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Original Research Article

Digital Skills and Human–Technology Collaboration for Augmented Supply Chain Workforce Transformation in Saudi Arabia under Vision 2030

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Abstract: Digital transformation is altering the work of planners, purchasers, warehouse specialists and transport coordinators, although the ability to use new systems is often confused with the ability to work smartly with them. This integrative analysis investigates the role of digital skills development and human technology collaboration in facilitating the transformation of the augmented supply chain workforce in Saudi Arabia within the framework of Vision 2030. A systematic thematic synthesis of 30 peer reviewed materials published between 2020-2025 separates foundational digital fluency, domain specific analytical competence, collaborative judgement and responsible technological oversight. The review finds ways via which talents become operational value: comprehensible decision assistance, role redesign, feedback rich learning and cross organisational coordination rather than arguing that automation immediately boosts labour performance. It offers a framework relating worker preparedness, system affordances, governance circumstances and quality adjusted performance, from capability to cooperation. Cautious interpretation of international manufacturing and logistics evidence for the Saudi context. The research finds that training investments should be evaluated on the basis of observable changes in decision quality, workload distribution, resilience and career mobility rather than on attendance or software usage alone.

Keywords: Human Technology Partnership, Digital Skills, Supply Chain Workforce, Industry 5.0, Saudi Arabia, Vision 2030, Workforce Augmentation.

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1. BACKGROUND

Digital platforms are playing an ever more important role in procurement, freight coordination, inventory replenishment, supplier appraisal and production planning. Supply chain workers are now using predictive dashboards, digital twins, automated document checks and algorithmic recommendations along with traditional corporate software. These tools can uncover dependencies that were previously invisible, but the availability of these tools does not ensure that workers can understand evidence, coordinate exceptions or contest improper judgements. A logistics professional may grasp how a forecasting interface functions, without understanding the contractual implications of modifying an order. Alternatively, an experienced planner may be aware of supplier limits but lack the analytical confidence to probe a machine generated

scenario [1–3]. Workforce transformation occurs at the convergence of these capabilities; it does not happen only by buying technology.

Saudi Arabia is a consequential setting for this argument. Vision 2030 integrates logistical development with economic diversification, digital services, industrial competitiveness and labour involvement. The aspirations cover organisations of different sizes and digital maturity, including large infrastructure providers, industrial suppliers, freight intermediates and small contractors. Their personnel work in geographically distant sites, spanning linguistic interfaces and regulatory boundaries. The national task is not simply to increase the number of technology-trained people, but to build distributed competence to support dependable coordination across supply networks. Saudi study on skills for the future workforce indicates that online literacy, adaptability and collaboration are essential elements of preparedness, while logistics scholarship reveals an increasing focus on technology and sustainability [15, 16].

A fundamental conceptual problem in the digital supply chain discussion is the combination of automation, augmentation, and replacement. Automation is the delegation of human tasks to software or machines. Augmentation modifies what workers can see, assess and do, but leaves consequential judgement with recognised professionals. Replacement is the removal of a human position or task and should not be assumed just because electronic devices are coming into an enterprise. For instance, automatic proof of delivery matching might remove repetitious transcription, but it may also raise the need to investigate discrepancies. Even if the person has to enter fewer transactions manually, their contribution may be more useful. Human-centred approaches consequently explore how competence, autonomy, safety and learning change with information technology [3–5].

2. Conceptual Underpinnings and Contribution to Research

This review defines digital skills as a layered set of competences that enables a worker to receive, interpret, safeguard and act upon digitally mediated information in a specific occupational situation. Basic application fluency is important, but not adequate. The higher layers include data reasoning, model literacy, cybersecurity judgement, workflow comprehension and the capacity to integrate technical results into collaborative operational choices. Logistics competence remains essential: a technically accurate algorithm can produce an operationally unsatisfactory choice because it has not taken into account supplier reliability, customs limits, equipment criticality or customer objectives. The research thus supports the combination of commercial, logistical, digital and human competence domains, rather than regarding digital talent as a separate technical qualification [1-13].

