COGNITIVE LOAD AND ALGORITHMIC LITERACY: UPSKILLING GIG WORKERS FOR SMART AND GREEN LOGISTICS CORRIDORS

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Keywords: Cognitive Load, Algorithmic Literacy, Upskilling Readiness, Digital Learning Orientation, Smart and Green Logistics Corridor, Perceived Algorithmic Control

1. ABSTRACT

The rapid digitalization of global logistics, coupled with the transition toward smart and environmentally sustainable logistics corridors, has significantly reshaped the landscape of last-mile delivery. Increasingly, this critical segment of supply chain depends on gig-based workers, often engaged through platforms such as food delivery apps and ride-hailing services. These workers operate within highly digitized ecosystems where algorithmic systems dictate task allocation. While such technologies promise efficiency, they increase workers' cognitive load and hinder their ability to meaningfully interact with these technologies. Emerging sustainability mandates require gig workers to develop new forms of algorithmic literacy, digital competency, and environmental delivery practices. This paper examines how cognitive load affects gig workers' ability to adapt to smart and green logistics corridors and proposes a conceptual model explaining how algorithmic literacy mediates the relationship between cognitive load and gig workers' capability for smart and green logistics corridors. Building on insights from research in the gig economy, human–algorithm interaction, sustainable logistics, and cognitive psychology, the paper highlights algorithmic literacy as an essential competency for preparing workers to thrive in future gig logistics systems. The proposed model positions cognitive load as a key barrier to upskilling readiness and highlights the role of algorithmic literacy and capability for smart and green logistics corridors. This study offers theoretical insights and practical recommendations for policymakers, platform companies, and logistics educators seeking to prepare gig workers for an increasingly digital and sustainable logistics environment.

2. INTRODUCTION

Smart and green logistics corridors are redefining global supply chain systems through the integration of automation and low-emission transport systems. By linking distribution hubs, these corridors establish technology-enabled pathways that promote sustainable trade practices. Smart logistics is an effective way to meet the challenges of rapidly changing customer expectations and capitalize on the

opportunities brought by new technologies (Ding *et al*. [4]). Green logistics or green supply chain management is defined as an organization's activity considering environmental issues and integrating it into supply chain management (Nikseresht *et al*. [20]). These smart and green corridors include food delivery riders and e-commerce couriers, by gig workers who are vital to these corridors. Gig work is commonly defined by its tasks facilitated through technology platforms that match service supply with customer demand (Spreitzer *et al*. [21]). Gig workers are individuals contracted and compensated for short-term work by organizations or individual clients through external labor markets (Cropanazo *et al*. [2]).

With the development of smart and green corridors, food-delivery platforms have recently begun to apply algorithmic management (Lee *et al*. [17]), which uses artificial intelligence to match delivery tasks with workers and monitor gig worker performance (Won *et al*. [24]; Kellogg *et al*. [13]). The growing complexity of algorithmic systems used for task allocation, automated ratings, and route recommendations increases the mental effort required by gig workers while performing tasks and learning new information, which is referred to as cognitive load (Martínez-Moles *et al*., [18]). Thus, cognitive load increases with task difficulty for gig workers, impairing decision-making and sustainable delivery behaviours. This limits their upskilling readiness, hampering the acquisition of new skills (Sun *et al*., [22]).

As smart and green logistics corridors accelerate, algorithmic literacy, defined as the ability to understand, interpret, and work with automated systems, becomes critical for gig workers who can understand vulnerability to sudden algorithmic and task assignment changes and improve their productivity. (Kadolkar *et al*., [12]) Digital learning orientation of gig workers enhances algorithmic literacy, which has a positive influence on upskilling readiness (Zaghloul *et al*. [26]). The proposed conceptual framework of this study presents a unique approach for researchers to investigate the role of cognitive load and algorithmic literacy on smart and green logistics corridors. To offer a more comprehensive understanding of the effects of digital orientation, this model was extended by exploring the mediated effect of algorithmic literacy and upskilling readiness on gig workers' capability for smart and green logistics corridors. Only some studies have presently applied cognitive load to examine the gig workers' capability for smart and green logistics corridors.

