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Review Article

Sustainable spatial strategies for mitigating air pollution in quick commerce environments

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ABSTRACT

This paper reviewed various studies on the impact of quick-commerce distribution services on the environment and local communities, with a particular focus on air pollution and increased packaging waste due to the increase in quick-commerce consumption. A systematic literature review was conducted using Web of Science, Google Scholar, and Scopus to comprehensively investigate and summarise the characteristics of quick commerce distribution, the impact of frequent logistics transport on air pollution, and the increase in packaging waste due to the increase in online shopping demand. Previous studies have mainly addressed the growth characteristics of quick commerce distribution services with the emergence of quick commerce. The results of this study show that quick-commerce distribution services are indeed associated with increased traffic due to frequent transport, which contributes to greenhouse gas emissions and traffic congestion in cities. In addition, due to the nature of quick-commerce consumption, packaging waste is also increasing due to excessive use of packaging materials for freshness and safe delivery. Therefore, this study suggests sustainable consumption behaviour using local shopping malls and private spaces to minimize environmental pollution in the era of changed distribution services.

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INTRODUCTION

The rapid development of technology and the widespread adoption of personal mobile phones have significantly expanded the accessibility of various goods and services for online consumption. This shift has led to an increasing number of people transitioning to online shopping, driven by the convenience of unrestricted access, reduced purchasing effort, and the flexibility of time and location [1–3]. The growth of the online shopping market offers advantages not only to consumers but also to companies, enabling easier product promotion and distribution to a larger customer base while providing valuable insights into consumer preferences through purchase histories [4].

In the United States, approximately one-third of Internet users engage in online shopping at least once a week. In 2017, online shopping transactions in the U.S. amounted to $448.3 billion, accounting for 8.8% of all retail transactions, with an annual growth rate of approximately 15% over the past five years [5]. Furthermore, the COVID-19 pandemic catalyzed a paradigm shift towards online shopping, as offline stores faced temporary closures during lockdowns. The contactless nature of online shopping made it an attractive option for consumers, and businesses reinforced their online presence [6, 7]. The post-pandemic surge in the online shopping market has been remarkable. According to a survey by Nint, Inc., Japan's seven major online trading markets witnessed a 7% increase in sales in January

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2020, followed by 13% in February and 14% in March compared to the same months the previous year. Notably, sales of medical products surged, and while offline retail sales worldwide are projected to decline by 19% in 2021, online retail sales are expected to grow by 19% [8].

In the fast-paced modern world of 2023, quick commerce has emerged as a prominent consumer behavior trend. Quick commerce offers consumers the convenience of rapidly placing orders and receiving doorstep deliveries within a short timeframe [9]. Consumers are willing to pay extra for expedited home deliveries, driven by the desire for delivery time flexibility [10]. Although companies have successfully tackled the logistical challenges of achieving fast delivery by establishing densely packed warehouses and continuous operation, this convenience also comes with drawbacks, including increased environmental impact associated with frequent deliveries [11]. An exclusive focus on the convenience of quick commerce may result in underestimating the emissions and environmental consequences of online delivery and quick-commerce distribution. Frequent deliveries, particularly in the context of groceries, contribute significantly to air pollution through a 125% increase in food-related vehicle miles traveled (VMT). While reducing distribution frequency can mitigate VMT, it may come at the expense of revenue. Considering that all delivery vehicles currently rely on internal combustion engines, the environmental implications of frequent online grocery deliveries encompass traffic congestion, emissions, and energy consumption [12]. Frequent delivery consumption is a behavioral factor exacerbating air pollution, further affecting daily air quality fluctuations influenced by both anthropogenic emissions and atmospheric conditions, which determine the concentration and dispersion of pollutants [13].

Consumption practices that contribute to air pollution create a cycle of deteriorating air quality and heightened waste emissions. This study aims to investigate the air pollution implications of distribution services associated with quick commerce, with a specific focus on the surge in packaging waste resulting from delivery services. We present a synthesis of recent research findings in this area and, based on these insights, propose sustainable consumption behaviors leveraging local shopping malls and personal spaces to mitigate environmental pollution.

MATERIALS AND METHODS

This review aims to update the current state of research with a focus on sustainable consumption using local commercial and personal spaces to reduce environmental pollution that contributes to climate change, noting that air pollution and packaging waste from quick-service retailing are on the rise. Below we describe in detail our search strategy, article selection methods, and data synthesis procedures.

