
Digital Employability Skills for Gig Workers: A Systematic Literature Review and Network Analysis

Suci Maghfiroh^{1,2*}, A. Ana¹

¹Technology and Vocational Education, Indonesian education university

²Bandung Advanced Center for Vocational and Productivity Training, Indonesia

*Correspondence: sucimaghfi@upi.edu

Abstract

This study examines the development of Digital Employability Skills (DES) among gig workers. Utilizing a Systematic Literature Review combined with Network Analysis to identify the mechanisms behind their growth and the challenges encountered from 2015 to 2025. A total of 27 peer-reviewed articles that met the inclusion criteria were analyzed in accordance with the PRISMA 2020 guidelines. Bibliometric analysis shows a significant increase in research after 2020, in line with the digital transformation of work and the expansion of the platform-based economy. Thematic synthesis identified five conceptual domains: input, mediator, output, intervention, and gap, which explain the contribution of DES to employability outcomes. The study results show that core digital skills, such as information literacy and problem-solving, act as human capital that strengthen workers' adaptive abilities, self-efficacy, and collaboration. On the other hand, institutional interventions, including inclusive training, policies, and evaluation, were found to strengthen the conversion of skills into sustainable work performance. However, the impact of training remains limited due to structural and algorithmic barriers, especially for vulnerable groups such as women, refugees, and rural communities. These findings underscore the need for a stronger connection between individual preparedness, innovative teaching practices, and policy reform in building a fair, adaptive, and inclusive digital work ecosystem.

Keywords: Digital employability skills, gig economy, human capital theory, inclusive training, systematic literature review.

1. Introduction

The gig economy has grown rapidly and has become one of the defining features of today's global labor market (Diba et al., 2025; Liberona et al., 2024). Digital platforms, such as online freelancing, ride-hailing, delivery services, and online micro-tasks, play a vital role as app-based intermediaries, providing project-based, short-term, and cross-location work (Fiers & Hargittai, 2023; Lata et al., 2023). Digital job platforms are now globally recognized as one of the most significant manifestations of the changes brought about by digitalization in the labor market (ILO, 2025; OECD, 2020). The ILO (2021) report shows that many workers worldwide are engaged in digital platform-based work. Meanwhile, the Future of Jobs Report 2025 projects that by 2030, around 170 million new jobs will

be created, but approximately 39% of existing skills will become obsolete (WEF, 2025). This fact confirms that the world of work is undergoing a major transformation toward a work system that is increasingly digital, flexible, and mediated by technology. This change also reforms of relationship between workers and clients, as well as patterns of use of digital services, which are now heavily influenced by the interaction algorithms and human management (Cruz & Gameiro, 2023).

Digital transformation has had a major impact on the way we view the concept of employability, namely the ability of individuals to acquire, retain, and enhance careers in an ever-changing job market (Dacre Pool & Sewell, 2007; Yorke, 2006). In the last context, employability is understood as a set of static skills and adaptive capacities formed through the interaction between individual capital, contextual factors, and technological advances (Clarke, 2018). For gig workers who rely on project-based work systems and algorithms, digital skills such as adaptability and self-study within the platform are essential factors that determine the extent to which they can access employment opportunities and maintain income sustainability (Fiers, 2024; Zhang, 2025; Zheng et al., 2024). These skills encompass not only technical mastery but also reflective, collaborative, and adaptive competencies that enable gig workers to navigate the digital platform ecosystem (Hargittai & Micheli, 2019; van Laar et al., 2020).

Research by Audrin et al. (2024) emphasizes the importance of digital communication and collaboration competencies, as well as the ability to quickly adapt to new systems and exhibit learning agility in the context of digital work dynamics. The findings reinforce the view that digital skills serve as the main foundation for workers to adapt to system and policy changes within the platform. In developing countries, digital skills are proven to increase the competitiveness of platform workers (Diba et al., 2025). While the study results of Soriano (2021) showing that the formation of social and economic mobility in the informal sector is influenced by the skill-making process and the role of the intermediation platform, several other studies also confirm that platform-based digital learning and the learning by doing approach can strengthen career adaptability, resilience, and the participation of vulnerable groups such as women, migrants, and refugees in the digital economy (Hackl & Najdi, 2024; Keskinen et al., 2022; Zwettler et al., 2024).

Not all gig workers have the same opportunities to acquire or develop digital skills. This inequality creates gaps in the digital job market, particularly affecting vulnerable groups (Abkhezzr & McMahon, 2024; ILO, 2019; WEF, 2025). Although gig work can serve as a stepping stone for them to participate in the digital workforce, limited access to training and digital literacy could exacerbate social and economic disparities. Several studies indicate that differences in abilities in STEM fields remain the primary cause of the income gap between men and women (Petroff & Fierro, 2023). In Bangladesh, the gig economy remains highly segregated by gender (Sarker et al., 2024). A similar phenomenon occurred in Kazakhstan, where the adoption of digital platforms increased from 23% in 2015 to 87% in 2023; however, the income gap widened to 45% between urban and rural areas due to regional inequality and infrastructure limitations (Tolegen et al., 2024). In Indonesia, research shows that technology support and hybrid work systems can increase the productivity and engagement of gig workers. However, the effectiveness of employment policies is still hampered by the gap in social protection and digital inclusion (Alfarizi et al., 2025).

Numerous studies emphasize the significance of digital skills. Still, there is limited empirical evidence explaining how DES directly impacts employability outcomes such as income, job sustainability, or career mobility in the context of the gig economy (Fiers, 2024; Graham et al., 2017; Zhang, 2025). Most studies are still descriptive in nature, not measuring the relationship between specific types of digital skills and actual work outcomes (Zhang, 2025). Previous studies on the gig economy have generally focused on issues of precarity, algorithmic fairness, and labor regulations, highlighting how platform-based work systems create forms of uncertainty and digital control over workers (De Stefano, 2015; Wood et al., 2019).

