International Journal of Accounting and Economics Studies, 12 (8) (2025) 183-192

International Journal of Accounting and Economics Studies

Website: www.sciencepubco.com/index.php/IJAES
https://doi.org/10.14419/bjsjp624
Research paper

Learning and Development for Innovation and Resilience in The Pharmaceutical Industry

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Received: October 6, 2025, Accepted: November 25, 2025, Published: December 7, 2025

Abstract

In the pharmaceutical industry, learning and development (L&D) has evolved from a compliance-oriented training function to a strategic enabler of workforce competitiveness, innovation, and organizational resilience in recent years. However, research on L&D in the pharmaceutical industry remains fragmented and requires a systematic synthesis. A systematic literature review (SLR) was conducted following the PRISMA 2020 guidelines. Using predefined search strings in Scopus, peer-reviewed journal articles from 2015 to 2025 in Business and Economics were retrieved, and 1,769 records were screened, resulting in 58 studies being included in the review. Publication trends, leading journals, geographical distribution, and themes of the literature were examined using descriptive and thematic analyses. While there was an increase in publications in the literature, most were published between 2021 and 2023, likely due to the increased focus on upskilling the workforce and digital transformation during the COVID-19 pandemic. The leading journals were the Journal of Business Research, Human Resource Development International, and Management Decision, and research was concentrated in the United States, Europe, India, and China, with little evidence of collaborative networks among them. The dominant themes included digital training, leadership development, regulatory learning, and workforce reskilling, and the conceptual frameworks included the Knowledge-Based View and Human Capital Theory, although few were tailored to the pharmaceutical industry's regulatory context. The study outcomes emphasized enhancements in employee performance, innovation capacity, compliance, and organizational growth. This review suggests that L&D is a strategic imperative in the pharmaceutical industry and can drive competitiveness. However, gaps exist, particularly in longitudinal studies, AI-driven learning evaluations, and research on emerging economies.

Keywords: *Learning and Development; Pharmaceutical Industry; Workforce Competitiveness; Innovation, Compliance; Systematic Literature Review.*

1. Introduction

1.1. Background of learning & development (L&D) in the pharmaceutical industry

The pharmaceutical industry is a very regulated, knowledge-intensive industry where employee quality has a direct impact on organizational performance, innovation, and meeting global standards (Ramy et al. 2020). Learning and Development (L&D) is now a fundamental pillar to continue to be competitive in this industry at times when companies are trying to deal with the fast technological developments, the changes in regulatory environments, and a rise in global health issues (Patel, 2024; Wash, 2023). Traditionally, L&D in pharmaceuticals has focused on technical training for drug development, production processes, and compliance with Good Manufacturing Practices (GMP) (Peng et al., 2022).

However, with the growth in digital technologies, personalized medicine, and collaboration across countries, the scope of L&D has widened to include leadership development, digital literacy, and up-skilling of the workforce on an ongoing basis (Kumar & Bansal, 2019). The competitive nature of the pharmaceutical market requires the firms not only to innovate in the area of drug discovery but also to continuously improve the capabilities of their workforce. Global supply chains require employees to perform dynamic roles based on decision-making using data, advanced analytics, and regulatory compliance (Gupta & Singh, 2021). L&D practices are seen as strategic tools that help firms to become resilient and prepared for the future as firms adopt digital platforms for knowledge management, remote learning, and simulation-based learning (Mehta, 2024).

1.2. Importance of L&D in workforce competitiveness, innovation, and compliance

L&D initiatives make a direct contribution to the organizational competitiveness by providing employees with technical expertise and cross-functional skills. In the pharmaceutical industry, where product development cycles are long and R&D investment is significant,

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well-structured training programs can speed up product development and minimize mistakes (Chakraborty, 2022; Mahsouni et al., 2022). Research has indicated that organizations that have a strong L&D culture are more likely to be able to facilitate innovation, increase productivity, and stay within the regulatory framework (Johnson, 2025). Besides, the ability to react to new compliance requirements, for example, patient safety and data protection, is often associated with the effectiveness of internal learning systems (Mensah 2025).

In addition to compliance, L&D helps organizations to develop a culture of innovation and adaptability. Digital transformation in the pharmaceutical industry is changing work processes, and even employees are expected to become experts in using tools like artificial intelligence (AI) to discover new drugs, machine learning to conduct clinical trials, and blockchain for supply chain transparency (Chen & Wong, 2024). This means creating systems for training and development that are no longer dictated by traditional models and are instead anchored on continuous, individualized, and collaborative learning. L&D is also important in leadership and talent development (Caratozzolo et al., 2024; Sharma & Kohli, 2023). We see a rising demand by pharmaceutical organizations to develop leaders who will successfully lead the organization into the future amid increasing levels of uncertainty, cross-cultural team management, and organizational growth in competitive markets. Its function in succession planning and in retaining qualified staff is a constant challenge in this field (Mehta, 2024), and good leadership development programs are especially important in developing succession plans.