Search Strategy

For this review, we searched six databases in the natural sciences, social sciences, environmental engineering, and management and consumption, following PRISMA flow guidelines: PubMed, Scopus, Medline, ResearchGate, and Google Scholar, using the search terms (a) 'quick-service retail' and 'online shopping' (b) 'packaging waste' (c) 'transport' and 'air pollution'. Figure 1 is a flowchart showing the process of selecting studies for inclusion in this review.

Eligibility Criteria

Articles included in this review had to meet the eligibility criteria for this review, including selecting studies related to the characteristics of quick commerce distribution, types of air pollutants, frequent distribution services, online shopping, and packaging waste.

Screening and Data Extraction

Articles were included in the corpus if they (1) investigated the increase in distribution logistics due to quick commerce, (2) addressed the association between quick commerce distribution services and air pollution, (3) related to online shopping and packaging waste, (4) addressed the impact of online shopping on environmental pollution, (5) were peer-reviewed, and (6) were journal articles or conference presentations.

We excluded papers that (1) did not investigate the characteristics of quick commerce or online shopping, (2) did not investigate the link between retail logistics services and air pollution or environmental pollution, or (3) did not investigate online shopping and packaging waste.

Different types of articles were considered, including original articles, full-text articles, internet articles, summary reports, and series, and no restrictions were placed on publication date or language. Exclusion criteria included inaccessible full text, full text without raw data, inappropriate topic, and doctoral dissertations; these articles were retrieved through the ProQuest Dissertations and Theses global database.

Study Selection and Data Extraction

We used a literature review approach: a total of 297 references were selected using the PRISMA flowchart from the major journal search sites PubMed, Google Scholar, ResearchGate, Medline, and Scopus. This resulted in a total of 44 articles being selected. The PRISMA flowchart is shown in Figure 1.

3. ENVIRONMENTAL IMPACT OF QUICK COMMERCE CONSUMPTION

Air Pollution From Frequent Transport

Quick commerce is a sector characterized by the adept utilization of advanced technological solutions and intricate logistics systems, aimed at achieving the swift delivery of products mere hours or even minutes subsequent to their order placement. This paradigm centers its core objectives on expeditiousness and customer convenience, striving to furnish a shopping experience that is utterly seamless and devoid of friction [14]. The progression towards food