Human-technology collaboration is the reciprocal adaptations of workers and digital systems. An effective arrangement means people can understand recommendations, appropriately accept or veto them, contribute adjustments, and modify procedures as circumstances change. This is different from a superficial human in the loop setup where an employee is requested to approve outputs without sufficient time or evidence. Studies on collaboration architectures and human centric artificial intelligence indicate that explanation, feedback and allocation of decision rights are required design elements, not optional usability features [6–9]. The special contribution of this review is to link those features to supply chain occupational learning, and to differentiate competence development from quantitative operational augmentation.

The unit of analysis is important. Workers has individual capabilities but collaborative competence is derived from relationships, processes and technological interfaces. A capable employee may be unable to act if a corporation withholds data or penalises overrides. In contrast, well designed systems may not function when staff lack the confidence to evaluate their outputs. Thus the analysis examines workforce augmentation as a collectively produced organisational consequence rather than a total of training certificates [3-7].

3. Goals, Objectives and Research Questions

The purpose is to build an evidence based explanation of the interaction between digital skills and human technology collaboration to enable sustainable transformation of supply chain jobs in Saudi Arabia. Five objectives guide the review: to identify the competency bundles needed for augmented supply chain roles; to compare technological support against the remaining need for contextual judgement; to explain organisational conditions that transform training into collaborative capability; to evaluate risks of exclusion, deskilling and overreliance; and to develop a measurable implementation framework relevant to Vision 2030. The guiding research issues are: what skills matter at different decision points, when should machines recommend rather than execute, how can learning be coordinated across supply networks and what evidence would show real improvement in worker and system results. It is not a general assessment of national artificial intelligence investment [10–12], but an emphasis on workforce change.

4. METHODOLOGY REVIEW

A structured integrative review was used because the study question spans operations management, logistics education, human factors and information systems. These literatures employ varied methodologies and outcome measurements and hence statistical pooling is premature. The review nonetheless proceeds by critical thematic synthesis, contrasting conceptual mechanisms and empirical qualifications. A replicable search strategy was established around four overlapping domains: (i) digital competence and learning, (ii) human AI or human robot collaboration, (iii) supply chain or logistics vocations, and (iv) Saudi or equivalent industrial change. Representative combinations were ("digital skills" OR "upskilling" OR digital literacy) AND ("supply chain" OR "logistics") AND ("human–machine collaboration" OR "Industry 5.0" OR "decision support"). Separate targeted searches retrieved relevant Saudi papers as well as core scholarship on digital supply chain design.

The eligibility window was January 1, 2020 - December 31, 2025. Eligible articles were scholarly research that made a recognisable contribution to competence development, human-centric operational systems, technology acceptance, supply chain performance or Saudi skills requirements. Studies that just examined prediction accuracy without an occupational or organisational relevance were not considered as direct evidence of worker outcomes. Studies of logistics workers were separated from those of similar operational activity and from larger conceptual contributions by a three-tier relevance rule. This structure ensures that incorrect transmission from manufacturing robot experiments to procurement or transport coordinators is prevented. The last collection includes 30 DOI identified publications that were purposefully chosen. It is a purposive critical corpus not a claim that all relevant database records were retrieved.

The review addressed the research context, major construct, study methodology, reported mechanism, practical boundary, and transferability to Saudi supply chains for each source. Concepts were iteratively coded as skills, interaction design, organisational learning, governance and outcomes. Rather than averaging out contradictory meanings, they were retained: technology may relieve physical strain but enhance cognitive monitoring; greater transparency may improve coordination but encourage surveillance. The theoretical recommendations were delinked from the empirical evidence, and the findings of non-Saudi organisations were read as transferable hypotheses rather than proven local impacts. There was no database export, independent dual screening record or formal risk-of-bias evaluation available and retrieval totals, agreement coefficients and certainty scores are not fabricated. These restrictions define the evidential assertions of the review [9–22].