A systematic review is essential to understand how current literature supports the link between digital skills and employability outcomes for platform workers. This study will conduct a Systematic Literature Review (SLR) and Network Analysis to map trends in DES among gig workers from 2015 to 2025. The focus will be on evidence of DES contributions to employability, examining relevant interventions, and exploring the challenges in developing digital skills. Four research questions (RQs) have been formulated to guide the analysis, listed in Table 1.

Table 1. Research Question

Research Question (RQ)	
RQ1	What are the research trends on digital employability skills among gig workers (2015–2025)?
RQ2	How do digital employability skills contribute to gig workers' employability outcomes?
RQ3	What practices or interventions are effective in building DES for gig workers?
RQ4	What are the challenges and research gaps in developing DES for gig workers?

1.1. Theoretical and Analytical Background

Three main theories serve as the conceptual foundation for this research: Human Capital Theory (HCT), Vocational Employability Enhancement Model (VEES), and Digital Competence Framework (DigComp). First, Human Capital Theory (Becker, 1962) Emphasizes that skills and knowledge are a form of investment that increases individual productivity and economic returns. In the context of the gig economy, this theory explains how mastery of digital skills increases job opportunities, income, and career mobility (De Stefano, 2015; Wood et al., 2019). However, these investments are individual and do not always guarantee job stability, especially when algorithms control the job market and demand fluctuates (Graham et al., 2017).

Second, the Vocational Employability Enhancement Model (VEEM), which is adapted from the CareerEDGE Model of Employability (Dacre Pool & Sewell, 2007; Yorke, 2006). Defines employability as the result of integrating skills, self-reflection, and career development. This model emphasizes the importance of self-efficacy, adaptability, and problem-solving as mediators between

individual competencies and work outcomes. In a digital context, these capabilities enable workers to learn independently, manage technological change, and maintain competitiveness in a platform-based work ecosystem.

Third, the Digital Competence Framework (DigComp), developed by the European Commission (2022), serves as the primary reference for defining the input components of digital employability for gig workers. The framework highlights five core areas of digital skills: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. In addition, in the context of vocational training and non-formal education, the DigCompEdu Framework also complements the role of DigComp by emphasizing digital pedagogical competence, adaptivity, and self-reflection in educators and trainers as reinforcements of technology-based learning processes.

The integration of these three theories forms a logical chain, which is visualized as in the following image:

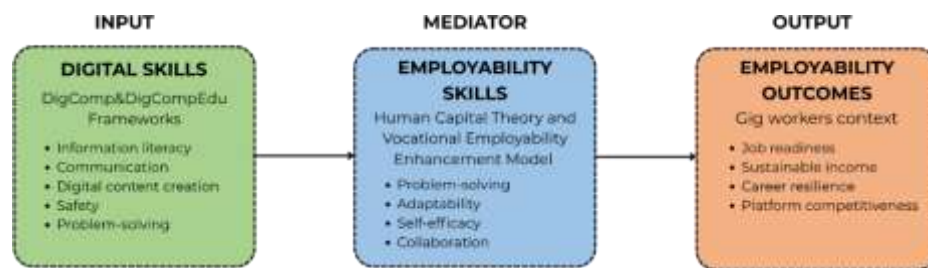


Figure 1. Research Conceptual Framework

Figure 1 illustrates the conceptual framework of the research, which comprises three main domains: digital skills, employability skills, and employability outcomes. The three domains are built on Human Capital Theory, the VEES, and the DigComp. Although further empirical findings identify institutional interventions and structural gap factors that influence the relationship between domains, this conceptual model focuses on the main causal mechanisms that link digital competencies to employability outcomes.

This framework serves as the basis for the thematic analysis and network mapping conducted in this study. Through an input–mediator–output approach, this study identified a pattern of linkages between digital skills and the employability of gig workers. Theoretically, this framework expands on Human Capital Theory by incorporating digital and algorithmic dimensions, while also reinforcing the VEES Model through its application to non-formal work contexts. In practical terms, this framework provides guidance for training institutions and policymakers to design an adaptive and contextual DES development model for gig workers.

2. Research Method

This study uses an SLR approach combined with network analysis, following the PRISMA 2020 guidelines (Page et al., 2021). A dual design was used to address two layers of research objectives: a bibliometric analysis to identify trends, productivity, and thematic evolution of DES research in the

gig economy context (RQ1), and a systematic thematic review to examine empirical contributions, training practices, and research challenges (RQ2–RQ4). This approach follows the recommendations. Donthu et al. (2021) and Snyder (2019) which emphasizes the importance of integrating quantitative and qualitative analysis in developing interdisciplinary studies.

The research consisted of two stages that combined bibliometric analysis and thematic synthesis to produce a mapping of research trends as well as an expanded conceptual framework, as shown in Table 2.