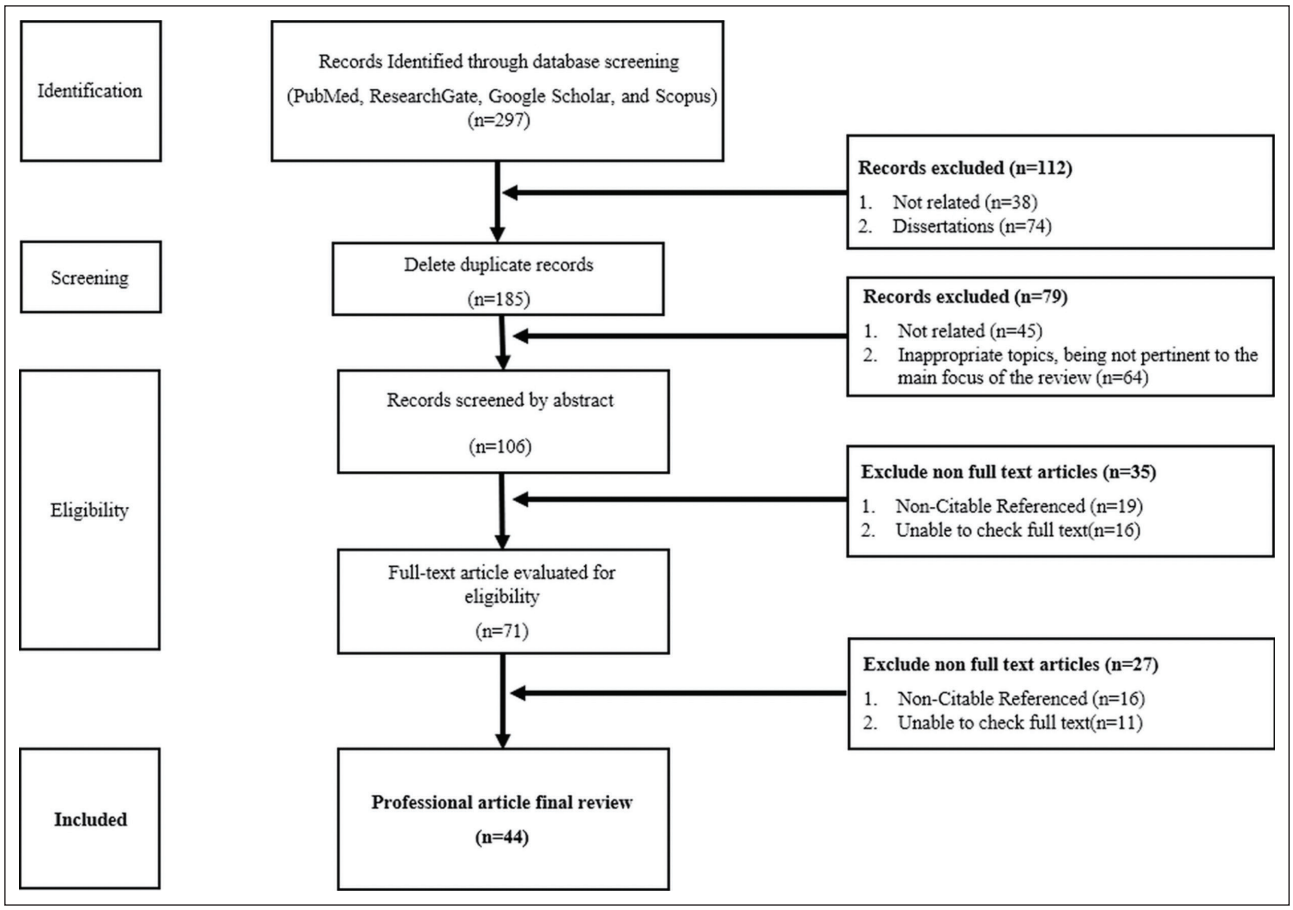

Figure 1. PRISMA flow chart for literature review search results.

e-commerce was facilitated through the assimilation of novel technologies, the emergence of innovative market participants that introduced heightened complexity and dynamism to the sector, and the cultivation of advanced logistical capabilities, exemplified by the advent of dark stores and micro-hubs. Quick commerce signifies the evolution of instantaneous delivery, now encompassing the entirety of the food and online shopping landscape. It is underpinned by an infrastructure of logistics micro-hubs, overseeing large-scale distribution, and exhibits a conspicuous reliance on transportation, characterized by the frequent movement of vehicles and the ensuing delivery workflows [15].

However, it is imperative to acknowledge the environmental ramifications and transportation intensiveness accompanying deliveries conducted through conventional means such as cars and gasoline-powered motorcycles, which emit significantly higher levels of greenhouse gases—approximately five to eleven times more—per delivery compared to their bicycle counterparts, particularly those confined to local shopping vicinities. This pronounced disparity in transport and greenhouse gas emissions underscores substantial policy considerations, particularly in light of the rapid global proliferation of such services [16].

According to a report published by the UK Department for Transport [17], the transportation sector constituted 27% of the total greenhouse gas emissions in the United Kingdom for the year 2019. Notably, heavy goods vehicles (HGVs) and vans accounted for a substantial 35% of emissions within the transport sector. Figure 2 illustrates a noteworthy escalation in the mileage covered by HGVs and vans spanning from 1990 to 2019, predominantly attributable to the burgeoning e-commerce sector. Furthermore, the persistent expansion of the quick-commerce market and the upsurge in intracity home delivery distribution engender the ingress of trucks and lorries into urban areas, thereby precipitating adverse externalities such as heightened traffic congestion, amplified emissions, and increased pollution levels [18, 19].

One of the most pivotal domains within urban goods transportation pertains to the last-mile delivery, encompassing the multifaceted processes requisite for conveying goods from their point of origin, typically a retail store or a warehouse, to their ultimate destination, culminating in the final leg of the delivery chain [20, 21]. It is worth noting that last-mile logistics exercises a discernible influence on customer satisfaction levels, shapes consumer impulsive buying tendencies [22, 23], and exerts a positive impact on the loyalty metrics for e-commerce enterprises [24].

