexts, so direct transfer to Malaysian metropolitan areas should be avoided. The value of the review lies in focused synthesis and gap identification, not in claiming an exhaustive or universally generalisable evidence base.

3 DIGITAL BILLBOARD DESIGN AS DYNAMIC VISUAL COMMUNICATION

3.1 From Static Signage to Programmable Displays

Digital billboards extend the communicative capacity of outdoor advertising by introducing time as a design variable. A static billboard presents one stable composition, whereas a digital display may change messages, sequences and visual intensity throughout the day. This temporal behaviour means that design quality cannot be judged from a single frame. The complete communication includes dwell time, transition duration, sequencing, repetition and the relationship between consecutive messages. A visually simple frame may still become demanding if it changes too frequently or uses abrupt transitions.

The literature on driver distraction repeatedly points to visual salience as the mechanism through which roadside advertising competes for attention. Salience may be generated through size, high contrast, saturated colour, brightness, novelty or motion. Digital technology intensifies several of these mechanisms because the display can be brighter than its surroundings and can introduce change where the broader scene is relatively stable. The systematic discussion by Lee and Park (2024) and the luminance-focused work of Wang et al. (2023) place digital-specific qualities at the centre of current safety concerns. Their inclusion in the corpus indicates that contemporary guidelines must move beyond static measurements of sign dimensions and setback.

3.2 Luminance, Brightness and Night-Time Contrast

Luminance is among the most frequently cited design variables because it directly affects the visibility and dominance of a display. A billboard must be bright enough to remain legible, yet excessive brightness can create glare, strong contrast and visual dominance, especially at night or in low-ambient-light conditions. Wang et al. (2023) specifically connect LED billboard luminance with driver attention under urban traffic conditions, reinforcing the need to understand brightness as a context-dependent variable rather than a single universal value.

The surrounding environment determines how luminance is experienced. The same display output may appear moderate in a brightly illuminated commercial district and highly intrusive near residential streets, heritage areas or darker road segments. Brightness control should therefore respond to ambient conditions, time of day, road geometry and the presence of other illuminated signs. This principle also links safety and urban visual quality: a display that is not technically dazzling may still weaken visual coherence if it becomes the dominant source of light in the streetscape.

3.3 Motion, Animation, Transitions and Dwell Time

Motion and change are powerful attention-capturing devices because human vision is sensitive to new or moving stimuli. The reviewed safety literature suggests that electronic billboards may influence how long and how often drivers look away from the forward roadway (Belyusar et al., 2016; Meuleniers et al., 2020). However, the term animation covers a wide range of behaviours, from subtle movement within an image to full-motion video and rapid scene changes. Treating all dynamic content as equivalent can obscure the design features that create the greatest demand.

Four temporal parameters require separate consideration. Animation concerns movement within a displayed message. Transition refers to the change between messages. Dwell time determines how long a message remains visible before changing. Sequence complexity concerns how multiple advertisements are ordered and repeated. A guideline that controls only the total duration of an advertisement may fail to address abrupt flashes, rapid cuts or continuous internal motion. Conversely, a complete prohibition on movement may be unnecessarily restrictive in locations where traffic demand is low and visual conditions are carefully managed. The literature therefore supports context-sensitive controls that distinguish among types and intensities of motion.

3.4 Colour, Contrast, Typography and Message Complexity

Colour and contrast support legibility but can also increase visual dominance. The Kuala Lumpur-oriented studies represented by Adam et al. (2022) and Rahman et al. (2022) emphasise the influence of colour content and cumulative billboard area on the visual quality of urban streets. Their relevance extends beyond aesthetic preference. Highly saturated or incompatible colour combinations can fragment the streetscape, while repeated areas of intense colour may become visually exhausting when viewed along a corridor.

Typography and message complexity influence the time required to understand an advertisement. Outdoor messages are normally viewed briefly and at a distance, making concise copy, large type and clear hierarchy important. When a billboard contains too many words, competing typefaces, multiple product claims or dense imagery, the driver may need additional glances to extract meaning. The literature does not provide a single agreed limit for message complexity, but the relationship between complexity and attention demand is consistent with the broader findings of simulator and review studies (Edquist et al., 2011; Oviedo-Trespalacios et al., 2019). This suggests that visual communication effectiveness and road safety should not be treated as opposing goals. Simpler communication can improve both rapid comprehension and attention management.