5. Digital Competence Architecture for Supply Chain Vocations

The first thematic finding is that logistics workforce readiness is built on layers. Being digitally literate means that employees can enter, find and share records across enterprise applications. Information literacy means they can identify incomplete, stale or inconsistent records. Analytical literacy means they can interpret forecast intervals, lead-time dispersion and exception patterns. Domain expertise is then used to determine the feasibility of a proposed route or replenishment instruction. Finally, relational capabilities enable workers to negotiate trade-offs between customers, suppliers, carriers and maintenance teams. Koh and Yuen's competency synthesis and Modgil and colleagues' prioritisation explain why managerial and operational skills cannot be secondary to high technical capabilities [1, 2].

These layers should be evaluated using genuine tasks and not generic software certificates. A buying officer could be good with spreadsheets, but miss a deceptive supplier score that encourages short lead times over qualification status. An inventory controller may perfectly understand a statistical prediction but they may not have the power to fix a critical-stock imbalance. Competence evaluation should therefore include genuine scenarios with missing fields, competing aims and confusing evidence. Workers should be asked not only what a system advises, but also why the recommendation may fail, who has to approve a deviation and how the decision should be documented. Such assessment reflects expert opinion that short classroom examinations can not capture [5-14].

The combination of competencies also varies by job level. An entry level logistics coordinator needs to be reliable with data processing, document logic, security awareness and escalation discipline. Analysts require interpretation of scenarios, mapping of processes and testing of assumptions. The involvement of team leaders in collaborative workload design, conflict resolution and the assessment of the impact of automation is necessary. Senior executives require investment analysis, data governance, supplier inclusion and workforce change planning. There is no plausible universal ranking of abilities across these roles: the relevance of machine learning literacy to a route planner is not the same as its usefulness to a dangerous-goods compliance specialist. Thus, occupational maps need to be

updated as operational systems and external obligations grow [1-15].

Cybersecurity capacity has a specific vocational character. Employees may detect a dubious email, but may not have systems in place to check a changed supplier bank account or a doctored delivery instruction. Training should therefore relate identity verification, access control and information security with the economic activities that employees actually authorise. Testing using scenarios that are realistic but safe can show whether staff know how to pause a transaction, retain evidence and engage the security function without unduly delaying legal processes [1-30].

Another hidden element of competence is data quality. A planning model may use lead times from incomplete supplier records, while a warehouse dashboard may use inconsistent material identification. Professionals should be able to identify the origin, definition and limitations of the data input. The goal is not to make every logistics coordinator into a data engineer. It is to acquire sufficient diagnostic literacy to know when the system's apparent precision surpasses the evidence available. This competence connects operational experience with analytical caution [6-19].

Table 1: Digital competence and collaboration needs based on occupation

Capability	Representative skills	Operational relevance	Evidence
Foundation	Data entry, information hygiene, identity verification	Document accuracy; trusted system use	[1-14]
Analytical	Uncertainty interpretation, scenario comparison, data provenance	More reliable exceptions and forecasts	[2-18]
Domain	Transport constraints, sourcing logic, inventory criticality	Operationally feasible decisions	[1-17]
Collaborative	Explanation, negotiation, escalation and feedback	Coordinated human–system response	[3-24]
Governance	Override justification, privacy and accountability	Safer delegation and auditability	[20-29]

6. Forms of Human–Technology Collaboration

Collaboration exists on a continuum between information assistance and autonomous action. At the least intrusive level, technology displays signals without directing choices. Decision support ranks alternatives and shows predicted consequences. Shared control allows employees to accept a proposed action within explicit constraints. Unattended execution may be suitable only for repetitive and reversible tasks with reliable data and clear escalation rules. The critical design principle is to allocate tasks according to uncertainty, reversibility and consequences rather than technological novelty. Human centric manufacturing models provide language for this division, but energy, freight and procurement operations add contractual, regulatory and interorganisational considerations [5–8].