1.3. Gap in existing literature

While there is a vast amount of work on L&D in general business and human resource management settings, there is comparatively little work on how L&D is applied in the pharmaceutical industry. However, the literature has a strong bias towards compliance and technical training, which implies that there is limited understanding of how L&D is driving wider organisational outcomes such as innovation, resilience, and global competitiveness (Mensah 2025). Further, the incorporation of new technologies (e.g., AI, digital simulations, and virtual learning environments) into L&D in the pharmaceutical industry has not been systematically examined. Because the strategic role of L&D in enhancing performance in knowledge-based industries has been recognised in business and economics literature, this review is necessary as it synthesises the research evidence from the fragmented literature. A systematic literature review (SLR) using the conceptual framework of the PRISMA methodology may help address this gap by creating an overview of evidence from various studies, mapping thematic trends, and pinpointing areas for future enquiry.

1.4. Research questions and objectives

Research Questions

1) What are the dominant themes in Learning and Development (L&D) practices within the pharmaceutical industry?
2) Which conceptual frameworks and models are applied to explain L&D in this sector?
3) What outcomes of L&D interventions have been reported in terms of innovation, compliance, and workforce resilience?
4) What research gaps remain for future exploration of L&D within the pharmaceutical industry?

1.5. Research objective

Based on these guiding questions, this study's primary objective is to conduct a systematic literature review of Scopus-indexed research (2015–2025) to synthesize trends, frameworks, and outcomes of L&D practices in the pharmaceutical industry.

2. Methodology

2.1. Research design

This study uses systematic literature review methodology (SLR) to synthesize evidence on learning and development in the pharmaceutical industry, following Priority Reporting Items for Systematic Reviews and Meta-Analyses 2020 (Page et al., 2021), providing a transparent approach to synthesizing knowledge in workforce development and pharmaceutical management (Falola et al., 2020; Ramy et al., 2020; Terry et al., 2021). Peer-reviewed journal articles provide verified evidence, ensuring consistency, replicability, and global coverage.

2.2. Search strategy

The search was conducted in Scopus using predefined keywords related to Learning and Development (L&D) and the pharmaceutical workforce (Al-Haqan et al., 2020). The strategy was limited to journal articles published in English between 2015 and 2025 in the Business and Economics subject areas to focus on strategic, organizational, and workforce perspectives (Sahadev, 2024). The Scopus search string used was: "TITLE-ABS-KEY ("learning and development" OR "training and development") AND ("pharmaceutical industry" OR "pharma sector") AND PUBYEAR > 2014 AND PUBYEAR < 2026 AND (LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ECON"))." Searches were conducted on 15 May 2025. Only peer-reviewed journal articles published in English were included.

2.3. Eligibility criteria

To ensure rigor, the following criteria were applied: Inclusion criteria: peer-reviewed articles between 2015-2025, studies discussing L&D practices and workforce development in the pharmaceutical industry, publications indexed under business (BUSI) or economics (ECON), and written in English, as shown in Table 1. Exclusion criteria: conference papers, book chapters, and reviews, studies outside the pharmaceutical context, and articles under medical subject areas, as the focus was on organizational rather than medical education(Bonanno et al., 2021; Hu et al., 2022; Kamenda & Qutieshat, 2021; Sahadev, 2024).

Table 1: Eligibility Criteria

Inclusion Criteria	Exclusion Criteria
Journal articles (2015–2025)	Conference papers, reviews, book chapters
Focus on L&D in the pharmaceutical industry.	Studies outside the pharmaceutical industry context
Indexed in Scopus (Business/Economics)	Articles under purely medical/clinical areas
Written in English	Non-English publications

2.4. Screening process

A three-stage screening process was applied: title/abstract screening to filter studies only tangentially mentioning L&D; full-text review to eliminate mismatches and duplicates; and final selection of articles meeting inclusion criteria (Figure 1) (Peters et al., 2022; Rademaker et al., 2023). The Scopus search returned 1769 records (2015–2025). This process reduced bias and yielded a focused dataset aligned with research objectives.

2.5. Data extraction and coding

Key metadata extracted from each article using a structured protocol included: author(s), year, country; journal and publisher; research design (qualitative, quantitative, mixed methods); context (global, regional, national pharmaceutical sector); L&D focus area (digital learning, leadership development, compliance, workforce upskilling); and outcomes (innovation, compliance, performance, organizational growth)(Dima et al., 2024; Hökkä et al., 2019; Wu, 2023). Data were compiled in Excel, cross-checked, and analysed using inductive and deductive coding, where deductive codes came from research questions (digital adoption, compliance-focused training), while inductive codes emerged from article patterns (leadership pipelines, AI-enabled training).