4 DRIVER VISUAL ATTENTION AND ROAD SAFETY

4.1 Attention as a Limited Driving Resource

Driving requires continuous selection of relevant information. A driver must monitor lane position, vehicle speed, road signs, other road users and possible hazards while planning the next action. Attention is therefore limited not because drivers are incapable of seeing advertisements, but because each additional glance or cognitive shift may reduce the resources available for the driving task. Young et al. (2009) describe roadside advertising as a potential conflict of interest in which the advertisement is designed to capture attention while road safety depends on attention remaining appropriately allocated.

This conflict is especially important in metropolitan areas. Urban roads combine frequent intersections, lane changes, pedestrian crossings, motorcycles, public transport stops and dense roadside information. A digital billboard placed near a decision-heavy location can add visual demand at the same moment that the driver must interpret traffic movement or navigation cues. The safety relevance of a billboard therefore cannot be separated from the task complexity of its location.

Table 1 Thematic Synthesis of the Reviewed Literature (Source: Authors, 2026)

Theme	Key Sources	Main Contribution	Remaining Gap
Driver attention and road safety	Belyusar et al. (2016); Edquist et al. (2011); Lee and Park (2024); Meuleners et al. (2020); Oviedo-Trespalacios et al. (2019); Wang et al. (2023); Young et al. (2009)	Roadside advertising can alter glance allocation and compete with driving information. Effects depend on salience, content behaviour and road context.	Limited context-specific thresholds and limited Malaysian field evidence.
Urban visual quality and clutter	Adam et al. (2022); Kim and Choi (2024); Rahman et al. (2022)	Colour content, cumulative advertising area and signage density affect streetscape coherence and perceived clutter.	Dynamic digital effects and cumulative night-time impacts remain underexplored.
Spatial planning and regulation	Abdullahi et al. (2025); Wakil et al. (2021); Zhang et al. (2023)	GIS, decision-support and smart-city governance can improve siting, review and stakeholder coordination.	Location controls are weakly integrated with content-level design criteria.
Guideline development methods	Braun and Clarke (2006); Creswell and Creswell (2018); Hsu and Sandford (2007); Palinkas et al. (2015)	Qualitative synthesis, purposive expertise and consensus methods support contextual guideline development.	Methodological processes must be connected to empirical safety and visual-quality evidence.

4.2 Evidence from Simulator Studies

Driving simulators allow researchers to control billboard exposure while observing behaviour under repeatable traffic conditions. Edquist et al. (2011) examined advertising billboards during simulated driving and linked billboard exposure with changes in drivers' responses to road-related information. Meuleners et al. (2020) similarly used simulation to identify distracting aspects of electronic advertising billboards. Together, these studies support the view that the effect is not produced solely by the existence of a sign. Specific characteristics of the advertisement and the surrounding driving task influence whether attention capture becomes operationally significant.

Simulator findings are useful for isolating variables, but they also have limitations. Participants know that they are in an experimental setting, the visual field differs from real roads and exposure duration may be shorter than everyday travel. Simulator evidence should therefore inform design controls without being treated as a perfect substitute for field observation. It is most valuable when combined with naturalistic glance data, urban visual evaluation and location analysis.

4.3 Evidence from Field and Review Studies

Field research provides direct evidence of how drivers distribute their gaze in real traffic. Belyusar et al. (2016) studied the effects of digital billboards on glance behaviour during highway driving, helping to connect controlled findings with actual road exposure. Field studies capture real speed, traffic flow and environmental complexity, but they are more difficult to control because different signs, weather conditions and traffic situations occur simultaneously.