The need for more research about gig workers' algorithmic literacy and upskilling readiness in smart and green logistics corridors limits the insights available to practitioners and researchers in this area of smart logistics. This discussion sheds light on research gaps in the context: First, few studies have focused on cognitive load and gig workers' capability for smart and green logistics corridors; second, there is a dearth of theory-driven investigations on the role of algorithmic literacy and upskilling readiness of gig workers; third, the digital learning orientation of gig workers and its impact on algorithmic literacy and upskilling readiness in smart and green logistics corridors is yet to be explored despite its established usefulness in the smart and green logistics literature. Therefore, the present study attempts to bridge these gaps by applying cognitive load and algorithmic literacy to understand upskilling readiness of gig workers in smart and green logistics corridors. Hence, the study examines research questions (RQs) as follows:

1. RQ1: How does cognitive load impact gig workers' algorithmic literacy?
2. RQ2: How do algorithmic literacy and upskilling readiness impact the link between cognitive load and gig workers' capability for smart and green logistics corridors?
3. RQ3: Are there any effects of digital learning orientation and upskilling readiness on the relationship between cognitive load and gig workers' capability for smart and green logistics corridors?

Based on the above research questions, we conducted a comprehensive literature review to understand extant literature on smart and green logistics using cognitive load and algorithmic literacy.

This study formulates a conceptual framework for future research on cognitive load that will drive smart and green logistics corridors. It considered cognitive load as an independent variable and capability for smart and green logistic corridor as a dependent variable, using algorithmic literacy and upskilling readiness as mediating variables, and digital learning orientation and upskilling readiness parasocial interaction as a moderating variable.

The study is novel as it is the first to combine cognitive load that will drive smart and green logistic corridors, along with algorithmic literacy and upskilling readiness. It further extends the digital learning orientation of gig workers to algorithmic literacy and upskilling readiness to the smart and green logistics corridor, adding to the relatively scant literature on the cognitive load.

3. METHODOLOGY

This study adopts a conceptual understanding to examine how cognitive load and algorithmic literacy shape gig workers' readiness for upskilling in the context of smart and green logistics corridors. Given that this research domain is still emergent, with fragmented theoretical foundations and limited empirical evidence, a structured interpretive review is particularly appropriate. In contrast to systematic reviews, this method enables deeper interpretive analysis, integration of cross-disciplinary scholarship, and conceptual model development.

The review process was conducted through three steps:

Step 1: Literature Identification

Relevant literature sources were selected from peer-reviewed journals, conference proceedings, and authoritative industry and institutional reports in the fields of logistics, gig economy, human–computer interaction, sustainability logistics, cognitive psychology, and algorithmic management. Databases such as Scopus, Web of Science, Google Scholar, and industry whitepapers were screened using keyword combinations including gig workers, cognitive load, algorithmic literacy, last-mile delivery, green logistics corridors, algorithmic control, and digital upskilling. We employed backward and forward citation tracking to capture foundational and emerging contributions.

Step 2: Thematic Categorization and Integration

The selected studies and sources were systematically reviewed and grouped into five thematic clusters:

1. Gig work and algorithmic management
2. Cognitive load and digital task complexity
3. Algorithmic literacy and digital skills development
4. Smart and green logistics systems
5. Worker upskilling and green competencies

These themes were synthesized to identify conceptual linkages and theoretical gaps relevant to gig workers' readiness to engage with advanced technologies for smart and green logistics corridors.

Step 3: Conceptual Model Development

Insights from the thematic synthesis were used to build an integrative conceptual model explaining the relationships between cognitive load, algorithmic literacy, and upskilling readiness. The framework draws on existing theories, including cognitive load theory, human–algorithm collaboration frameworks, and sustainable logistics concepts were integrated to formulate testable propositions and hypotheses for future empirical research.

Overall, this approach enables the construction of a theoretically grounded conceptual framework without relying on primary data collection. It is suitable for advancing emerging research areas and conference-oriented conceptual contributions.

4. LITERATURE REVIEW

Among the major shifts transforming contemporary labour markets, the rise of the gig economy stands out as a defining trend in the future of work. The rise of platform-mediated, on-demand work is becoming a structural feature of global labour markets (World Economic Forum [25]). As automation and algorithmic decision-making accelerate, the gig economy is expected to expand further, absorbing workers displaced from traditional roles and reshaping how work is organised, accessed, and valued. In recent years, it has been found that the global world of work has undergone a dramatic shift as gig-based arrangements have gained momentum, drawing workers away from stable, traditional employment and into flexible, platform-mediated forms of labour. (Hatos *et al*., [8])

This transformation is particularly evident in the supply chain and logistics sectors. Recent studies highlight that the gig economy has become an increasingly important feature of modern supply chains, particularly in last-mile delivery, where flexible, digitally mediated labour is reshaping how logistics activities are organised (Kozák, Kasza & Németh [14]). As platform-based work continues to expand, it brings new opportunities for efficiency but also introduces significant challenges related to coordination, worker capability, and digital skill demands (Kozák, Kasza & Németh [14]). With logistics systems evolving towards smarter and greener infrastructures, gig workers are increasingly required to engage with complex technological environments driven by algorithmic systems.

