



From Print to Pixel: Digital Signage as a Sustainability Strategy in Visual Merchandising

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Abstract

In the past, visual merchandising has often depended on the use of printed point-of-sale (POS) materials, temporary props, and short-term display equipment leading the retail industry to waste a large amount of products and energy in its supply chain. As sustainability acquires more relevance for retailers, digital signs have shown up as the technology enabling to reduce this footprint and improve customer engagement and sales at the same time. Nevertheless, research on visual merchandising dealt with digital signage from the behavioral and experiential points of view, while studies on sustainability mostly focus on 'green' aspects of merchandising, such as eco-friendly materials and store design leaving aside the question of how digital signage can contribute to sustainability. This conceptual paper aims at combining findings from visual merchandising, retail atmospherics, and digital signage studies and creating a framework that would connect digital signage adoption to three outcomes of sustainability: environmental, economic, and social. The paper proposes the concept of digital sustainability paradox whereby the ecological benefits of less usage of paper and materials may be offset by energy consumption, e-waste, and embodied power of the technology itself. The paper has made a contribution to theory by locating digital signage within the context of sustainable visual merchandising so that retailers can assess their investment in this technology from the standpoint of the triple-bottom-line.

Keywords: digital signage, visual merchandising, sustainable retailing, store atmosphere, point-of-sale technology, green retailing strategy

1. Introduction

The design of retail spaces has traditionally utilized material based visual merchandising, including printed banners, foam board signs, vinyl graphics, seasonal displays, and cardboard props, much of which changes frequently in accordance with marketing campaigns and events. Currently, the retail space designers are under pressure from their clients to use such visual merchandising with an increasing environmental consciousness. This issue is particularly noticeable in fast fashion and mass retailing, where the short life cycle of products and frequent rotation of product range makes displacement of the traditional visual merchandising approach less important (Bhardwaj & Fairhurst, 2010).

At the same time, retailers have been replacing static printed materials with digital signage that consists of video displays that provide customers with brand, promotional, and informational messages in the places of sale. The growing popularity of this merchandising approach can be attributed to the positive results obtained by the practitioners of the digital signage (Herhausen et al., 2025), with the digital signage having proven to increase volume of sales by 8.1%. There is no sustainability justification needed to use digital signage in retail just because it effectively works from commercial viewpoint, though it has not yet been considered from the perspective of sustainability (Bhardwaj & Fairhurst, 2010).

At the present time, we can observe two different streams of research in this field. First, sustainable visual merchandising is perceived mainly from the angle of its implementation. These studies were mostly interested in the aspect of sustainability signs (Megat Zambri & Saleh, 2020). Secondly, the research work on digital signage predominates the studies of the behavioral aspects of this process in the context of the perception of the store space atmosphere and the emotions of customers towards the place (Dennis et al., 2010 & 2012). Both of these research streams overlook the sustainability aspect of visual merchandising at retail establishments.

2. Literature Review

2.1 Visual Merchandising and Store Atmospherics

The intentional process of creating the visual atmosphere within the respective store is what visual merchandising is about (e.g., shop window design, signage, product display, etc.) (Basu et al., 2022). Over time, the field of visual merchandising has therefore changed from representing only an aspect of the store environment to becoming something much more complex. This is illustrated by the latest comprehensive literature review by Basu et al. (2022) who analyzed the works based on as many as 88 publications from the period between 2000 and 2020 that used the TCCM analysis framework. One of the findings of the review is that visual merchandising as a tangible product display activity has an important connection with but is at the same time different from atmosphere (i.e., the type of display activity) in a store environment. Most of the research referenced in the review is based on the S-O-R theory presented in environmental psychology meaning that store features, being the stimulus, affect emotions and cognitive processes in customers (the organism) thus leading to certain actions on their part (the response).

2.2 Sustainability issue of VM

The sustainability issue of VM is receiving more and more attention. According to Bhardwaj and Fairhurst (2010), a conflict exists in the fast-fashion business since the fast-fashion model is based on creating many new displays to keep shoppers excited and engaged, and yet mastering sustainability presents a big challenge. When new displays are created, the old ones are likely to be thrown away too, which exacerbates the sustainability problem due to the increase of materials consumed. Moreover, Choi et al. (2019) claim that sustainability research in fashion retailing has been focused mainly on its production supply chain and manufacturing aspects and retail practices of sustainability have not been studied significantly.