A transport planner, for instance, may use optimisation software to compare vehicle assignments, loading limitations and delivery windows. The model can rapidly process combinations that a person cannot inspect manually, but it may omit the practical reliability of a specific subcontractor or the receiving site's access arrangements. The planner needs an explanation of binding constraints and an auditable override pathway. Unexplained recommendations may encourage indiscriminate rejection, whereas persuasive but wrong outputs may induce automation bias. In both circumstances the failure is relational: workers are neither appropriately supported nor equipped to supervise the system. Effective collaboration requires calibrated trust rather than maximum compliance [6-26].

Warehouse robotics illustrates an adjacent but distinct case. Machines may lift, move or identify stock while employees perform exception handling, sequencing and safe recovery. Evidence from industrial human robot collaboration cannot be transferred uncritically to every warehouse because workspace layout, task variability and safety regimes differ. Nevertheless, it reinforces two broadly relevant propositions: interfaces must make system state legible, and operators need training for abnormal conditions rather than only normal throughput. Collaboration should be judged by combined human-system performance, including incident exposure, fatigue, recovery time and quality, instead of robot utilisation alone [8-26].

Collaborative interfaces must distinguish confidence from authority. A probability estimate summarises model uncertainty but does not grant permission to depart from a contract or safety requirement. Software should show the recommendation, its material assumptions, relevant constraints and the person responsible for the

ultimate choice. Workers should be able to record a challenge in a way that supports learning rather than being treated automatically as noncompliance. The broader evidence on human-centric tensions indicates that trust, autonomy and accountability can conflict during implementation, requiring deliberate governance [6-21].

7. Learning Mechanisms and Workforce Augmentation

The second major finding is that training transfers into performance only when work organisation allows new skills to be exercised. A short course in data visualisation will have limited value where staff cannot access trusted event data or have no authority to change decisions. Conversely, access to an intelligent dashboard can amplify capability when supervisors encourage workers to test assumptions, discuss exceptions and record learning. Professional development research identifies peer networks, communities of practice and organisational commitment as important enablers, suggesting that training delivery should be integrated with everyday tasks [13, 14].

A productive learning sequence begins with understanding the operational problem, not the tool interface. Employees examine a real process, identify decisions and data requirements, practise with simulated exceptions, then participate in supervised deployment. After implementation, errors and rejected recommendations become learning material. Cross functional reviews allow procurement, inventory and transport personnel to understand how their choices create downstream consequences. These feedback loops also help technology teams improve data definitions and algorithms. Merely counting training hours or licences issued cannot establish whether such organisational learning is taking place [2-13].

Augmentation should create professional pathways rather than a permanent division between technology designers and passive users. Front line workers often possess tacit knowledge about seasonal congestion, carrier behaviour and informal coordination that models cannot infer reliably from incomplete records. Structured participation in system design can convert this knowledge into explicit constraints while preserving the employee's capacity to challenge recommendations. Without opportunities for progression, automation may remove the routine tasks through which junior staff previously learned foundational logistics judgement. Organisations therefore need mentoring, rotation and scenario based instruction to compensate for reduced exposure to simple cases [3-21].

An effective organisational learning system must also address turnover. When experienced planners leave, informal knowledge about customers and carriers often disappears. Documenting exceptional decisions and explaining why a recommendation was rejected can preserve some of that judgement without creating a rigid rule for every situation. Shared case libraries should be curated, anonymised where needed and reviewed for relevance, so that outdated practices do not become permanent algorithmic assumptions. Learning infrastructure is thus part of both operational resilience and talent continuity [2-13].