E-commerce undertakings are not without their ecological footprint, with environmental consequences stemming from packaging, labeling, transportation activities, energy consumption, and the transmission of information, all of which contribute to the generation of carbon emissions and associated costs [25]. Beyond environmental ramifications,

Countries	Energy development strategies and policy trends
Russia	Russia will reduce net greenhouse gas emissions by 60% from 2019 levels by 2050 and by 80% from 1990 levels, and achieve carbon neutrality by 2060.
Canada	Canada will ban new gas car sales in 2035 and aims for net-zero emissions b y 2050.
China	China strives to reach the peak of carbon dioxide emissions by 2030 and stri ves to achieve carbon neutrality by 2060.
France	France will rely on renewables and nuclear power to achieve net-zero emiss ions by 2050
United Kingdom	The UK will reduce greenhouse gas emissions by 78% in 2035 compared wit h 1990 and will achieve a 100% clean carbon-free power supply in the powe r system by 2035.
United States	The United States seeks net-zero electricity sector emissions by 2035 and n et-zero greenhouse gas emissions by 2050.

Figure 2. Changes in mileage and emissions from 1990 to 2019 (Gund, H.P. & Daniel, J. (2023). "Q-commerce or E-commerce? A systematic state of the art on comparative last-mile logistics greenhouse gas emissions literature review". International Journal of Industrial Engineering and Operations Management).

the domain of e-commerce last-mile logistics significantly permeates into the economic and societal dimensions of sustainability [20], which encompasses the betterment and preservation of natural resources, economic vitality, and overall quality of life [26].

Increased Packaging Waste

The surge in food delivery services has experienced remarkable growth in recent years, notably catalyzed by the onset of the COVID-19 pandemic. A noteworthy transformation in consumer behavior unfolded, with the data reflecting a remarkable shift. In July 2019, a mere 20 percent of US consumers engaged in online grocery shopping. However, by June 2020, amidst the pandemic's aftermath, this figure surged to an unprecedented 80 percent, exemplifying the rapid expansion of the sector [8].

Fundamentally, packaging serves as the paramount means of safeguarding various products, encompassing a spectrum ranging from food items to electronics and manufactured goods, against potential damage. The principal role of product packaging revolves around the preservation of product integrity, ensuring that items are delivered in an optimal condition conducive to successful trade. This pivotal facet of product packaging concurrently facilitates the processes of transportation, handling, storage, and preservation [27]. In the context of food orders facilitated through quick commerce, the conspicuous characteristic of generating substantial packaging waste emerges as a salient concern. The packaging arsenal employed encompasses an array of elements, spanning from delivery packaging boxes to plastic containers, all aimed at averting food deformation or damage during transit. However, it is essential to underscore that the extensive use of plastics within this framework imposes a significant environmental burden. The repercussions associated with greenhouse gas emissions (GHGs) and the production and consumption of plastics transcend national boundaries, exerting a global impact. This underscores the imperative of curbing current levels of plastic waste to address the urgent imperative of limiting global warming to below 1.5 °C [28].

Many quick commerce enterprises advocate the adoption of eco-friendly practices, including the utilization of paper tape for packaging and water-based ice packs for the delivery of frozen food. Nevertheless, these endeavors, while rooted in resource-conscious principles, are not entirely devoid of resource utilization and waste generation. Express delivery packaging predominantly incorporates recycled materials, but post-consumer packaging waste is subjected to only partial recycling efforts. Additionally, plastic packaging predominantly derives from recycled agricultural film, carrying residual chemical residues from pesticide applications, potentially posing health risks to industry personnel and consumers alike [29].