Table 2. Two Stages of Analysis in Research

Stage	Focus of Analysis	Database & Number of Articles	Objective	Output
Stage 1 – Bibliometric Analysis	Trends, thematic evolution, country collaborations, and dominant keywords	Scopus (n=68)	Answering RQ1	Bibliometric maps (network visualization, trend by country, collaboration map)
Stage 2 – Systematic Thematic Analysis	Empirical contributions, development practices, and challenges	Multi-database (n=480, 27 final)	Answering RQ2–RQ4	Thematic synthesis and expanded conceptual framework

3.1. Data Source and Search Query

The first stage utilizes Scopus as the primary source due to its extensive reach and compatibility with Biblioshiny/Bibliometrix software in Rstudio (Aria & Cuccurullo, 2017) and VOSviewer for bibliometric network visualization (Jan & Ludo, 2010). The search query is: ("digital employability" OR "digital skills" OR "digital literacy" OR "ICT skill*" OR "online skill*" OR "digital competency" OR "digital competence*" OR "technology skill*" OR "platform literacy" OR "employability skill*" OR "skill development") AND ("gig economy" OR "gig work*" OR "platform work*" OR "freelance work*" OR "gig worker*" OR "digital labor" OR "independent contractor*" OR "crowdwork*") applies a publication year limit of 2015–2025, article document type, and english language.

The second stage expanded the search to nine databases (Scopus, SpringerLink, SAGE, Taylor & Francis, Wiley, Emerald, ACM Digital Library, Oxford Academic, and JSTOR), resulting in 491 articles that were then screened for duplication and content suitability.

3.2. Screening, Inclusion–Exclusion Criteria, and Eligibility

Article selection was conducted through four stages, as shown in Figure 2. of the 491 articles, 11 duplicates were removed, leaving 480 articles for screening. Initial screening was based on title and abstract to ensure relevance to the topic of DES and the gig economy. Articles that did not discuss gig

workers, did not explicitly link DES, or were not peer-reviewed were excluded from the analysis. To ensure consistency and transparency, a set of inclusion and exclusion criteria was used throughout the article selection process, based on topic focus and publication quality. Table 3 shows the inclusion criteria as follows:

Table 3. Inclusion Criteria

Inclusion Criteria
Focus on gig, platform, or freelance workers who work through digital platforms.
Discussing digital skills, digital literacy, or digital employability in the context of platform-based work
Scopus-indexed, peer-reviewed publications in English, published between 2015 and 2025

Meanwhile, articles discussing general employment issues without an explicit link to digital employability or originating from non-academic sources were excluded. An initial screening process was conducted using Rayyan QCRI (Ouzzani, 2016) to facilitate blind screening at the title and abstract stages. Subsequently, a full-text review and data extraction were conducted manually using Microsoft Excel, containing all selected articles ($n = 27$) along with the results of thematic coding and domain categorization.

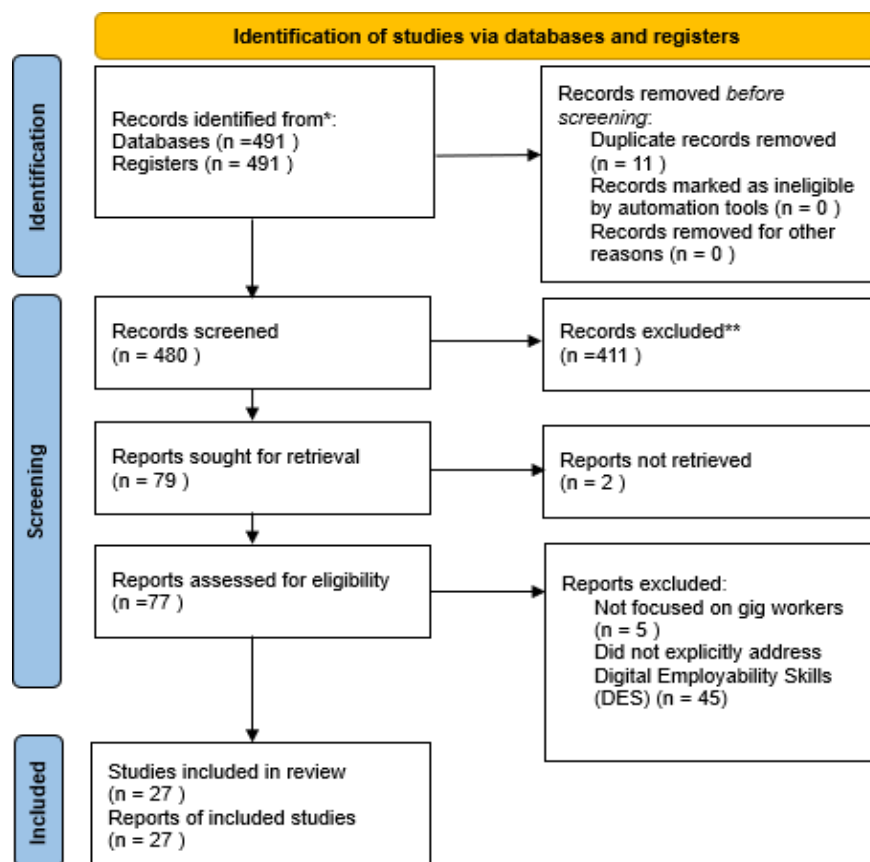


Figure 2. PRISMA Diagram

3. Results and Discussion

3.1. Research Trends on Digital Employability Skills among Gig Workers (RQ1)

A bibliometric analysis of 68 Scopus articles from 2015 to 2025 reveals a sharp increase in publications on DES in the context of the gig economy after 2020. This surge correlates with changes in global work patterns due to the COVID-19 pandemic and the acceleration of the digital transformation of the workforce.

3.1.1. Temporal Trends

The Annual Scientific Production chart, as presented in Figure 3, shows a sharp upward trend after 2020, reaching its peak in 2024. This pattern marks a new wave of research emerging from the pandemic, as the digitalization of work and the adoption of online platforms have increased exponentially. The 2023–2024 period represents a conceptual consolidation phase, during which research begins to shift from descriptive studies to theory-based analysis and digital competency frameworks, such as DigComp and DigCompEdu.