Within these digitally intensive contexts, the cognitive demands placed on gig workers have intensified as digital labour platforms rely increasingly on algorithmic coordination. According to cognitive load theory, working memory has well-documented limitations when processing new and complex information, and learning becomes impaired once these limits are exceeded (Sweller [23]). In the gig context, these limits are frequently surpassed as workers must rapidly interpret a continuous stream of system-generated cues, task alerts, route changes, customer ratings, and performance indicators, while simultaneously trying to make sense of opaque rules and irregular algorithmic decisions (Hajiheydari & Delgosha [7]). The opacity and complexity of platform algorithms further restrict workers' ability to understand or influence key aspects of their work (Jarrahi & Sutherland [11]), leaving little cognitive capacity available for developing algorithmic literacy. As a result, cognitive overload constrains workers' ability to form the mental models needed to comprehend algorithmic logic, limiting their capability to function effectively within increasingly digitalized and sustainability-oriented logistics systems.

In this environment, algorithmic literacy becomes a foundational resource. When gig workers understand how algorithms allocate tasks, assess performance, or determine incentives, they experience a stronger sense of competence, self-satisfaction, and digital efficacy (Collier & Sherrell [3]). This increased confidence reduces uncertainty, enhances perceived control (Jarrahi & Sutherland [11]), and encourages positive engagement with platform systems (Lazarus [16]). Such psychological conditions are critical precursors to upskilling readiness, which reflects a worker's willingness and perceived ability to acquire new competencies. Without algorithmic literacy, upskilling may be perceived as overwhelming or irrelevant. However, with it, learning becomes more achievable and meaningful,

enabling workers to participate in training that supports smart and green logistics transitions. In this way, algorithmic literacy not only shapes workers' understanding of digital systems but also increases their openness to developing capabilities essential for green logistics corridors.

Algorithmic literacy alone, however, does not guarantee capability development. Workers must also be willing and motivated to transform their understanding into new behaviours, making upskilling readiness a crucial psychological mechanism. When workers feel competent in navigating algorithmic systems, they are more inclined to invest in learning and more confident in applying new skills required by smart and green logistics. Thus, algorithmic literacy enhances capability because it first strengthens upskilling readiness, which then translates knowledge into behavioural proficiency within sustainability-driven logistics environments.

These relationships are further shaped by individual differences in digital learning orientation. Within the context of digital environments, learning orientation involves a drive to build competence in areas such as digital literacy, online connectivity, multitasking, hands-on or experiential learning, and a preference for visual rather than text-heavy information (Bullen *et al*. [1]). Workers who naturally embrace new technologies, enjoy experimentation, and prefer hands-on digital learning tend to display higher motivation and self-efficacy (Bullen *et al*., [1]; Hawk & Shah [9]; Erhel & Jamet [5]). Such workers experience fewer cognitive barriers and show greater resilience to technological complexity, allowing them to benefit more from algorithmic literacy and to convert readiness into meaningful capability. Consequently, digital learning orientation is likely to amplify the pathway through which algorithmic literacy and upskilling readiness translate into enhanced capability within green logistics corridors.

Workers' perceptions of how tight algorithms control their behavior also shape these developmental processes. Algorithmic control refers to the use of algorithmic systems to monitor, direct, and evaluate gig workers' actions (Möhlmann *et al*. [19]). As workers interpret these systems differently based on their experiences and contexts, perceived algorithmic control varies considerably (Fugate, Kinicki & Prussia [6]). When control is perceived as overly restrictive, workers may feel limited in their autonomy, hindering their willingness to apply new skills or invest in further learning. Conversely, lower perceived algorithmic control gives workers greater room to exercise judgment, experiment with new competencies, and make constructive use of their algorithmic understanding. This sense of autonomy can strengthen the influence of algorithmic literacy and upskilling readiness on capability development (Lang *et al*., [15]), allowing workers to translate what they know and what they are willing to learn into more effective performance in smart and green logistics systems.

5. FINDINGS

Based on the conceptual review of literature discussed in the preceding section, the relationships between the key variables in this study were critically examined to understand how they interact in shaping capability for smart and green logistics corridors. Insights drawn from the literature were synthesised to identify the antecedents that enable such capability. This synthesis informed the development of a conceptual research model that maps the interplay among these constructs and explains their collective influence on capability development within logistics ecosystems. The proposed conceptual model is presented below.