Systematic and critical reviews help interpret this mixed evidence. Oviedo-Trespalacios et al. (2019) reviewed the impact of road advertising signs on driver behaviour and road safety, while Lee and Park (2024) focused more specifically on digital roadside advertising and visual distraction. Review-level literature generally supports caution, yet it also shows why simple claims are inadequate. Not every glance is unsafe, and not every visually prominent display produces the same effect. Risk depends on glance duration, glance frequency, timing, road complexity and the driver's ability to return attention to the roadway.

4.4 Contextual Moderators of Distraction

The literature suggests that at least four contextual moderators should be included in future assessments. The first is traffic complexity, including intersections, merging zones, congestion and pedestrian activity. The second is road geometry, including curves, sight distance and the direction from which the display enters the visual field. The third is environmental contrast, especially the relationship between screen luminance and ambient light. The fourth is cumulative exposure, because several signs along a corridor may create repeated attention shifts even when each sign appears acceptable in isolation.

These moderators explain why universal controls are difficult. A rapid transition may be relatively inconsequential on a low-demand road but problematic near a pedestrian crossing. A bright display may be legible in daylight but visually dominant at night. An advertisement with moderate complexity may become distracting when placed among several competing signs. The evidence therefore points toward risk-based evaluation rather than a single checklist applied without reference to place.

5 URBAN VISUAL QUALITY AND VISUAL CLUTTER

5.1 Understanding Urban Visual Quality

Urban visual quality concerns the perceived coherence, attractiveness, legibility and comfort of the built environment. Billboards contribute to this experience because they occupy public visual space and interact with buildings, landscape, street furniture, lighting and traffic infrastructure. A billboard may be structurally safe and commercially effective while still weakening the character of a street if its scale, colour or illumination overwhelms surrounding elements.

The reviewed literature highlights a shift from evaluating individual signs to considering cumulative effects. Adam et al. (2022) and Rahman et al. (2022) foreground colour content and cumulative advertising area as factors influencing the visual quality of urban streets. This is particularly important for metropolitan corridors where numerous signs are visible within the same view. The visual impact of the corridor cannot be predicted by assessing each billboard separately because the combined field may produce density, repetition and incompatibility that are not evident at the level of a single permit.

5.2 Signage Density and Perceived Clutter

Visual clutter occurs when too many elements compete for attention without a clear hierarchy. In urban settings, clutter may result from the combined presence of billboards, shop signs, road signs,

building facades, lighting, utility structures and moving traffic. Kim and Choi (2024) connect digital signage density with perceived urban visual clutter in metropolitan districts. Their emphasis on density reinforces the need for area-based management rather than isolated sign approval.

Digital displays can intensify clutter because their visual state changes over time. A streetscape that appears balanced in one moment may become dominated by several simultaneous transitions in the next. Night-time conditions further alter the relationship between display and setting. The screen becomes a source of light, not simply a coloured surface, and its influence may extend beyond the sign boundary through glow and reflected illumination. Existing urban visual studies provide a strong basis for cumulative assessment, but the dynamic nature of digital clutter remains less developed than the analysis of static colour and area.

5.3 Compatibility with Place Character

Visual quality is not identical across all districts. A large, animated display may be expected in a high-intensity entertainment zone but inappropriate near heritage architecture, residential streets or civic spaces. Compatibility should therefore be evaluated in relation to local identity, building scale, pedestrian use and the intended night-time character of the area. This place-sensitive approach aligns with the broader planning literature, which treats billboard management as a spatial decision rather than only a design approval.

The literature also suggests that commercial visibility and urban quality do not have to be mutually exclusive. Clear hierarchy, restrained colour palettes, appropriate scale and controlled brightness can allow an advertisement to remain legible without overwhelming its context. In this sense, urban visual quality should be treated as a design criterion from the beginning of the creative process, not as an external restriction applied after the advertisement has been completed.

6 SPATIAL PLANNING, REGULATION AND IMPLEMENTATION

6.1 Location as Part of Billboard Design

Billboard design is often discussed as though the visual content can be separated from the site. The spatial planning literature challenges this assumption. Abdullahi et al. (2025) use Fuzzy-AHP and GIS to analyse outdoor advertisement locations, while Wakil et al. (2021) propose a multi-stakeholder spatial decision-support approach to reduce urban visual pollution and optimise billboard location. These studies show that suitability is produced by the relationship among display, road, land use, visibility, surrounding development and stakeholder priorities.