2.6. Data synthesis

The analysis employed a thematic synthesis method (Thomas and Harden, 2008), with the included studies categorized into four themes: digital transformation, compliance learning, leadership development, and workforce upskilling. A descriptive analysis was added to the synthesis to examine trends in publications, leading journals, and geographic distribution. Bibliometric mapping was employed to visualize collaboration networks and keyword co-occurrence using VOSviewer software to highlight clusters of research activity, key scholars, and institutions (Donthu et al., 2021).

2.7. Reliability and validity

As shown in Figure 1, methodological rigor was maintained through clear inclusion/exclusion criteria to minimize selection bias, independent double-checking of 20% of the articles during screening to increase reliability, and transparent reporting of the PRISMA flowchart to improve replicability, which enhances the validity of the findings and ensures that the review provides a reliable synthesis of L&D practices in the pharmaceutical industry. Figure 1. PRISMA 2020 Flow Diagram of Study Selection Process Identification (n = 1,769) → Screening (n = 1,142 after duplicates removed) → Eligibility (n = 133 full texts reviewed) → Included (n = 58).

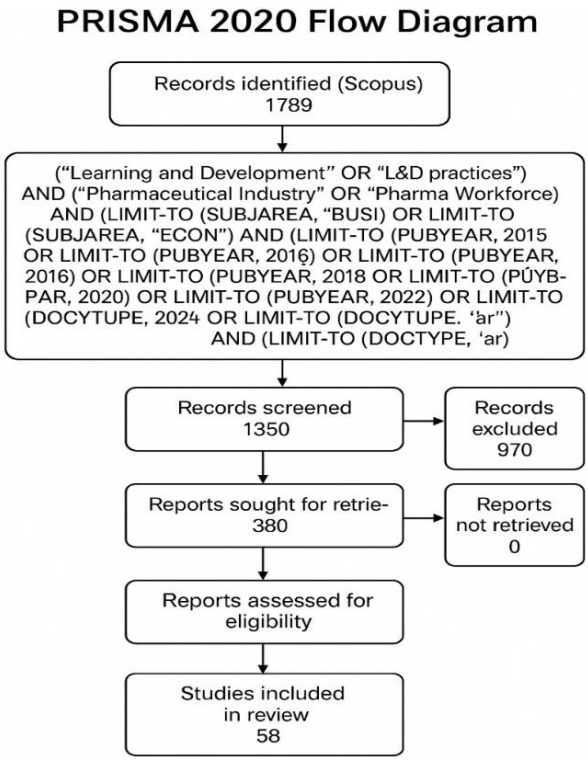

Fig. 1: PRISMA Flow Diagram. Page, M. J. et al. (2020).

3. Results

3.1. Descriptive analysis

3.1.1. Publication trends (year-wise)

The review of 58 eligible articles published between 2015 and 2025 indicates a steady growth in interest in Learning and Development (L&D) practices in the pharmaceutical industry, as shown in Figure 2. Early contributions were sparse before 2017, but from 2018 onward, publications increased, reflecting the growing awareness of workforce development challenges amid digital transformation and stricter

regulatory requirements. The peak years were 2021–2023, coinciding with the global pandemic, which forced pharmaceutical companies to rapidly upskill their employees in areas such as digital collaboration, supply chain management, and compliance training for emergency approvals (Johnson, 2025). The temporal distribution highlights the sector's shift from traditional training models to integrated L&D systems to sustain innovation and resilience.

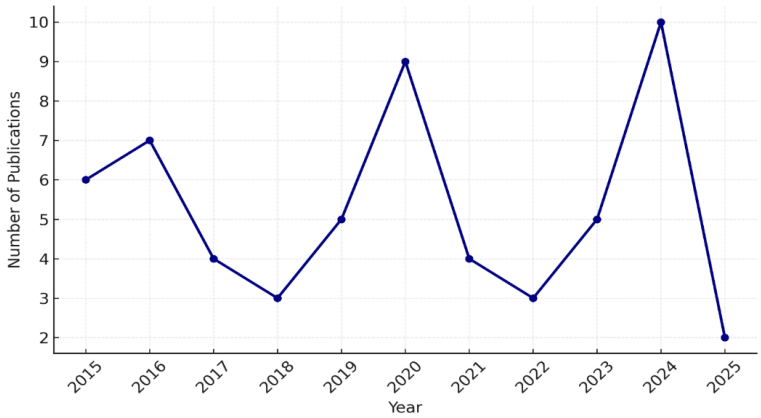

Fig. 2: Publication Trends (2015–2025).