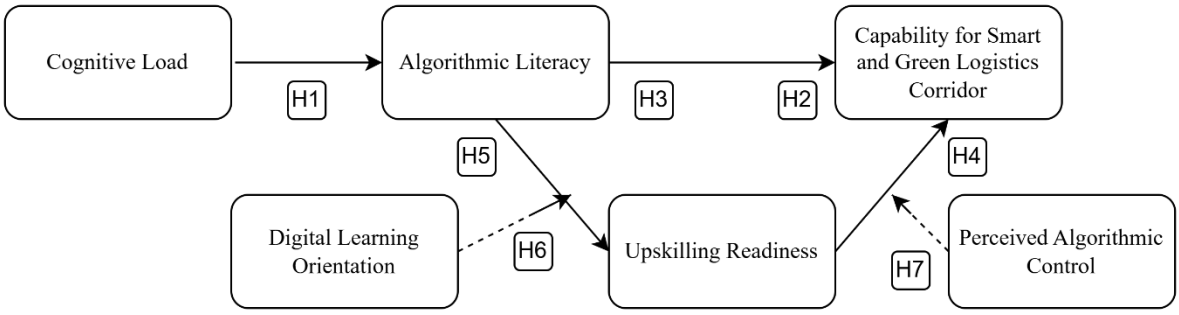

Figure 1: Conceptual Model of Research

Direct effect ——→
Moderation effect - - - - - -→

Based on the relationships between the different variables in Figure 1, the following hypotheses are proposed.

H1: Cognitive load negatively influences algorithmic literacy

H2: Algorithmic literacy has a positive influence on upskilling readiness.

H3: Algorithmic literacy mediates the relationship between cognitive load and gig workers' capability for smart and green logistics corridors.

H4: Upskilling readiness mediates the relationship between algorithm literacy and gig workers' capability for smart and green logistics corridors.

H5: Algorithmic literacy and upskilling readiness sequentially mediate the relationship between cognitive load and gig workers' capability for smart and green logistics corridors.

H6: The mediated effect of algorithmic literacy and upskilling readiness on cognitive load and gig workers' capability for smart and green logistics corridors is moderated by digital learning orientation.

H7: The mediated effect of algorithmic literacy and upskilling readiness on cognitive load and gig workers' capability for smart and green logistics corridors is moderated by perceived algorithmic control.

6. DISCUSSION

This research expands the understanding of gig work within smart and green logistics systems. Findings emphasize that training programs must reduce cognitive load. Algorithmic literacy is crucial for automation readiness, and green delivery skills cannot be developed without digital competency. In addition, fair and transparent platform design enhances learning, and upskilling gig workers strengthens sustainability goals. The study paves the way for platforms and policymakers to co-develop accessible training modules for gig workers to meaningfully participate in the transition to greener, smarter logistics.

The proposed conceptual framework illuminates how algorithmic literacy operates as the cognitive and psychological bridge between cognitive load and upskilling capacity in the gig-based logistics ecosystem. As logistics networks become embedded in smart and green corridors, workers' ability to engage with algorithmic systems will determine not only their employability but also their contribution to sustainability goals (Ivanov & Dolgui [10]; Lang *et al*. [15]). The findings reinforce that reducing cognitive load is not merely a performance or productivity goal but a sustainability mechanism. When cognitive overload is reduced through transparent task design or adaptive platform interfaces, workers gain cognitive load to engage with eco-efficient delivery practices such as route optimization, battery

conservation, and green vehicle handling. This repositions cognitive load as a green performance variable, linking mental effort directly to environmental outcomes.

While prior studies have focused on digital literacy, this model distinguishes algorithmic literacy as a next-generation competency required for sustainable logistics. Understanding how delivery algorithms allocate routes or prioritise low-emission options empowers workers to make eco-conscious choices within the boundaries of platform logic (Jarrahi & Sutherland [11]; Hajiheydari & Delgosha [7]). Thus, algorithmic literacy becomes both a technical and ethical literacy, enabling workers to align digital efficiency with ecological responsibility. Thus, algorithmic literacy is the "new green skill" for gig workers.

Upskilling readiness represents a psychological gateway through which cognitive understanding translates into sustainable logistics behaviour. Workers who feel digitally competent are more likely to adopt EVs, embrace low-carbon routing, and experiment with new learning tools (Collier & Sherrell [3]; Lazarus [16]). The implication indicates readiness is not taught; it is triggered by design environments that balance control and autonomy.