Figure 3. Annual Scientific Production

3.1.2. Geographic Distribution and Collaboration



Figure 4. Country Collaboration Map

An analysis of the cross-country collaboration network, as shown in Figure 4, was conducted to answer RQ 1 regarding global research trends. The results of the analysis indicate that the research network remains concentrated in countries of the Global North, particularly the United States, the United Kingdom, and Australia, which have the highest levels of connectivity. Western European and

Nordic countries, such as Germany, the Netherlands, and Sweden, occupy a middle position, reflecting the stability of collaboration in the digital economy within the region. Meanwhile, there is a growing involvement from Asian and Eastern European countries, signaling an expansion of research focus to developing regions. This pattern suggests that, although DES research remains centered in the Global North, there is now a shift towards more inclusive and global participation, in line with the direction of diversification of research contexts also identified in the thematic analysis of RQ1.

3.1.3. Keyword Network Analysis

The co-occurrence network map illustrated in Figure 5 displays four primary clusters. The first cluster, in green, highlights the interconnectedness of the gig economy, digital literacy, and digital skills, with a fundamental theme that emphasizes digital literacy as a key asset for platform workers. The second cluster, in red, connects employment, commerce, and education, explaining the relationship between digital skills and economic and educational opportunities. The third cluster, in blue, illustrates the issue of professionalization of the workforce through digital labor and labor markets. In contrast, the fourth cluster, highlighted in yellow, emphasizes new research directions, including skills development and the future of work.

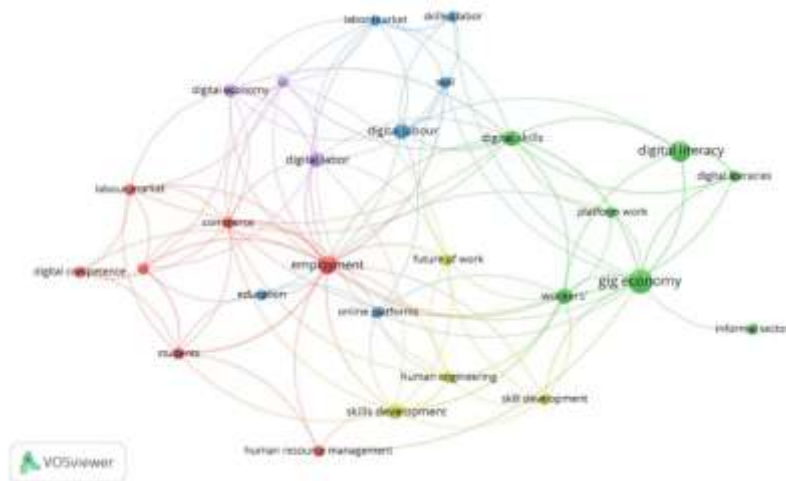


Figure 5. Co-occurrence Network

3.1.4. Thematic Map

The thematic mapping results in Figure 6 show that the gig economy and digital literacy are included in the basic themes category, while employment and digital competence are the driving themes driving theory development. Themes such as AI literacy, the informal sector, and developing countries are emerging as niche areas, with potential for future research in the Global South context. These findings reflect the evolution of DES research from a descriptive to a conceptual approach. Still, it has not sufficiently explored the dimensions of inclusivity, algorithmic fairness, and digital readiness among workers from developing countries.

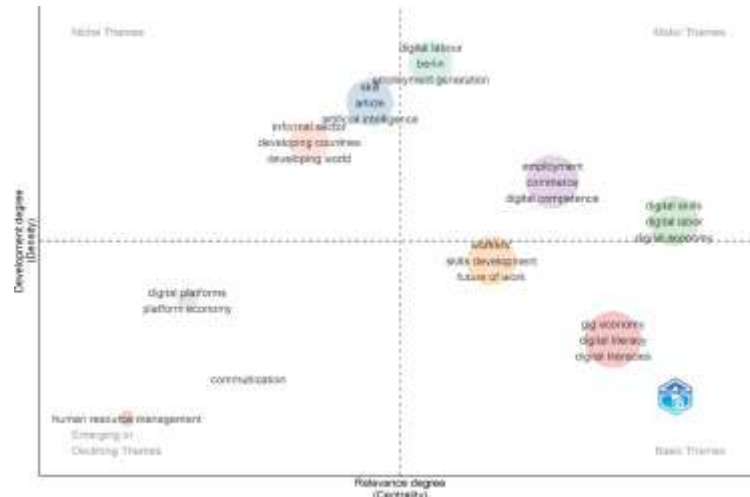


Figure 6. Thematic Map

3.1.5. Synthesis of Findings and Classification of Main Domains of DES

The bibliometric analysis on RQ1 provides an overview of the developmental direction, collaboration patterns, and evolution of DES research themes in the context of gig workers. The shift in research focus from descriptive studies on digital literacy to conceptual issues, such as algorithmic fairness, AI literacy, and the future of work, is evident in the results of thematic mapping. This development aligns with the DigComp Framework, which positions digital literacy as the primary foundation of employability in the algorithmic era. In addition, advanced synthesis analysis was also conducted to further explore how the various components of DES interact with each other and contribute to employability outcomes. As a result, a total of 27 articles that met the inclusion criteria became the basis for discussion in RQ2 to RQ4.

The results of the synthesis group the main concepts into five domains that describe the conceptual relationships in the development of DES, namely: (1) Input, (2) Mediator, (3) Output, (4) Intervention, and (5) Gap. This classification is generated through co-occurrence analysis to determine how often and how strongly certain concepts appear in correlation with each other in various studies. Through this mapping, it becomes clear that the conceptual relationships between the main components of DES exist in various study contexts. The Input, Mediator, and Output domains, as the first three domains, illustrate the mechanism by which DES contributes to employability outcomes and are analyzed in greater depth in RQ2 through mapping relationships between clusters (see Tables 4 and 5). The other two domains, Intervention and Gap, are further discussed in RQ3 and RQ4.