The practical work carried out by Sadachar, Konik, and Chakraborty (2021) indicates that the opinions regarding sustainable

VM influence the consumers' buying behavior and this is of great importance for retail stores. The review article by Megat Zambri and Saleh (2025), in its turn, confirms the findings with regard to VM methods and mentions that sustainable materials and methods allow retailers achieve good environmental performance as well as loyal customers. Among other things, the review article highlights the need for further research to be carried out in regard to the way of using modern technologies to achieve higher waste reduction in retail display. However, it does not treat digital signage as a separate technology.

2.3 Digital Signage as Retail Technology

Digital signage may be described as the type of digital sign and display used by retail customers to receive information messages and advertising at the moment of purchase. Recent research in the area of retailing has been conducted related to digital signage from the viewpoint of its influence on ambiance and consumer behavior in the shops. One of the first studies made by Dennis, Michon, Brakus, Newman, and Wright showed considerable findings about the perception of shoppers and their emotional state in shopping malls by being affected by environmental psychology. The affected approach behavior of customers is related to the emotions that occur in the consumers when being in contact with this kind of media. The study conducted by Dennis, Michon, Brakus, Newman, and Alamanos continued the previous research by providing qualitative research on effectiveness of digital signage as audio-visual messages play an important role in effectiveness of advertising. The study performed by Dennis, Brakus, Gupta, and Alamanos (2014) made it clear what is the difference between sensory cue content and benefits-and-features content. The study results proved the assumption that the influence of affective content is much stronger than that of intellectual content. The research was carried out by Nanni and Ordanini (2024). They identified the effect of digital signage with information about price discounts on consumer costs and help of Herhausen, de Jong, and Grewal (2025) who provided the results of their experiment carried out with the help of 237 advertisements and 30 million customers who proved that digital signage is influential in products buying as well specifically when it is used together with the data about benefits of the product in special time (weekends) and in favorable situations (good weather, few people in the store, etc.). All listed studies prove that digital signage can be used as an efficient advertising tool in retail operations, but no environmental aspect connected with the implementation of digital signage has been investigated.

2.4 The Missing Link: Digital Signage as an Explicitly Sustainability Strategy

The analysis of the two previous pieces of literature lets us conclude that they have a distinct vacancy in their contents. The previously discussed literature has raised the issue of changing materials and consumer perceptions of sustainability but nobody has connected Digital Signage with this issue. On the other hand, the literature on Digital Signage emphasizes the role of online advertising from commercial and social perspectives and totally ignores the ecological aspect that does not seem to be of any importance in this line of research. According to industry experts, the move from printed to digital signage saves considerable amounts of paper and reduces pollution made in the process of printing, which proves the necessity for scholars to examine the possibilities for digital signage substituting printed media.

Figure 1. Conceptual Framework Linking Digital Signage Adoption to Sustainable Visual Merchandising Outcomes