Notably, the multifaceted nature of express delivery amplifies its environmental footprint, prominently evident in the diverse array of packaging materials employed. For instance, research conducted by Fan et al. [30] elucidated the environmental burden imposed by express delivery packaging materials through a comprehensive life cycle assessment approach. Indeed, each express delivery order necessitates the deployment of a multitude of packaging components, encompassing corrugated and cardboard boxes, plastic and bubble wrap, adhesive tabs, polystyrene foam, and air blister fillers. Figure 3 graphs the growth of packaging waste from the 1990s to the 2020s based on China. While certain packaging materials, such as corrugated boxes, offer recyclability and reusability prospects, a significant proportion of packaging waste from shipping finds its way to municipal

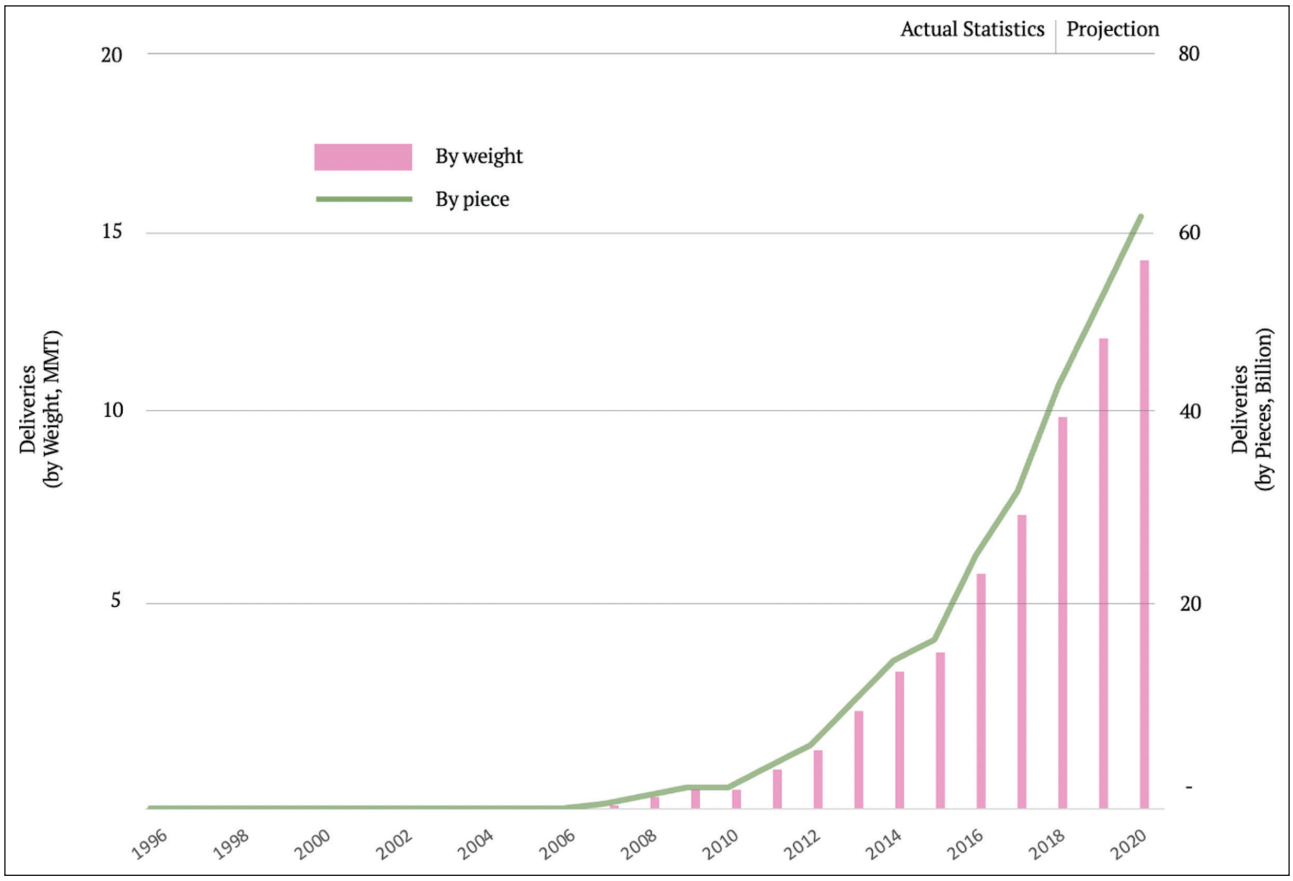

Figure 3. Total volume of express delivery packages and weight of packaging waste in China from 1996 to 2020 (Huabo Duan, Guanghan Song, Shen Qu, Xiaobin Dong, Ming Xu, Post-consumer packaging waste from express delivery in China, Resources, Conservation and Recycling, Volume 144,2019, Pages 137–143).