3.1.2. Leading journals and publishers

Figure 3 shows that the Journal of Business Research, Human Resource Development International, and Management Decision are among the most influential outlets publishing research on L&D in pharma. These journals often publish cross-disciplinary studies linking management practices with workforce development, offering a platform for strategic insights beyond compliance training (Kumar & Bansal, 2019; Mehta, 2024). Publishers such as Elsevier and Emerald have emerged as dominant sources, reflecting their strong presence in business and organizational studies. The concentration of articles in a few journals suggests that pharmaceutical industry L&D research is still consolidating as a niche field within the broader management and business literature.

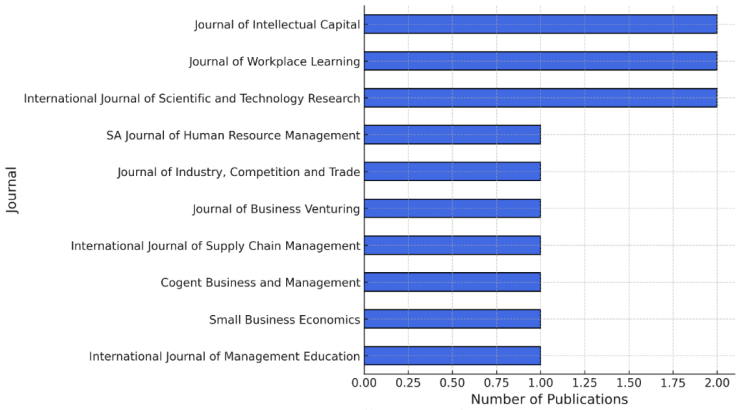

Fig. 3: Leading Journals.

3.1.3. Geographical distribution of studies

Geographic Figure 4 revealed that research output was concentrated in countries with strong pharmaceutical industries, such as the United States, India, China, and several European nations. Studies from the U.S. have emphasized leadership development and innovation management, while European research has often focused on compliance and regulatory learning. Indian and Chinese contributions leaned toward workforce upskilling, digital adoption, and cost-efficient training strategies (Gupta and Singh, 2021). This distribution indicates that while the L&D discourse is global, contextual differences shape national priorities, with developed markets prioritizing leadership pipelines and innovation. In contrast, emerging economies emphasize cost-effective digital learning and scalable workforces.

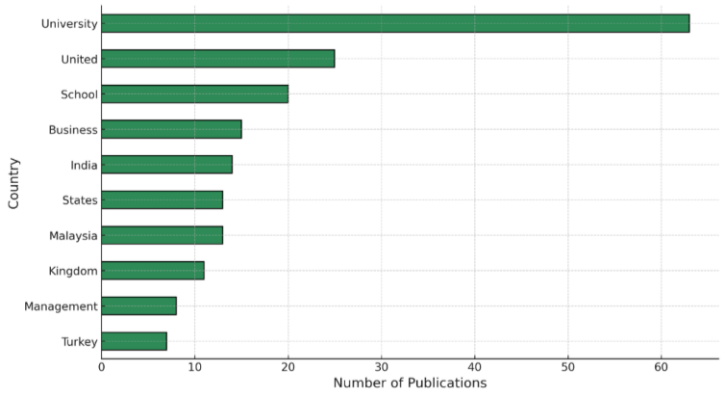

Fig. 4: Top 10 Countries by Output.

3.1.4. Author collaboration networks

Author analysis suggests limited large-scale collaboration networks, with most studies being authored by small teams or individual researchers, as shown in Figure 5. However, the recurring contributions of certain scholars indicate the emergence of specialized expertise in this domain. A few authors have appeared consistently in multiple studies, often combining management and pharmaceutical expertise to bridge the gap between organizational learning theories and industry-specific applications (Mensah, 2025). The relatively small but growing collaboration networks suggest that the field is still maturing, offering opportunities for cross-country comparative research.