Table 4. Component and Cluster Distribution Table

RQ	Component	Cluster	Code	Frequency	Article
2	Input	Core Digital Skill	IN-DSK-IL IN-DSK-PS	12	1, 5, 7, 15, 27, 4, 8, 10, 11, 14, 17, 22
		Communication	IN-DSK-COM	3	8, 18, 16

RQ	Component	Cluster	Code	Frequency	Article
	Mediator	Adaptability Learning	& IN-DSK-SOC MED-ADAPT MED-SRL	11	7, 10, 12, 14, 15, 16, 20, 21, 25, 26, 27
		Self-Efficacy Motivation	& MED-SE	5	8, 10, 11, 25, 27
		Collaboration	MED-COLLAB	4	14, 17, 22, 23
		Socio-employability	MED-SOCMED-PS	2	13, 23
	Output	Economic Outcome	OUT-SUS	2	1, 2
		Readiness Outcome	OUT-JOB	2	2.5
		Competitiveness	OUT-COMP	2	7, 22
		Resilience	OUT-RES	2	7, 27
	3 Intervention	Organizational & Policy	INT-ORG INT-POL	3	2, 3, 10, 25
		Training Pedagogical	& INT-TRN INT-PED	5	2, 3, 5, 9, 21
Evaluation Inclusion		& INT-EVL INT-INC INT-INF	3	4, 10, 26	
4 Gap	Structural Systemic	& GAP-STR GAP-SOC GAP-ECO	18	2, 4, 5, 6, 7, 8, 9, 10,11, 13, 15, 16, 17, 18, 20, 23, 24, 25	
	Pedagogical Training	& GAP-PED GAP-TRN GAP-LRN	7	3, 5, 6, 9, 12, 13, 20	
	Technological Algorithmic	& GAP-TEC GAP-ALG	10	4, 14, 18, 20, 23, 6, 9, 10, 11, 26	
	Evaluation Resource	& GAP-EVL GAP-RES	3	4, 19, 21	

3.2. The Role and Evidence of DES on the Employability of Gig Workers (RQ2)

Table 5. Input Cluster Connectivity

Source	Target	Link Strength	Relationship Category
Core Digital Skill	Adaptability & Learning	5	Input–Mediator
Core Digital Skill	Self-Efficacy & Motivation	4	Input–Mediator
Core Digital Skill	Collaboration	3	Input–Mediator
Adaptability & Learning	Resilience	2	Mediator–Output
Core Digital Skill	Competitiveness	2	Input–Output
Core Digital Skill	Resilience	2	Input–Output

As shown in Table 5, the strongest relationship exists between Core Digital Skills and Adaptability & Learning (link = 5), indicating that basic digital skills form the primary foundation for developing gig worker employability. Digital literacy and problem-solving skills are crucial for operating online platforms and navigating algorithmic systems (Orth, 2024; Zhang, 2025). In line with the findings in Kazakhstan, the increased use of platforms indicates an acceleration of national digital adaptation (Tolegen et al., 2024). Mastery of core digital skills also helps workers solve technical problems independently and reduce the gender gap when combined with STEM competencies (Fiers, 2024; González et al., 2025; Soriano, 2021). In addition, online communication forms a new digital capital that strengthens productivity and trust between workers (Yao & Liu, 2025).

Prominent connections between inputs and mediators include Core Digital Skills linked with Self-Efficacy and Motivation (link = 4) and Collaboration (link = 3). Adaptability and Learning are emerging as the primary mediators that connect digital training to career advancement (Fiers, 2024; Frenzel-piasentin et al., 2022; Margaryan et al., 2022; Orth, 2024). Workers with high digital literacy tend to exhibit stronger self-efficacy and career motivation (Tolegen et al., 2024), while platform algorithms promote self-reliance and work autonomy (Raval & Pal, 2019; Waldkirch et al., 2021). Additionally, collaboration and socio-employability play vital roles through mentoring and informal learning communities (Keskinen et al., 2022; Soriano, 2021). The establishment of digital trade unions, such as IFAT, enhances civic digital competence and critical thinking skills, particularly in response to automated evaluation systems (Anwar & Graham, 2020; Jha et al., 2025).

The relationship between the Mediator–Output and Input–Output domains in the table illustrates how digital skills contribute to building resilience (link = 2) and competitiveness (link = 2). Workers with strong digital literacy can better adapt to changes in algorithms or disruptions on the platform

(Fiers, 2024; Frenzel-piasentin et al., 2022). Additionally, digital skills have been shown to enhance income and overall well-being (Kaneti, 2025; Petroff & Fierro, 2023). Access to online jobs has also become more widespread, while the skills-to-income pathway is becoming stronger (Kaneti, 2025; Van Slageren & Herrmann, 2024).

Overall, this relationship pattern confirms that core digital skills function as a form of human capital (Becker, 1962) that bridges adaptability, motivation, and work outcomes in algorithmic ecosystems. These findings are also aligned with the DigComp Framework (European Commission, 2022), which places digital literacy and problem-solving skills as critical foundations for transforming skills into sustainable work performance.