8. From Skills to Supply Chain Performance

The pathway from skills to performance has multiple mediating stages. Better data literacy can reduce misclassification; better judgement can prevent inappropriate substitutions; effective interfaces can accelerate coordination; and shared understanding can improve resilience during disruption. These are mechanisms, not guaranteed outcomes. Research on Industry 5.0 associates human centred design with supply chain visibility, responsiveness and operational viability, while digital twins support scenario analysis rather than replace operational responsibility. The effectiveness of these technologies depends on data fidelity, organisational response and the quality of the decisions taken after a warning is issued [4-19].

Performance assessment should consequently separate individual learning outcomes from operational metrics. A worker may complete advanced training but encounter no suitable system in which to practise. A team may reduce handling time while another department absorbs correction work. Meaningful measures include first time right completion, quality-adjusted tasks per staff hour, exception resolution accuracy, service reliability, supplier coordination and the time required to recover from disruptions. To avoid misleading claims, evaluations should stratify cases by complexity and track changes in workload across the entire process. Survey associations are informative but cannot, by themselves, demonstrate causal improvement following a training programme [17-28].

One further consideration is the distribution of gains. An algorithm may make experienced analysts more effective while increasing entry barriers for workers with limited digital access. A highly automated exception queue can also concentrate difficult decisions among a small group of specialists. Productivity indicators should capture whether new workloads are sustainable and whether staff gain discretion and career mobility. Social sustainability and operational efficiency need not

conflict, but they can diverge when management uses surveillance style metrics or rewards speed independently of safety and accuracy. The human centric literature repeatedly warns against measuring technological progress without examining occupational consequences [10-29].

Service outcomes can be difficult to attribute when a logistics organisation introduces several reforms simultaneously. Process redesign, new suppliers, revised staffing and changes in demand may coincide with technology deployment. Evaluations should therefore retain a plausible counterfactual and document concurrent interventions. Interrupted time-series comparisons or staggered rollouts can be more informative than an uncontrolled survey of employee satisfaction. Qualitative case evidence is needed to explain why similar investments produce different results across occupational groups [17–28].