Gig platforms that disclose algorithmic decision rules and offer transparent feedback loops foster algorithmic trust, which strengthens both learning motivation and sustainability participation. This echoes Lang *et al*. [15], who found that perceived algorithmic fairness enhances engagement and mitigates burnout. Hence, fairness, explainability, and worker agency are not ethical add-ons; they are cognitive preconditions for sustainable digital transformation.

7. MANAGERIAL IMPLICATIONS

Based on the findings, this research proposes recommendations for logistics managers. First, gig platforms should redesign their interfaces with cognitive load optimization in mind by simplifying data visualization (minimal notifications, progressive task disclosure); implement AI-driven cognitive balancing, where task complexity adjusts dynamically to worker load levels; use color-coded cognitive load indicators to signal task difficulty and assist pacing. Additionally, platforms should integrate algorithmic literacy modules into onboarding.

Second, training should go beyond operational guidance and include "algorithmic sensemaking" sessions by explaining how dispatch, ratings, and incentives are calculated; provide digital simulations of algorithmic scenarios (e.g., route optimization for emission reduction); and integrate gamified learning modules rewarding mastery of algorithmic logic.

Third, policymakers should integrate gig worker upskilling into smart and green logistics corridor policies by including subsidized eco-delivery certifications; partner with platforms to develop open-access sustainability learning hubs; and create AI-sustainability training incentives through tax credits. Governments should incentivize training for EV and e-bike use.

Fourth, transparency builds both compliance and confidence. Logistics companies should treat gig workers as essential sustainability partners. Platforms should integrate explainable AI modules, enabling workers to query system logic in real time. For example, dashboards could show how a delivery assignment reduces total emissions or increases fairness across riders.

Fifth, educators and logistics organizations should develop micro-credentials that combine algorithmic literacy with sustainability competencies, green routing strategy, digital navigation, and carbon management; AI-driven decision ethics. Educators should develop micro-credentials for gig logistics skills.

Sixth, rather than temporary labor, gig workers should be recognized as micro-agents of green transformation. Platforms can create participatory feedback systems where workers contribute to improving eco-routing algorithms and reporting sustainability challenges. Cities should design infrastructure that supports green last-mile delivery (charging stations, bike lanes).

8. LIMITATIONS AND FUTURE RESEARCH

Although the rigor was followed, this study has limitations that should be acknowledged when interpreting its findings and conducting future research. First, the study focuses primarily on last-mile gig logistics, a segment most affected by digital routing, sustainability mandates, and cognitive complexity. However, gig work in ride-hailing, inter-city freight, or warehouse coordination may involve different forms of algorithmic interaction and cognitive challenges. The results, therefore, cannot be generalized across all platform-based labour ecosystems. Future researchers may expand the study to ride-hailing, warehouse automation, or maritime logistics gig work, comparing algorithmic literacy effects across contexts to identify sector-specific cognitive strategies.

Second, the constructs such as algorithmic literacy, upskilling readiness, and perceived algorithmic control remain conceptually defined rather than empirically measured. This limits the ability to assess their causal pathways or mediating roles. Future research may develop and validate psychometrically robust measurement scales for these variables. For instance, cognitive load in the algorithmic work index or the green capability readiness inventory. These tools could advance quantitative research on–algorithm sustainability dynamic.

Third, the current conceptual model assumes sequential mediation on the path from cognitive load, algorithmic literacy, upskilling readiness, and capability. However, cross-sectional data may not capture how these relationships evolve as workers gain experience or as platforms update their systems. Future research may implement longitudinal studies tracking gig workers' algorithmic literacy, cognitive adaptation, and sustainability performance over time to capture learning trajectories and cumulative effects. These longitudinal studies could measure skill progression over time.

Fourth, gig platforms operate globally, but perceptions of control, fairness, and digital learning orientation are often culturally contingent. Workers in collectivist societies may perceive algorithmic supervision differently from those in individualistic contexts. Future research may conduct cross-cultural comparative studies to explore how national culture, regulatory frameworks, and digital infrastructure influence the cognitive and emotional dynamics of algorithmic work. Thus, cross-country studies may uncover cultural differences.

9. CONCLUSION

As smart and green logistics corridors transform global trade, gig workers must adapt to increasingly automated and sustainability-oriented delivery systems. Cognitive load and algorithmic literacy play critical roles in shaping workers' ability to upskill and succeed within these digital ecosystems. This paper provides a conceptual foundation for understanding the human factors that shape the future of green, smart logistics and offers pathways for training and policy innovation.

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11. DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES

During the preparation of this work, the authors used ChatGPT in order to improve language, clarity and formatting. After using this tool/service, the authors reviewed and edited the content as necessary and take full responsibility for the content of the publication.