The relationship patterns outlined in Table 5 demonstrate that core digital skills are essential for connecting the various adaptive dimensions and work outcomes of gig workers. In addition to the direct connections between input, mediator, and output, network analysis reveals other factors that can either reinforce or hinder these relationships. These factors include Organizational & Policy, Pedagogical & Training, and Evaluation & Inclusion, which highlight the role of institutional and educational interventions in fostering the development of DES. This linkage is illustrated in Figure 7, which also serves as a foundation for discussing RQ3 regarding the nature and effectiveness of these interventions.

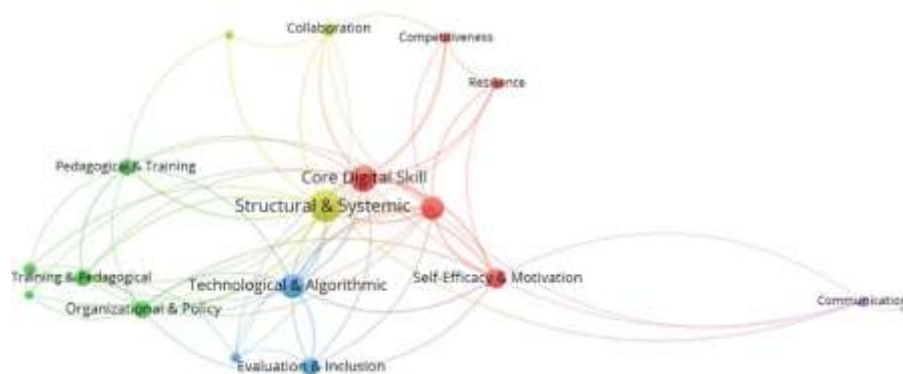


Figure 7. Network of Connectedness DES Components in Gig Workers

This visualization illustrates the interrelationships between DES components from 27 selected articles. Core Digital Skills is seen as the central node connecting the structural and systemic factors with the self-efficacy and motivation domain, indicating that mastery of digital skills plays a crucial role in bridging the systemic gap towards job readiness. On the left side, the Training & Pedagogical, Organizational & Policy, and Evaluation & Inclusion clusters form a cluster of institutional interventions that strengthen the relationship between digital skills and adaptability. Meanwhile, the Collaboration, Competitiveness, and Resilience clusters reflect employability outcomes formed through adaptive and motivational processes. Overall, this map illustrates the dynamic interplay between digital capabilities, institutional support, and systemic barriers in shaping the employability of gig workers.

3.3. Practices or Interventions to build DES for Gig Workers (RQ3)

Based on the extraction results, the number of publications explicitly discussing interventions for developing DES was significantly lower than those focusing on the relationship between digital skills and employability outcomes and the challenges of developing them. This indicates that research on effective training strategies, institutional policies, and pedagogical approaches to strengthen DES remains relatively limited. This situation indicates an empirical gap between the theoretical understanding of the importance of DES and practical evidence in the context of digital work training and policies.

This section examines the practices and forms of interventions in the literature, focusing the analysis on training strategies, institutional policies, and inclusive approaches that enhance digital work readiness across diverse social and economic contexts. Based on the results of the thematic linkage analysis, interventions in the literature do not stand alone but emerge as cross-domain connecting elements between digital skills development (input), adaptive learning processes (mediator), work outcomes (output), and structural factors (gap). The five key linkages with the highest linkage strength are shown in Table 6 below.

Table 6. Intervention Cluster Connectivity

Source	Target	Link Strength	Relationship Category
Evaluation & Inclusion	Core Digital Skill	2	Intervention–Input
Evaluation & Inclusion	Adaptability & Learning	2	Intervention–Mediator
Organizational & Policy	Self-Efficacy & Motivation	2	Intervention–Mediator
Training & Pedagogical	Readiness Outcome	2	Intervention–Output
Training & Pedagogical	Structural & Systemic	3	Intervention Gap

Based on the linkage analysis as shown in the table above, the strongest relationship emerged between Training & Pedagogical and Structural & Systemic (link = 3), indicating that training innovation is often associated with structural reforms and digital work policies. Kaneti (2025) exemplifies a holistic approach through Humans in the Loop (HiTL), which combines multidimensional training, fair work policies, and social advocacy to enhance the employability of vulnerable groups. Donner et al. (2020) highlight the effectiveness of platform-led training for self-employed workers. At the same time, Hackl & Najdi (2024) describe how community-based donor training is working to close the digital employment gap for refugees, although its impact remains

limited. The link between Training & Pedagogical and Readiness Outcomes (link = 2) reinforces the idea that training interventions directly contribute to digital job readiness. A blended learning approach that combines online, face-to-face, and in-workflow learning has been shown to increase the effectiveness and flexibility of the learning process (Donner et al., 2020; Kaneti, 2025).

The findings underscore the pivotal role of policy and organizational interventions in shaping gig workers' self-confidence and motivation within the digital ecosystem. While Tolegen et al. (2024) Although the study did not explicitly evaluate interventions, the results of crowdsourcing mapping in Kazakhstan suggest the need for macro-level policies that support platform regulation and the implementation of fair compensation standards. The three-tiered recommendations, developed through the Platform Career Impact Index, highlight the potential of integrated policies to strengthen income stability and career confidence for digital workers in developing countries. At the organizational level, (2019) presents a platform perspective, demonstrating that platforms act as structural interventions that provide flexibility and alternatives to traditional exploitative work systems. Through this dynamic, workers are encouraged to develop identities as entrepreneurial workers with high self-efficacy, digital risk literacy, and an entrepreneurial orientation that strengthens their adaptability in the platform economy.

These two studies demonstrate the continuity between institutional interventions and individual motivation: macro policies strengthen the sense of security and career opportunities, while structural changes at the platform level shape self-efficacy and the intrinsic drive to persist in a volatile digital job market.