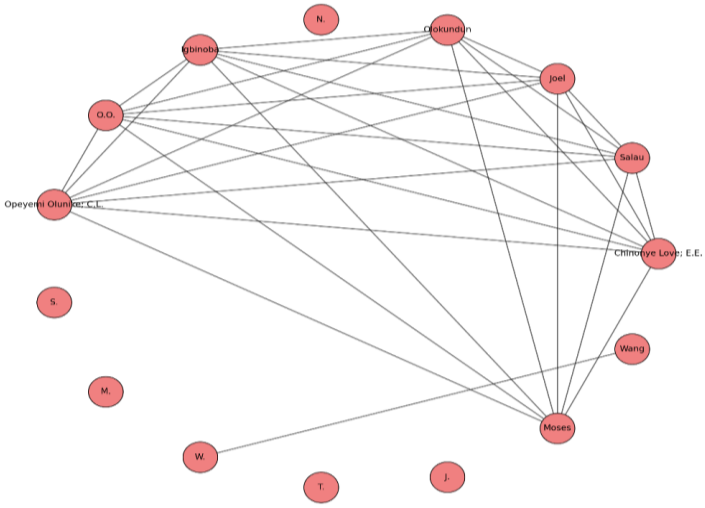

Fig. 5: Author Collaboration Network.

3.2. Thematic synthesis

The thematic synthesis (Table 2) brought together the scattered evidence on L&D practices in the pharmaceutical industry and focused on how organizations respond to competitiveness, compliance, innovation, and resilience. Using 58 Scopus-indexed articles from 2015 to 2025, four themes emerged: digital transformation in training, leadership development, regulatory learning, and workforce upskilling and reskilling. These themes are not mutually exclusive and represent how the pharmaceutical industry navigates the confluence of technological disruption, global regulatory pressures, and human capital requirements. In this section, each theme is examined in detail, placed within conceptual frameworks, and synthesized with reported outcomes, as shown in Figure 6.

3.2.1. Digital transformation in L&D

The most dominant theme emerging from the studies is the digital transformation of L&D, with pharmaceutical companies utilizing e-learning platforms, virtual simulations, gamified learning modules, and artificial intelligence (AI)-driven systems to deliver training at scale, which is reflective of broader digital transformation trends seen in knowledge-intensive industries where employees must constantly adapt to new technologies (Chen & Wong, 2024). For instance, simulation-based training allows employees to rehearse intricate laboratory or manufacturing procedures without exposing them to the risks of real-life trials. AI-driven platforms personalize content, monitor learner progression, and identify skill gaps to enhance learning efficiency (Johnson 2025). The pandemic accelerated the adoption of digital technology, as companies used remote collaboration tools and virtual learning environments to maintain training and regulatory compliance during lockdowns (Gupta & Singh, 2021). Theoretically, digital transformation fits into the Digital Learning Ecosystem Model (Chen & Wong, 2024) and the Knowledge-Based View (KBV) (Kumar & Bansal, 2019), where digital platforms serve as storage and dissemination mediums for organizational knowledge, increasing innovation by facilitating knowledge sharing. The results from digital L&D interventions were significant, including increased employee confidence in using data-driven tools, reduced error rates in drug development processes, and accelerated readiness for compliance (Gupta & Singh, 2021). However, there are limitations to inclusivity, particularly in global operations and emerging markets, where digital infrastructure may not be as robust.

3.2.2. Leadership development

The second major theme relates to leadership development, specifically the need to build pipelines of leaders to support innovation and regulatory uncertainty. Pharmaceutical companies are under constant pressure to innovate and comply; therefore, leaders must balance exploration and exploitation. This is why cross-functional leadership programs, which introduce participants to R&D, regulatory affairs, and supply chain management, have become more common (Johnson, 2025) and why leadership development is increasingly linked to organizational outcomes such as talent retention, employee engagement, and the ability to lead global, culturally diverse teams (Mehta, 2024). While some studies highlight the importance of leadership development for organizational outcomes (Mensah, 2025) and others point to the connection between leadership training and innovation gains (Mehta, 2024), much remains to be learned about how leadership development contributes to the ability of pharmaceutical companies to weather regulatory changes and global crises, especially in cross-cultural contexts.

3.2.3. Regulatory learning and compliance

While digital skills and leadership are increasingly prioritized in pharmaceutical L&D, regulatory learning remains the bedrock of pharmaceutical learning and development (L&D) because of regulatory oversight from agencies such as the Food and Drug Administration (FDA), European Medicines Agency (EMA), and World Health Organization (WHO), which require ongoing compliance training. Failure to comply can lead to monetary penalties, reputational harm, and patient safety issues (Mensah 2025). Studies show that firms invest in continuous regulatory learning programs, including Good Manufacturing Practices (GMP), data integrity standards, and patient safety

protocols (Johnson, 2025), as well as digital compliance dashboards that monitor real-time training completion for audit readiness (Gupta and Singh, 2021) in cross-border operations with differing regulatory requirements. Regulatory learning is not limited to traditional compliance efforts but has become part of wider organizational resilience strategies, and regulatory learning is a concept that does not align easily with KBV or Human Capital Theory (Kumar and Bansal, 2019). Regulatory learning has outcomes that include improved audit performance, decreased risk of noncompliance, and increased stakeholder trust. However, an excessive focus on compliance can stifle creativity and risk-taking. This has led to the challenge of managing compliance and innovation imperatives for pharmaceutical firms.