solid waste (MSW) sites, where it either undergoes landfilling, incineration, or simply improper disposal. This is particularly concerning considering that a substantial portion of packaging waste comprises non-biodegradable materials such as PVC plastic, polyethylene plastic, expanded polystyrene plastic, and polyester plastic, thus underscoring the severe environmental consequences stemming from inadequate disposal practices [31]. The persistence of non-biodegradable materials, notably PVC, not only exacerbates environmental concerns but also presents challenges related to plastic waste marketability, emissions, and corrosion during thermal treatment. The prevalence of non-biodegradable plastics represents a pervasive issue, manifesting in landfills, roadside litter, and the infamous phenomenon of plastic pollution in aquatic ecosystems, commonly referred to as the "plastic soup" [29].

Food Security Inequalities Caused by Quick Commerce

The proliferation of food purchases through quick commerce channels is having a discernible impact on local commercial districts, underpinned by several key factors. Firstly, the global population is on a trajectory of continuous growth, necessitating an increased demand for food resources. While residents of developed megacities enjoy the convenience of swift access to a wide array of food options via quick commerce, many other areas remain underserved by this burgeoning trend. Consequently, disparities in food security are exacerbated, posing a challenge to equitable access to sustenance [32]. Furthermore, the environmental footprint stemming from the rapid adoption of quick commerce food consumption systems in large urban centers is poised to escalate gradually, emphasizing the exigency of exploring alternative approaches to food provisioning. A pivotal strategy involves the mitigation of food wastage while ensuring a sufficient supply of food within local regions. This approach is geared towards ameliorating the associated environmental consequences [32].

Large cities, by their nature, furnish a conducive social milieu replete with novel opportunities for interaction, thereby fostering individual learning and personal development. However, the distribution of these opportunities among individuals varies considerably and tends to diverge over time, primarily contingent upon the city's size and the prevailing inequalities within its confines [33]. Analogously, disparities in food consumption patterns manifest, with discernible discrepancies in food security emerging between generations possessing easy online access and those bereft of such access or contending with the dominance of overheated quick commerce enterprises. These disparities may potentially precipitate challenges related to food availability and subsequently exert upward pressure on market food prices. Hence, it is incumbent upon the nation to pro-

actively attend to and strategize for the development of infrastructure and initiatives pertaining to various facets of the food system, encompassing arable land, water resources, agricultural crops, livestock, and fisheries [18]. Indeed, the burgeoning quick commerce consumption landscape is impinging on the vitality of local brick-and-mortar establishments, which find themselves in competition with online platforms that are endowed with inherent advantages and must also contend with rivalry from other physical retail outlets. In response, local retailers are compelled to adapt their strategies for product and service offerings. They are actively exploring innovative approaches to attract consumers in the digital shopping realm, bridging the divide between consumers and their storefronts by harnessing the potential of online interfaces [34].

DISCUSSION

Space for Sustainable Consumption Behavior: Local Commerce

Food processing and transportation processes entail significant energy consumption, primarily attributable to water utilization and the generation of waste. In developed nations, an increasing level of consumer consciousness regarding the environmental and societal repercussions embedded within the food supply chain has ushered in a proliferation of single-use plastic-free grocery establishments. While these novel retail entities represent a sustainable alternative, their environmental and societal merits, as well as their utilization potential, are inadequately communicated to consumers. Empirical evidence gleaned from surveys underscores the potential for stimulating resource-efficient behavior among consumers when they are apprised of the reduction in packaging waste and food waste resultant from patronizing these stores. Alternative retail concepts that amalgamate principles of organic food provisioning, ethical sourcing, and zero-packaging systems into conventional local supermarkets offer a promising avenue for the development of sustainable local commercial centers [35, 36].

An alternative approach involves harnessing the existing network of brick-and-mortar stores as logistical hubs, with particular emphasis on the ubiquitous presence of convenience stores in virtually every locality. Traditionally, convenience stores have primarily functioned as conventional supermarkets; however, the advent of novel delivery modalities such as quick commerce and early morning delivery opens up new vistas for this business model to realize its niche potential [37]. This can be achieved through diversifying the product repertoire to encompass fresh and small-quantity food items. Notably, South Korea's prominent convenience store franchise, CU, has undertaken a transformational initiative by outfitting convenience stores with dedicated refrigeration units for fresh meat and establishing meal kit stands, thereby optimizing their role as logistical hubs. Given the widespread ubiquity of convenience stores within urban landscapes, with outlets nestled in every nook and cranny, this presents an opportunity to establish logistical hubs in close proximity to consumers [38].