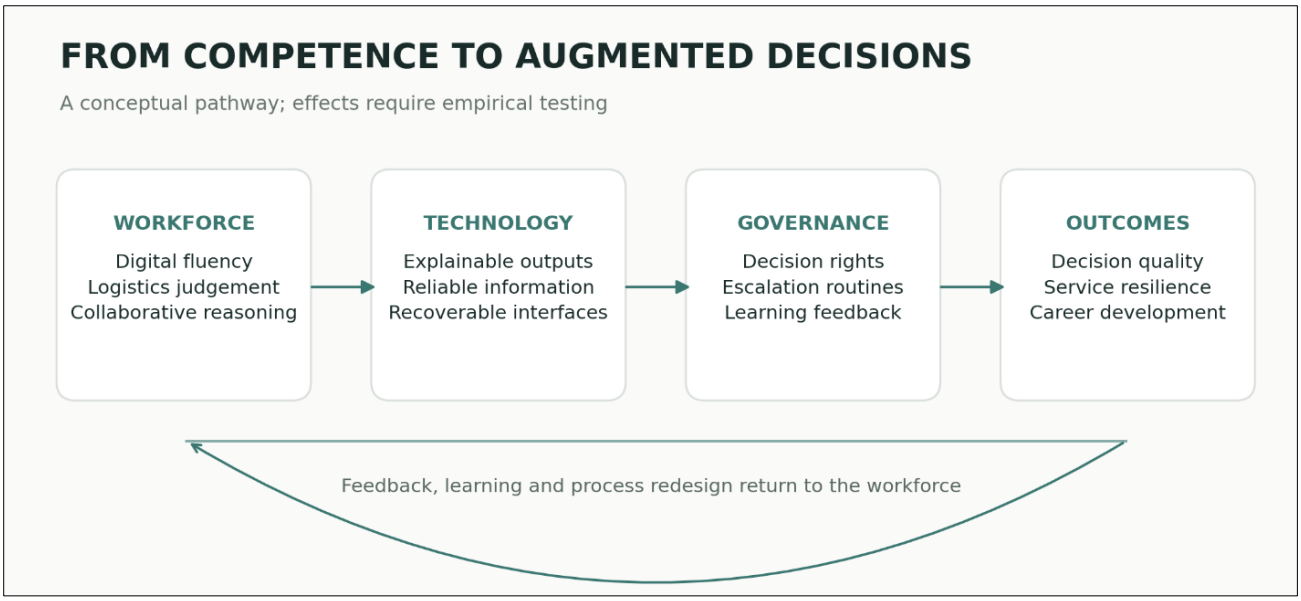


Figure 1: Proposed competence-to-collaboration pathway. Original conceptual synthesis; arrows indicate hypothesised mechanisms

9. Saudi Arabia: Transferability and Vision 2030 Alignment

Saudi Arabia's transformation agenda provides an institutional rationale for connecting logistics digitisation to workforce capability, but it does not remove contextual differences among employers. Major operators may finance data platforms and specialised training, whereas subcontractors and smaller carriers may rely on inconsistent spreadsheets or customer specific portals. Programmes designed for digitally mature organisations could unintentionally exclude smaller suppliers. A sector wide capability strategy should therefore combine common data standards, accessible training, portable credentials and affordable routes to system participation. These are policy implications derived from the literature, not claims of measured national programme success [15-30].

Local implementation should also recognise differences in language, education, occupational licensing, shift patterns and connectivity. Remote industrial sites may experience unreliable access to cloud services; international freight teams navigate customs, shipping documentation and jurisdiction specific standards. Training materials must address these situations directly rather than rely on generic examples of automated retail warehouses. A collaborative team may need multilingual interfaces, clear handover conventions and defined responsibilities when an algorithm conflicts with a safety procedure. Research on Saudi future ready skills provides an initial basis for discussing preparedness, but sector-specific longitudinal evidence remains limited [15, 16].

A defensible contribution to Vision 2030 would be demonstrated through improvements in employability, operational reliability, digital knowledge transfer and participation across the supply network. Policymakers should therefore distinguish headline enrolment targets from measured competence. Institutions can collaborate with employers on authentic cases involving demand planning, supplier due diligence, customs workflows and sustainable freight choices. Certification should indicate demonstrated capability to interpret evidence and coordinate action, rather than simple exposure to a named software product. Partnerships between vocational educators, universities, logistics firms and technology providers could develop

interoperable skills standards while retaining flexibility for occupational specialisms [1-16].

Small suppliers deserve attention because digital compliance can generate unequal costs. A large customer might require electronic invoicing, live consignment updates and standardised product records, yet a small contractor may lack specialised integration staff. Transitional interfaces, shared onboarding support and proportionate information requirements may improve participation without weakening assurance. Research should compare digital capability development across firm sizes to determine whether integration actually broadens market access or unintentionally concentrates business among already sophisticated providers [16-30].

Local workforce transformation also requires careful communication about automation. Employees may interpret a digitisation initiative as a threat if managers describe only headcount savings. Credible change programmes explain which activities will change, which decisions remain human and how new skills support professional progression. Participation in pilot design is particularly important where practical knowledge is distributed across operators, dispatch teams and external transport partners. This gives the programme a stronger basis for trust and operational improvement [3-15].

10. Integrated Capability-To-Collaboration Framework

The proposed framework links four layers: occupational digital competence, usable system affordances, collaborative decision governance and observable performance. Competence comprises information judgement, analytics, logistics expertise and interpersonal coordination. System affordances include interpretable recommendations, reliable master data, traceability and recoverable workflows. Governance establishes decision rights, feedback practices, cybersecurity controls and escalation thresholds. Outcomes combine service quality, resilience, employee development and workload sustainability. Figure 1 depicts these relations as a sequence with reciprocal learning, not as a claim that any single variable determines productivity [2-24].