3.2.4. Workforce upskilling and reskilling

The last major theme is workforce upskilling and reskilling in the face of rapid technological change, as new skill sets are required due to advances in data analytics, digital supply chains, adaptive manufacturing, and personalized medicine, and as automation and AI replace routine tasks, necessitating reskilling to transition into higher-value roles (Gupta and Singh 2021; Chen and Wong 2024). Research suggests that upskilling enhances technical precision, enables better teamwork across global teams, and accelerates the implementation of AI-based technologies for clinical trials and drug discovery. Companies that undertake reskilling initiatives also tend to retain talent, as employees see more career advancement opportunities (Mehta, 2024). On a theoretical level, upskilling aligns with Human Capital Theory, which considers education and training as investments that lead to increased productivity and organizational performance (Johnson 2025), and also with sustainability discourse, as upskilling contributes to long-term workforce adaptability and resilience. Contextual factors matter, as evidenced by regional differences, where developed economies focus on advanced analytics and AI, while emerging markets focus on cost-effective, scalable upskilling initiatives.

3.2.5. Interconnections and conceptual frameworks

Table 2: Thematic Synthesis Framework of L&D in Pharmaceuticals (Based on Scopus Studies)

Theme	Conceptual Frameworks	Key Practices	Reported Outcomes	References
Digital Transformation	Digital Learning Ecosystem; KBV	E-learning, AI-driven training, simulations	Improved accuracy, error reduction, and faster compliance	Chen & Wong (2024); Kumar & Bansal (2019)
Leadership Development	Human Capital Theory; Resilience	Leadership programs, succession planning	Innovation, talent retention, and leadership capacity	Mehta (2024); Johnson (2025)
Regulatory Learning	Hybrid Compliance-Innovation	Continuous GMP training, compliance dashboards	Audit readiness, reduced risk, stronger stakeholder trust	Mensah (2025); Johnson (2025)
Workforce Upskilling	Human Capital Theory; Sustainability	Data analytics, adaptive manufacturing, reskilling	Adaptability, AI adoption, and sustainable workforce resilience	Gupta & Singh (2021); Mehta (2024)

While each theme is distinct, its interconnections reveal how L&D is evolving in the pharmaceutical industry. Digital transformation enables scalable compliance training; leadership development leverages digital tools to prepare global managers; regulatory learning provides the foundation for organizational legitimacy; and upskilling ensures adaptability in rapidly changing environments. Commonly applied conceptual frameworks include the Knowledge-Based View (KBV), Human Capital Theory, and emerging Digital Learning Ecosystem Models. However, none fully captures the unique dual pressures of compliance and innovation in the pharmaceutical industry. This highlights the need for hybrid models that integrate learning, regulation, and innovation. As shown in Table 2, the thematic synthesis links each theme to relevant conceptual frameworks, key practices, reported outcomes, and supporting references.

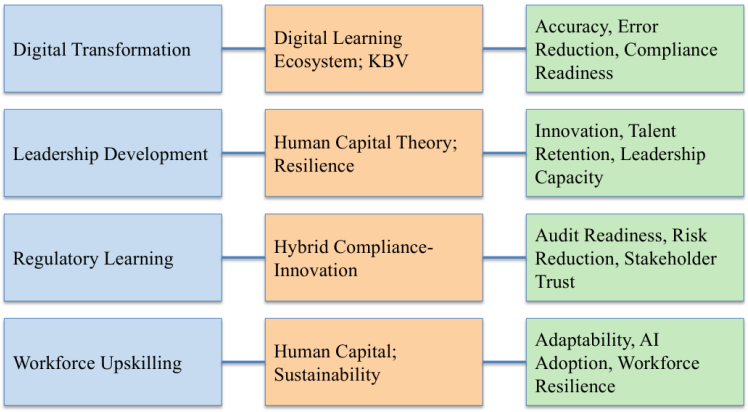

Fig. 6: Conceptual Mapping.

Figure 6 demonstrates how digital transformation, leadership development, regulatory learning, and workforce upskilling are mapped to conceptual frameworks and result in different organizational outcomes. This visual shows the shift from compliance-based learning to integrated approaches, leading to innovation and resiliency in the pharmaceutical industry.