GIS and multi-criteria methods can help authorities identify areas where billboards are compatible, sensitive or inappropriate. They are particularly useful for cumulative analysis because they can map sign concentration, proximity to intersections, land-use character and visual corridors. However, spatial suitability does not guarantee acceptable content behaviour. A well-sited display can still create excessive brightness or rapid motion. Location assessment and content assessment must therefore operate as linked stages of the same approval process.

6.2 Regulatory Challenges in Digital Environments

Traditional billboard controls commonly emphasise dimensions, structural safety, setback, ownership and permit duration. These criteria remain necessary, but they do not fully address programmable content. Zhang et al. (2023) frame digital billboard regulation in smart cities as a balance between commercial activity and public safety. The regulatory challenge is to manage a medium whose visual behaviour can change after installation. Approval of the physical structure alone cannot guarantee that later content will remain within acceptable limits.

Effective regulation requires measurable design parameters, monitoring procedures and clear responsibility. Brightness limits may need automatic dimming and recorded output. Animation controls require definitions that distinguish transitions, full-motion video and subtle internal movement. Dwell-time rules require a method for verifying schedules. Cumulative visual quality requires corridor-level or district-level review. Without implementation mechanisms, design guidance remains advisory and may be applied inconsistently.

6.3 Multidisciplinary Expertise and Consensus

The literature indicates that no single profession can resolve the issue independently. Road safety specialists understand traffic demand and distraction risk; visual communication designers understand hierarchy, typography, colour and motion; urban planners understand land use, streetscape character and regulatory processes; and advertising practitioners understand technical operation and commercial constraints. Purposeful selection of participants with direct knowledge is therefore appropriate when developing context-sensitive guidelines (Palinkas et al., 2015).

Consensus methods can then be used to refine and prioritise criteria. Hsu and Sandford (2007) describe the Delphi technique as a structured process for developing expert agreement on complex matters. In the context of digital billboards, Delphi rounds could test the clarity, importance and feasibility of proposed controls. However, expert agreement should not replace empirical evidence. Its role is to interpret evidence, adapt it to the local context and resolve implementation questions that cannot be answered by individual studies alone.

7 INTEGRATED SYNTHESIS AND RESEARCH GAPS

7.1 Areas of Convergence

Across the reviewed literature, four areas of convergence are evident. First, visual attention is affected by the interaction of design and context rather than by the mere presence of advertising. Second, dynamic variables such as luminance, motion and transition behaviour require controls beyond those used for static signs. Third, urban visual quality depends on cumulative conditions, including colour content, total advertising area and signage density. Fourth, effective management requires integration among content design, spatial planning, regulation and monitoring.

These points suggest a chain of influence. Design characteristics determine the visual salience and comprehension demand of a billboard. Location and traffic conditions determine when that demand occurs and what other information is competing for attention. The combined number and appearance of displays determine the broader effect on streetscape coherence. Regulation and implementation determine whether acceptable design behaviour is maintained over time. A complete guideline must therefore address the entire chain rather than selecting one isolated stage.

7.2 Fragmentation Between Safety and Urban Design Evidence

The most important conceptual gap is the separation between road safety research and urban visual quality research. Safety studies typically measure glances, reactions or driving performance, whereas urban studies assess visual preference, clutter or spatial compatibility. Both fields discuss attention and visual competition, but they rarely use a shared framework. This prevents a clear understanding of whether the same design feature, such as brightness or colour contrast, creates parallel effects on driver attention and streetscape quality.

An integrated research design should therefore evaluate the same billboard characteristics across both domains. For example, alternative luminance levels could be assessed for glance behaviour and perceived night-time compatibility. Different transition styles could be evaluated for attention capture and visual coherence. Sign density could be related to both repeated driver glances and public evaluation

of clutter. Such integration would support guidelines that are evidence-based rather than assembled from unrelated rules.