Two contingencies govern the framework. First, task criticality determines the acceptable degree of automated autonomy: a low consequence document check differs from a decision affecting hazardous goods, product conformity or equipment safety. Second, organisational maturity determines whether digital competence can be exercised meaningfully. A skilled employee cannot compensate indefinitely for missing identifiers and conflicting systems. Conversely, technically sophisticated platforms cannot compensate for inadequate training or unclear authority. This interaction explains why similar technologies can produce different workforce outcomes across firms and why transferability must be assessed at task and organisational levels [5-30].

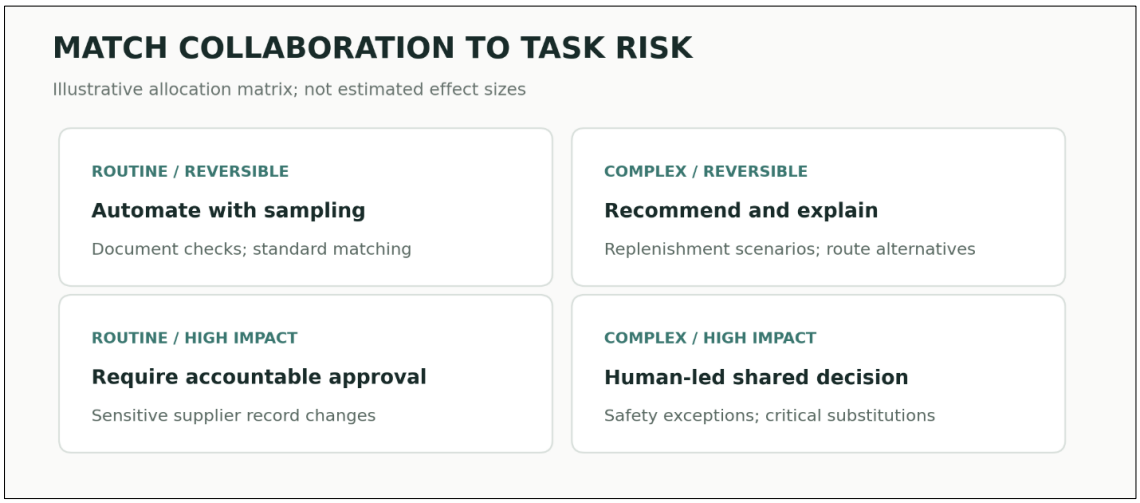


Figure 2: Risk-sensitive allocation of human and technological decision authority. Original conceptual illustration

11. Research Gaps and Agenda

First, few studies directly observe how logistics workers develop new judgement during repeated encounters with AI recommendations. Controlled experiments might establish whether explanation tools improve immediate task accuracy, but longitudinal fieldwork is needed to examine retention, confidence and evolving role boundaries. Second, the relationship between training format and occupational transfer remains unclear. Comparative studies could evaluate formal courses, coached workplace practice and peer learning using

comparable logistics scenarios and delayed assessments. Third, the distribution of benefits across employment groups requires attention, including entry level workers, older employees and staff in small subcontractors. Researchers should disaggregate outcomes rather than report a single aggregate productivity gain [1-21].

Fourth, Saudi supply chain research would benefit from matched studies across ports, industrial estates, freight operators and procurement functions. A staggered introduction of decision support tools could compare performance before and after training, while documenting simultaneous process changes. Data could include system logs, exception categories, safety observations, structured interviews and worker retention. Fifth, scholars should distinguish human AI collaboration from human robot collaboration rather than assume shared mechanisms. The former often concerns information credibility and accountability; the latter additionally involves physical proximity, ergonomics and occupational safety. Neither can be captured adequately by a single adoption index [7-28].

A further methodological gap concerns measurement of cognitive workload. Time savings from automated classification can be offset by continual alert monitoring or the need to check opaque recommendations. Research designs should combine event based productivity records with validated workload measures and observation of employee interruptions. This would help separate beneficial assistance from the redistribution of attention costs. Studies should report negative as well as positive outcomes, especially when technology changes the balance between routine work, analytical demands and staff autonomy [20-25].