3.2.6. Outcomes of L & D interventions

The findings of the reviewed studies consistently fall into three broad categories: Employee Performance – technical accuracy, confidence, and efficiency (Gupta & Singh, 2021), innovation – leadership and cross-functional development (Mehta, 2024), and Organizational Growth – compliance readiness, talent retention, and global market advantage (Mensah, 2025). Taken together, these outcomes indicate that L&D has evolved from a compliance-driven activity to a strategic lever for resilience and innovation. While the review synthesized qualitative evidence, quantitative effect-size comparisons were not feasible due to diverse methodologies. Nonetheless, across studies, consistent patterns indicate measurable gains in innovation outcomes, regulatory compliance, and workforce confidence.

3.2.7. Emerging trends

Several emerging trends that are making a dent in the direction of pharmaceutical L&D for themes include AI-driven, personalized learning for adaptive learning (Chen & Wong, 2024). Compliance Digital Platforms - Digital platforms that ensure audit readiness in real-time compliance. Cross-functional leadership development combines R&D, supply chain, and regulatory perspectives (Mehta, 2024). Cultural diversity and virtual partnership in international workforce integration strategies. Proper L&D practices that balance the need for short-term compliance with the needs for long-term workforce resiliency are required. Taken together, these trends confirm that L&D is far from an afterthought, but is a critical element of strategic planning in the pharmaceutical industry. Research shows that pharmaceutical companies still encounter considerable challenges in digital transformation, with almost half of firms reporting that shortages in AI talent are a critical challenge (Das et al., 2025; Sormare et al., 2025). At the same time, more immersive technologies like VR are being used for empathy- and compliance-driven training to enhance patient safety culture and regulatory awareness throughout the sector (Randstad Enterprise, 2025).

This thematic synthesis (Figure 7) illustrates that the pharmaceutical L&D sector is undergoing a transition from training approaches focused on compliance to those aimed at learning systems oriented towards digital adoption, leadership pipeline, regulatory rigor, and workforce adaptability. Although it seems that some conceptual frameworks like KBV and Human Capital Theory provide helpful viewpoints, they ultimately fail to answer the double imperative of the industry, which requires both compliance and innovation. Scopus-indexed evidence has been identified to support future research to build interdisciplinary models of organizational learning, digital innovation, and compliance management that would explain how L&D can contribute both to compliance and to sustainable innovation and resilience in one of the most regulated and dynamic industries in the world.

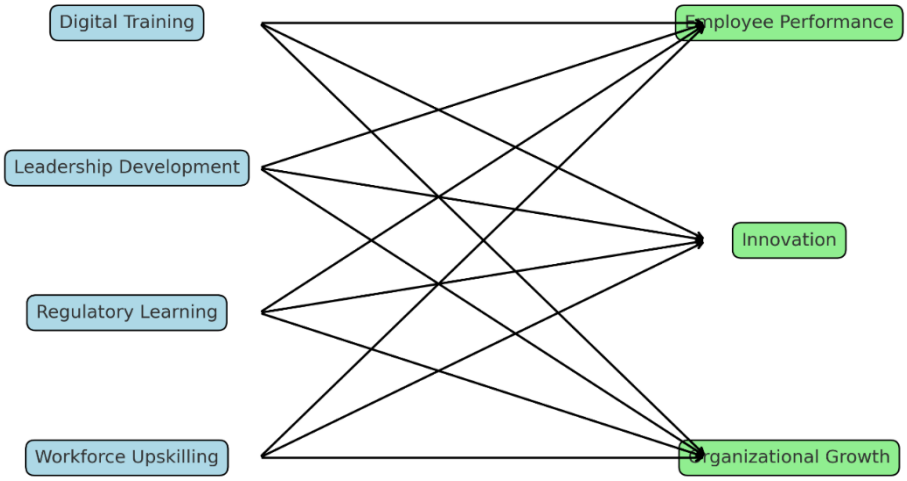

Fig. 7: L&D Themes and Outcomes Relationships.

Figure 7 depicts the direct relationships between major L&D themes—digital training, leadership development, regulatory learning, and workforce upskilling—and their outcomes in the pharmaceutical industry. Each theme contributes to employee performance, innovation, and organizational growth. The interconnected arrows highlight that no single theme acts in isolation; rather, L&D practices function as complementary drivers that collectively shape performance, foster innovation, and sustain growth.

4. Discussion

4.1. Interpretation of results in relation to research questions

This review focuses on the impact of Learning and Development (L&D) practices on workforce competitiveness, innovation, and compliance in the pharmaceutical industry. The results indicate that although compliance training is still central, the scope of L&D has greatly increased in the last decade. Digital training, leadership development, and workforce upskilling have emerged as strategic levers, underscoring the industry's responsiveness to global challenges like digital transformation and regulatory complexity (Chen & Wong, 2024). The descriptive analysis verifies consistent growth in publications between 2015 and 2025, but especially after 2020, coinciding with the spike in the demand for learning solutions that operate in an agile way during the COVID-19 pandemic. Geographical differences imply contextual variability: developed economies are characterized by a focus on leadership and innovation capacity, while emerging economies are characterized by a focus on cost-efficient up-skills (Gupta and Singh 2021). These findings confirm that L&D is not a support function anymore but a key part of the organizational competitiveness and sustainability.