In addition, the relationship between Evaluation & Inclusion and Core Digital Skills and Adaptability & Learning demonstrates the importance of data-driven evaluation and inclusive training in developing adaptive skills. Zhang (2025) emphasizes the need for training designs that consider gender and racial dimensions, while Doggett et al (2024) exemplify community interventions, such as community-driven energy strategies, that help maintain the sustainability of digital work amid the energy crisis. Continuously, these results demonstrate that interventions serve as a multidimensional mechanism that combines training, policies, and social evaluation to enhance the employability and resilience of gig workers in the face of digital economic shifts.

3.4. Research Challenges and Gaps (RQ4)

Table 7. Gap Cluster Connectivity

Source	Target	Link Strength	Relationship Category
Structural & Systemic	Core Digital Skill	8	Gap–Input
Technological & Algorithmic	Core Digital Skill	4	Gap–Input
Structural & Systemic	Adaptability & Learning	6	Gap–Mediator

Source	Target	Link Strength	Relationship Category
Technological & Algorithmic	Evaluation & Inclusion	4	Gap–Intervention
Pedagogical & Training	Training & Pedagogical	3	Gap Intervention
Structural & Systemic	Readiness Outcome	2	Output Gap

The relationship analysis in Table 7 shows that the Structural & Systemic Gap is the strongest link, particularly for Core Digital Skills (link = 8) and Adaptability & Learning (link = 6). These barriers are rooted in inclusive training policies and limited digital infrastructure, which impact job readiness and overall employment opportunities. Meanwhile, the Technological & Algorithmic Gap is related to biases in algorithm-based evaluation and control systems, deepening access inequality. The Pedagogical & Training Gap, on the other hand, encompasses barriers to transferable digital training that are relevant to the needs of a dynamic digital market.

Several cross-border studies emphasize that the primary factor influencing the development of DES is structural barriers (Beier et al., 2025; Kaneti, 2025; van Slageren & Herrmann, 2024; Zhang, 2025). Income uncertainty and limited worker mobility as a result of rampant institutional inequality, weak policy support, and unclear digital market regulations. The lack of flexible certifications, combined with social factors such as age, migration, and gender, further exacerbates the employability gap. In the Global South, reliance on donors, lack of social security, and bias against educated youth exacerbate digital exclusion (Anwar & Graham, 2020; Tolegen et al., 2024). Eventually, the promise of digital work flexibility turned into a new form of structural control.

In addition, the study also identified systemic limitations to ongoing training for digital workers, particularly for migrant workers who face language and digital literacy barriers (Fiers, 2024; Kowalik et al., 2024; Orth, 2024). Furthermore, workers with disabilities in the context of remote work also show significant gaps in digital competency and access to training (Sutherland & Dunn, 2020). This expands the dimensions of digital exclusion to include accessibility and adaptive training needs. This further widens the gap between local and migrant workers, reduces inclusive employment opportunities, and reinforces social stratification.

Algorithm-based work monitoring replaces traditional managerial functions and suppresses worker autonomy. (Rani & Furrer, 2019; Waldkirch et al., 2021) Age and gender bias in the evaluation system narrows job opportunities and reinforces the exclusion of vulnerable groups (Yao & Liu, 2025). In many developing country contexts, low technological literacy and digital infrastructure hamper the effectiveness of training interventions (Doggett et al., 2024; Hackl & Najdi, 2024). In addition, from an individual perspective, workers often sign digital contracts without understanding algorithmic systems and their associated digital rights, indicating a lack of algorithm literacy and accountability (Fiers & Hargittai, 2023; Jha et al., 2025). As a result, digital participation remains unequal, and control of work shifts from formal institutions to algorithms.

Pedagogical and resource limitations indicate a weak integration between formal and informal training. Many programs fail to produce skills that are both portable and sustainable (Donner et al., 2020; Margaryan et al., 2022). In addition, the future work learning system still faces conceptual gaps in the implementation of lifelong learning and self-directed upskilling, which have not been effectively integrated into training design (Beier et al., 2025). Furthermore, existing research still lacks quantitative approaches and theoretical frameworks that are appropriate for the context of platform work (Kim et al., 2023; Singha & Saikia, 2024). This gap highlights the need for contextual training design and evaluation models that are adaptive to the digital work ecosystem.

3.5. Empirical Framework of Findings

The synthesis results of RQ2-RQ4 were used to develop an empirical framework that describes the formation of DES through multilevel interactions between individuals, organizations, training, and systemic factors. This framework integrates the domains of input, mediator, output, intervention, and gap to explain the mechanisms that promote or inhibit employability development in the context of the gig economy.