Future investigations should also examine whether portable credentials improve mobility between logistics employers. A qualification can signal course completion without revealing the ability to coordinate a complex shipment or interrogate faulty data. Competency based assessments using authentic scenarios may offer stronger evidence, particularly when industry bodies agree on common performance standards. Researchers could evaluate these credentials against supervisor assessments, progression and retention over time [1-14].

Table 2: Critical evidence synthesis and transferability boundaries

Evidence stream	Research approach	Interpretive contribution	Sources
Role-focused skills research	Literature synthesis and multi-criteria prioritisation	Competence bundles extend beyond tool proficiency	[1,2]
Human-centric system research	Architecture, modelling and reviews	Interpretability and decision rights mediate collaboration	[5–9]
Supply chain performance studies	Surveys, conceptual models and digital twins	Visibility can support coordination; causality varies	[17–28]
Workforce transition evidence	Case-based learning and critical reviews	Role redesign and support shape skill transfer	[13-21]
Saudi and sector evidence	Survey and bibliometric analyses	Relevance is clear; local field trials remain needed	[15,16]

12. Managerial and Educational Implications

Managers should begin by mapping decisions in a specific workflow: who interprets information, what makes a case difficult, which errors are reversible and where approval responsibilities lie. A competence audit should follow the decision map rather than precede it. Training then targets real deficiencies, while system designers adapt interfaces to workers' information needs. Small pilots should report exception quality, time demands and staff experiences alongside output. Expansion is justified when operational improvements persist under normal staffing and realistic disruptions, not merely during a highly supported demonstration.

Educators should incorporate structured datasets, simulation of uncertain transport conditions and collaborative exercises requiring participants to justify divergent decisions. Employers can supply anonymised cases, while instructors make explicit the assumptions behind each recommendation. Assessment should cover evidence interpretation, team communication, ethical considerations and escalation behaviour. Where algorithmic tools produce credible but wrong suggestions, learners should practise refusal and correction without automatic deference. Programmes that combine technical insight with professional authority are more consistent with augmented work than narrowly tool specific courses [6-23].

A balanced governance committee should include operational supervisors, information specialists, human resources and worker representatives. Its remit would cover model

changes, significant overrides, training accessibility and unintended consequences. Such oversight can prevent productivity objectives from eclipsing occupational well-being or supplier fairness. Clear reporting should separate worker learning from system uptake: a high login count is an adoption indicator, while a well-supported decision in a difficult case is evidence of augmented capability [20-29].

13. LIMITATIONS

This is a structured integrative review, not an exhaustive bibliometric census or meta analysis. The 30 selected sources differ in populations, technology types and measurement approaches, and some provide primarily conceptual rather than causal evidence. The review includes studies from outside Saudi Arabia because directly comparable local workforce research remains sparse; their findings are treated as theoretical transfer candidates. Publication and implementation-success bias may overstate benefits. Bibliographic verification establishes identifiable publication records and DOI associations but does not validate every empirical claim in the underlying articles.

14. CONCLUSION

Saudi supply chain transformation will depend less on the volume of deployed digital technology than on the ability of workers and systems to make better decisions together. Digital skills are necessary but insufficient: logistics expertise, interpretability, organisational learning and accountable governance determine whether technical capability becomes valuable augmentation. An effective strategy combines occupation specific learning with redesign of decision rights, data practices and performance measurement. It should protect human discretion where uncertainty and consequences are substantial, while allowing appropriate automation of routine activity. The proposed capability to collaboration framework gives researchers a testable explanation and practitioners a basis for evaluating progress under Vision 2030. Its central proposition is that sustainable workforce transformation is demonstrated through competent, resilient and inclusive operational action, not technology adoption in isolation [1-24].

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