7.3 Limited Context-Specific Evidence in Malaysia

The corpus includes important Malaysian-oriented work on colour content, cumulative billboard area and spatial location (Abdullahi et al., 2025; Adam et al., 2022; Rahman et al., 2022). Nevertheless, direct evidence linking digital billboard behaviour with driver visual attention in Malaysian metropolitan traffic remains limited. International findings provide useful hypotheses, but Malaysian cities differ in motorcycle volume, road geometry, signage density, night-time commercial activity and enforcement arrangements.

Future research should examine representative metropolitan corridors and distinguish among road types, time periods and district characters. It should also account for cumulative exposure rather than selecting only one billboard. Without this contextual evidence, guidelines risk being either too general to enforce or too restrictive for locations where digital displays can be managed safely.

7.4 Absence of Operational Design Thresholds

The literature identifies relevant variables more clearly than it establishes operational thresholds. Brightness, motion, transition timing, dwell time, colour, complexity and density are repeatedly discussed, but the evidence does not produce a complete set of universally accepted values. This is partly because appropriate limits vary with ambient light, road context, viewing distance and district character. The gap should not be interpreted as a reason to delay guidance. Instead, it supports a tiered approach in which baseline controls are combined with stricter requirements for high-risk or visually sensitive locations.

8 IMPLICATIONS FOR EVIDENCE-BASED DESIGN GUIDELINES

The literature supports six principles for future digital billboard design guidelines. The first is to regulate visual behaviour, not only physical structure. Controls should address luminance, transitions, animation, dwell time and message complexity. The second is to evaluate context, with greater caution near intersections, pedestrian crossings, merging zones, curves and other decision-intensive locations. The third is to assess cumulative visual conditions, including the number, area, brightness and colour dominance of displays within a shared view or corridor.

The fourth principle is to preserve communication clarity. Readable typography, concise messages and clear hierarchy reduce the need for prolonged interpretation. The fifth is to connect design approval with technical monitoring. Automatic brightness adjustment, content scheduling records and periodic compliance review can help maintain approved behaviour after installation. The sixth is to use multidisciplinary validation, combining empirical findings with the practical knowledge of road safety specialists, planners, designers and industry practitioners.

These principles can be translated into a tiered guideline. A basic tier would establish minimum requirements for all digital billboards. A contextual tier would introduce additional controls based on traffic demand, land use, ambient brightness and streetscape sensitivity. A cumulative tier would evaluate the combined effect of multiple displays. An implementation tier would specify submission documents, monitoring methods and enforcement responsibilities. Such a structure would reflect the strongest message of the literature: digital billboard quality is produced by the interaction of content, place and governance.

CONCLUSION

This review has synthesised seventeen references related to digital billboard design, driver visual attention, urban visual quality, spatial planning and guideline development. The literature shows that

the attention-capturing potential of a digital billboard is shaped by luminance, motion, transitions, colour, contrast, message complexity, scale and location. Road safety evidence indicates that advertising can influence glance behaviour and the processing of driving information, but the level of risk depends on the surrounding traffic task. Urban visual research demonstrates that colour content, cumulative advertising area and signage density affect the coherence and perceived quality of metropolitan streetscapes.

The review also identifies a structural weakness in the evidence base. Safety, visual quality and planning are often studied separately, even though they concern the same display in the same public environment. Existing regulations are stronger in controlling location and physical form than in managing dynamic content behaviour. Malaysian metropolitan research remains particularly limited in connecting digital display characteristics with real driving conditions and cumulative urban visual effects.

An evidence-based guideline should therefore integrate content design, traffic context, urban character, cumulative assessment and implementation. It should not aim to remove the visibility or commercial value of digital advertising. Its purpose should be to ensure that visibility is achieved through clear communication rather than excessive visual demand, and that digital media contributes to metropolitan environments that are safer, more coherent and visually sustainable.

ACKNOWLEDGEMENT

The authors would like to thank all those involved directly or indirectly in this research.

FUNDING

This research is self-funded.

AUTHOR CONTRIBUTIONS

Each author shared the same contributions in this research.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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