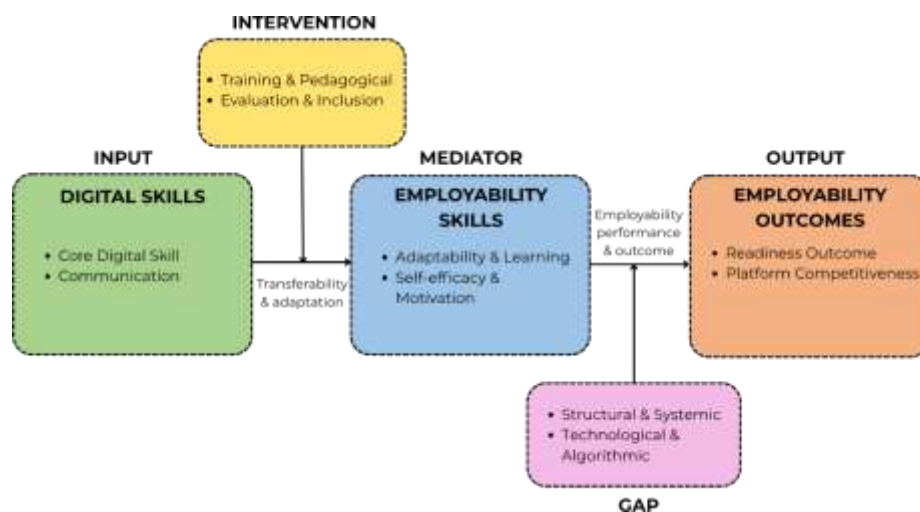


Figure 8. Empirical Framework DES for Gig Workers

Figure 8 demonstrates how each domain works simultaneously and influences the others. As primary input domains, Core Digital Skills and Communication provide the technical and cognitive foundations that enable workers to navigate digital platforms effectively. These skills stimulate adaptive abilities, self-directed learning, and motivation, which then form the mediators of adaptability and learning, as well as self-efficacy and motivation. Both act as transformative bridges that enable workers to transfer digital skills into sustainable performance and job readiness.

Furthermore, Training & Pedagogical, as well as Evaluation & Inclusion, serve as intervention domains that strengthen the relationship between inputs and mediators. Data-driven training, policy, and evaluation interventions accelerate employability by expanding access, supporting contextual learning, and improving digital equality. However, this process is not barrier-free. Two gap categories—Structural & Systemic and Technological & Algorithmic—emerged as dominant inhibiting factors that limit the intervention's positive effects.

Conceptually, the synthesis results of RQ2–RQ4 demonstrate that Human Capital Theory provides the economic foundation for digital skills, and the VEES Model explains the mechanisms of reflective and adaptive learning. At the same time, the DigComp Framework offers a competency structure that can be operationalized in policy and training. The integration of these three theories forms the DES–Employability Cycle, which emphasizes that the sustainability of digital employability depends on the synergy between individual readiness, institutional support, and structural reforms in the algorithm-based work ecosystem.

The findings of this study confirm that the development of DES in gig workers is multidimensional and occurs through the simultaneous interaction of individual, pedagogical, institutional, and structural factors. Theoretically, these results extend Human Capital Theory (Becker, 1962) by emphasizing that the economic value of digital skills depends on an individual's adaptive and reflective abilities. Integration with VEES (Pool & Sewell, 2007) strengthens the role of self-efficacy, lifelong learning, and social collaboration as mediators that transform digital skills into sustainable work outcomes. Furthermore, these results confirm the relevance of the DigComp Framework (European Commission, 2022) as a universal reference for understanding the relationship between digital literacy, problem-solving, and algorithmic abilities in platform-based work contexts.

Practically, these findings suggest that adaptive, context-based digital training can strengthen the pathway between core digital skills and employability outcomes such as readiness, resilience, and competitiveness. However, these positive effects are heavily influenced by systemic factors such as regulation, policy support, and equitable access. Institutional inequalities, algorithmic bias, and limited digital infrastructure in rural areas and developing countries continue to deepen participation gaps. Therefore, DES development strategies must be understood not simply as skills interventions, but as socio-economic instruments to increase inclusion, digital equity, and equal participation for all groups of workers, including women, migrants, rural communities, and people with disabilities.

4. Conclusion and Recommendations

This study identifies the evolution of DES research on gig workers (2015–2025) and maps the mechanisms of digital employability formation through five domains: input, mediator, output, intervention, and gap. The synthesis of results shows that core digital skills serve as a key foundation that stimulates workers' adaptive, reflective, and collaborative abilities, while institutional interventions strengthen the process of converting skills into sustainable work performance. However, structural and algorithmic barriers remain significant obstacles that hinder the impact of training and exacerbate digital inequalities, particularly among vulnerable groups. Holistically, the results of this study illustrate the cyclical mechanism between digital skills mastery, adaptive abilities, and institutional interventions in strengthening the employability of gig workers.

This study is limited by its scope, which only includes Scopus-indexed articles and covers the period from 2015 to 2025. Therefore, it may not represent the full range of digital training practices in non-formal contexts. Furthermore, this study did not conduct a quantitative meta-analysis due to the heterogeneity of the research designs. Nevertheless, the results of this SLR provide a strong theoretical

and conceptual foundation for further research on DES development strategies for a broader segment of digital workers.

Recommendations from the research include the need for the government and platform providers to develop inclusive digital employment policies based on principles of fairness, transparency, and algorithmic accountability. Social protection, fair compensation, and cross-sector recognition through formally recognized micro-credentials must be incorporated into the policies. Regulations must also incorporate principles of gender equality, access for migrant workers, support for rural communities with limited infrastructure, and accommodations for workers with disabilities to ensure equitable digital participation.

Furthermore, vocational training and higher education institutions need to integrate adaptive microlearning, project-based learning, and community mentoring approaches to encourage reflective and sustainable learning. Training programs should also be based on the local socio-economic context and facilitate access for vulnerable groups by providing support for language training, digital literacy, and inclusive tools. Collaborative learning models between communities (peer mentoring) should also be adopted because they have proven effective in increasing self-efficacy and digital career resilience. Furthermore, recommendations at the technological and design levels include designing algorithmic systems that are transparent, bias-free, and adhere to digital accessibility standards. Training technology should be user-centered, with disability-friendly interfaces and adaptive learning modules, and accessible in areas with limited connectivity.

Future research is expected to develop a quantitative and longitudinal evaluation framework capable of assessing the causal relationship between digital training interventions, employability outcomes, and social justice. Comparative studies across countries and genres are necessary to understand variations in DES development and identify the most effective strategies for countries in the Global South to establish equitable and inclusive digital work ecosystems.

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