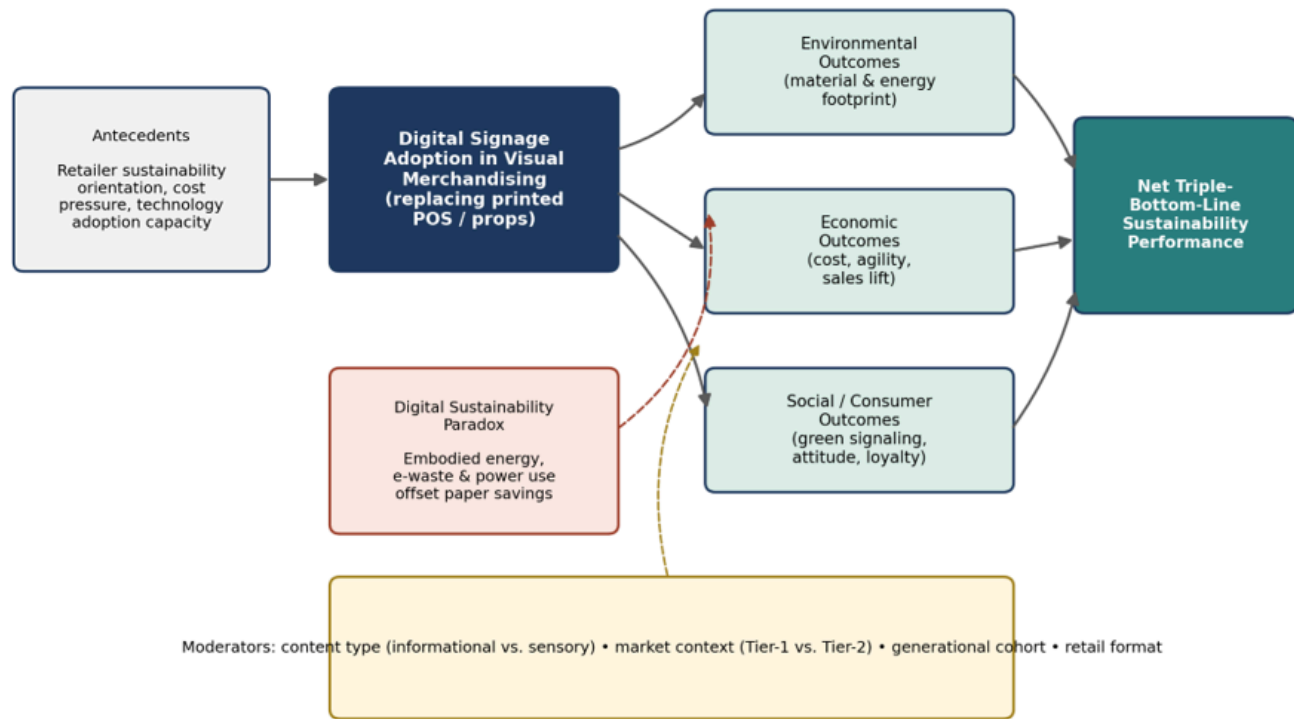


Figure 1. Conceptual framework linking digital signage adoption to sustainable visual merchandising outcomes.

3. Research Propositions on Digital Signage and Sustainable Visual Merchandising

3.1 Antecedents and the Core Construct

Three factors are likely to promote the increased use of digital signs in place of printed materials in visual merchandising (VM): a retail company's sustainability philosophy, the pressure from the need to save costs on endless printing and reproduction of printed VM materials, and the management competencies needed to implement and use the technological systems.

3.2 Search For Environmental Results And Examination Of Digital Sustainability Paradox

The first argument suggests that digital signage replaces printed visual merchandising formats and consequently minimizes visual merchandising's negative effects on the environment. Based on the statements made by Megat Zambri and Saleh, printed posters, billboards, etc. are believed to play a very significant role in eco-visual merchandising. However, this statement is partially false, as the use of digital signage equipment has an environmental cost. It is necessary to take into account production costs, the amount of electricity used during operation, and electronic waste that the device produces when its lifecycle ends.

3.3 Economic And Social Effects Of The Use Of Digital Signage

When viewed from an economic standpoint, digital signage provides retailers with various benefits such as content management flexibility (the option of remote and constant updates of promotions and prices) and the reduction of printing

and transportation expenses. Furthermore, these economic advantages bring about a boost in sales as indicated by the research results of Herhausen, de Jong, and Grewal and others.

Proposition	Statement
P1	The correlation between the use of digital signage in visual merchandising and the reduction of printed point-of-sale materials has been established.
P2	The positive effect of digital signage on the environment is influenced by the frequency of hardware replacement, energy management of signboards, and recycling practices (the digital sustainability paradox).
P3	Consumer perceptions of digital signage as a part of a retailer's sustainability goal positively predicts store attitudes and purchase intentions of consumers.
P4	The positive effect of digital signage on behavior and sales is stronger if the content of a screen's messaging contains not only promotional content but also an environmental framing.
P5	The monetary benefits of adopting digital signage (savings and flexibility) are more pronounced for multi-location retailers which have a high frequency of promotional events.
P6	The effect of digital signage on consumer attitudes is more prominent in the contexts of Tier-2 cities and emerging markets, where sustainable retail infrastructure is not developed.
P7	Consumer responses to the sustainability signaling of digital signage are moderated by generation, as Generation Z consumers exhibit higher responsiveness than their older counterparts.

The relationship between the application of digital signage in visual merchandising and the decrease of printing point-of-sale materials proves to be confirmed.

The positive impact of digital signage on eco-friendliness is affected by the frequency of technology switching, signage energy efficiency, and recycling (the phenomenon of digital sustainability paradox).