Despite the corporate ownership of convenience store chains, franchisees are individual entrepreneurs, warranting consideration of national-level support mechanisms to bolster their operations and incentivize sustainable consumer behavior, capitalizing on the accessibility inherent to these retail outlets. In parallel, it is imperative to recognize that environmental concerns have assumed a dimension of critical importance akin to security considerations. As such, state actors, businesses, and non-governmental organizations are endowed with a pivotal role in shaping decision-making processes that influence individual behaviors aimed at mitigating environmental harm and ensuring the availability of sustainable options [39].

Space for Sustainable Cnsumption Behavior: Local Commerce: Personal Space

Individuals who exhibit a forward-looking orientation possess the cognitive capacity to envision themselves engaging in sustainable behaviors and project the implications of such actions onto their future selves. This forward-thinking mindset assumes a pivotal role in fostering increased adoption of sustainable behaviors within their daily lives, primarily by heightening their awareness of associated risks and fostering deeper engagement in sustainable practices [40].

These forward-looking individuals actively curate their personal spaces to accommodate sustainable consumption behaviors. They actively seek out stores that introduce alternative retail concepts to the conventional neighborhood supermarket, establishing them as their preferred shopping destinations. In this personalized realm, they diligently embrace sustainable consumption practices aimed at reducing their personal carbon footprint. An exemplar of this is the practice of 'home gardening.' Home gardening is a potent avenue for exercising sustainability within one's personal space, underpinned by dual rationales. Firstly, it promotes a wholesome lifestyle, yielding psychological and physical health benefits. Home gardening encompasses various facets, including vegetable cultivation, gardening, and potted plant maintenance, all of which confer the environmental benefit of air purification and cleansing within one's immediate environment [41]. Home gardening can also be regarded as a form of small-scale, self-sustaining urban agriculture, with households cultivating their own produce. By nurturing their own fruits and vegetables, individuals not only reduce their carbon footprint but also circumvent the pollution associated with various external services, including water wastage and energy consumption in transportation. Furthermore, it facilitates the reduction of food wastage, as individuals can cultivate and consume only what is needed within their personal space. The presence of a home garden ensures easy access to fresh produce on a daily basis, thereby enhancing food security, diversification, and environmental sustainability in the vicinity of one's residence [42, 43]. Notably, businesses have responded to this

trend by introducing home gardening kits, facilitating the integration of sustainability into individuals' daily lives.

Forward-thinking consumers, especially the younger demographic, wield considerable influence by effecting a positive ripple effect. They actively propagate sustainability within their personal spheres and leverage the reach of social networking services (SNS), an intimate yet communal platform, to inspire fellow consumers to voluntarily adopt sustainable practices. Younger consumers, in particular, are more inclined and capable of disseminating examples of green local store reviews and sustainable dietary practices within their generational cohort [44].

CONCLUSION

In the contemporary world, characterized by a fervent pursuit of speed and efficiency, the quick commerce sector thrives by leveraging the rapidity of consumer trends as a strategic advantage. However, the escalating adoption of quick commerce practices has inevitably engendered adverse environmental consequences. These repercussions encompass infrastructure development to secure warehouses, heightened vehicular traffic stemming from frequent transportation activities, and an upsurge in packaging waste generated during product deliveries, thereby contributing to air pollution. Concurrently, the local retail establishments in our immediate communities are grappling with the ramifications of surging demand for quick commerce, underscoring the need to redress the inequitable concentration of food security within specific socioeconomic strata and urban centers. The imperative now calls for a paradigm shift toward consumption patterns characterized by sustainability considerations. This transformation transcends the individual level, necessitating robust national-level support for existing local retailers in their endeavors to embrace alternative retail concepts founded on principles of organic food provisioning, ethical sourcing, and the adoption of zero-packaging systems. On an individual front, consumers can contribute to sustainability within their immediate surroundings through engagement in home gardening activities, which not only enhance the quality of their personal environment but also establish self-sustaining food systems.

DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

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

ETHICS

There are no ethical issues with the publication of this manuscript.

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