Consumer perceptions of digital signage connected with the sustainability goals of retailers are positively influencing store attitudes and purchasing intentions.

Digital signage impacts customers positively when the content of the messages delivered by screens includes not only advertising messages but greens as well.

The economic advantages brought by digital signage are more noticeable in case of multi-location retailers that conduct their promotional actions constantly.

The effectiveness of digital signage on consumer attitudes is higher in Tier-2 cities and developing economies where the sustainable retail infrastructure is still under development.

Responses of consumers to sustainability signaling produced by digital signage are affected by the generation factor as members of Generation Z are more responsive than older ones.

4. Proposed Research Methodology

The article does not present empirical information which can be expected from a theoretical piece; instead it presents a phased mixed-methods research approach to be used to check the provisions outlined in the 3rd part of the article. This will make it possible for further research both by the authors and other researchers in the field.

4.1 Phase 1 – Comparative Lifecycle Assessment

Through a comparative life-cycle assessment (LCA) process, the material, energy and carbon footprints of printed and digital signage would be estimated as consumers would assess printed vs. digital signs at particular points in time as per the ecosystem approach. The assessment would factor in the impacts related to manufacture, in-use energy absorption as well as disposal and recycling stages of manufacture.

4.2 Phase 2 – Qualitative Interviews with Retail Managers

Semi-structured interviews conducted with visual merchandising and store-operations managers will provide information needed for researchers to investigate aspects like adoption drivers, limiting factors, cost structures and hardware management practices for a better understanding of the various elements in the framework and help in developing P5.

4.3 Phase 3 – Consumer Survey and Structural Equation Modeling

The study in the form of a quantitative consumer study would carry out an adaptation of the S-O-R model that was proposed by Sadachar et al. (2021) so that the impact of sustainability on customer purchasing decision would be analyzed in the context of digital signage.

4.4 Phase 4 – Field Experiment on Content Framing

By using the field-experimental methodology of Herhausen, de Jong, and Grewal (2025), an experimental setup could be implemented to experiment with effects of the digital screens used in different conditions of stimuli by introducing the idea of ecological integrity and effect on the end-user.

5. Theoretical Contributions

This article contributes to the academic literature in three major areas. It brings together two areas of research that have developed independently with little or no linkage – sustainable visual merchandising and digital signage/store atmospherics – and combines them into an integrated theoretical framework in which digital signage is acknowledged as a substitution mechanism with environmental, economic, and social implications, and not just as a means to influence consumers. It broadens the application of the stimulus-organism-response paradigm, which was applied to physical sustainable VM practices (Sadachar, Konik, & Chakraborty, 2021), to the context of digital sustainable signaling. In the process, it introduces a new phenomenon – digital sustainability paradox as an important limiting condition, highlighting the fact that the widely accepted and yet untested position that it is mostly correct to say that digital retail technologies are more sustainable than the physical materials they replace.

6. Managerial Implications

In terms of retail practice, the framework implies a number of practical implications for retailers. Retailers are encouraged to assess the sustainability features of digital signage in terms of its total lifecycle — sourcing of hardware, energy efficiency, and end-of-life disposal — instead of relying on the simple argument that replacing printed material makes a sustainability claim credible. Second, wherever digital signage is used there is also a need for retailers to deliberately include sustainability messages in the content, so that this environmental benefit would not remain an unspoken but implicit advantage of its application. Finally, retailers in developing countries may benefit significantly from the introduction of

sustainable practices in their retail stores, especially if they manage to do so at a time when sustainability is still very uncommon.

7. Limitations and Future Research Agenda

This work presents conceptual inputs which, by its nature, needs empirical evaluations as proposed in Section 4. Secondly, the current lack of standardized lifecycle assessment data for retail digital signage means that the data so far is either from vendors or trade publications and future research must address this issue. Future studies must also be directed towards cross-cultural and cross-format replication of results, the application of augmented and mixed-reality displays and the sustainability signaling impact of digital signage over time.

8. Conclusion

Digital signage is already an established method of retailing but its role with respect to sustainability of visual merchandising remains conceptually ambiguous. The paper attempts to fill the gap, related to digital signage and sustainability, by combining both bodies of literature and developing an integrative framework and seven propositions that should change the perception of digital signage from that of a tool for creating ambiance or persuasion to a system which can really bring sustainability advantage.

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