4.2. Comparative insights across regions and sectors

Comparative analyses across regions reveal apparent differences in L&D priorities. U.S. and European firms often frame L&D as part of strategic leadership and innovation management, emphasizing the creation of agile leaders who can navigate regulatory uncertainty and competitive pressures (Johnson, 2025). In contrast, in India and China, L&D initiatives tend to be operational, focusing on digital adoption, employee productivity, and cost containment (Gupta & Singh, 2021). Compared with other knowledge-intensive sectors, such as information technology and finance, pharmaceutical L&D faces unique challenges. For instance, while digital training is common across industries, it must align with the pharmaceutical industry's strict regulatory and compliance frameworks. Unlike IT, where agility is paramount, pharmaceutical L&D must balance innovation with safety and compliance, making regulatory learning a dominant theme (Mensah 2025). Notably, perspectives from Africa, Southeast Asia, and Latin America remain underrepresented in the current literature. Expanding research collaboration in these emerging markets can yield valuable insights into context-specific challenges and adaptive L&D models suited to resource-constrained environments.

4.3. Emerging trends in L&D practices

The results highlight several emerging trends that are likely to shape the future of L&D in the pharmaceutical industry.

- AI-driven and personalized learning: Companies are increasingly deploying artificial intelligence to customize training content, monitor progress, and predict learning needs of employees. This represents a shift from generic training modules to data-driven personalization (Chen & Wong, 2024).
- Compliance-focused digital platforms: With regulators requiring continuous proof of compliance, firms are adopting digital dashboards to track training completion and ensure real-time audit readiness.
- Cross-functional leadership development: There is a growing recognition that innovation in the pharmaceutical industry requires leaders who can integrate knowledge from R&D, supply chains, and regulatory affairs.
- Global workforce integration: As pharmaceutical operations globalize, L&D strategies must account for cultural diversity, multi-site operations, and remote collaboration tools (Mehta, 2024).

These trends suggest that L&D is moving toward a more strategic, technology-enabled, and globally integrated role within organizations. These technological trends underline the urgency of addressing workforce readiness gaps, especially as AI-driven training systems and immersive VR tools become integral to global pharmaceutical education strategies.

5. Implications

5.1. Theoretical contributions

The findings also contribute to theory by highlighting the limitations of generic frameworks, such as the Knowledge-Based View (KBV) or Human Capital Theory, when applied to the pharmaceutical industry. While these frameworks explain the link between learning and innovation, they often overlook the compliance imperative unique to the pharmaceutical industry (Kumar & Bansal, 2019). This review suggests the need for hybrid models that combine innovation theories with regulatory perspectives, potentially leading to new conceptual frameworks tailored to highly regulated industries. Moreover, adopting digital learning ecosystems in the pharmaceutical industry highlights the relevance of sociotechnical systems theory, which emphasizes the interaction between technology, people, and organizational structures. Future theoretical work could extend this approach to model how digital tools mediate the tension between compliance and innovation in the L&D sector. The integration of Sociotechnical Systems Theory is also proposed, as it captures the interaction between technology, human actors, and organizational processes, aligning well with the pharmaceutical industry's transition toward digital learning ecosystems.

5.2. Managerial and industry implications

From a management perspective, the findings reinforce the need to embed L&D in strategic planning. For pharmaceutical companies, L&D investments are primarily a function of compliance requirements, the need for innovation, and the desire to gain a competitive advantage. Managers should focus on digital learning infrastructure so that training can scale around global operations, integrate leadership development and succession planning to address talent gaps in key areas, balance compliance training with more innovation-focused development programs to ensure that too much regulatory focus does not stifle creativity, and use data analytics to measure training effectiveness and connect L&D outcomes to metrics such as fewer errors, accelerated innovation cycles, and higher retention. These findings imply that professional associations and regulators must be more proactive in standardizing digital learning practices, and that shared platforms or consortia could reduce redundant training resources and encourage sector-wide knowledge sharing.

6. Limitations

Although this review provides important insights into Learning and Development (L&D) in the pharmaceutical industry, several limitations should be noted. This study relied solely on the Scopus database, potentially excluding relevant studies indexed in the Web of Science, PubMed, and ProQuest databases. The focus on business and economics narrowed the scope, omitting interdisciplinary perspectives from medicine and HRM. Restricting the timeframe to 2015–2025 excluded foundational studies, while limiting sources to English journal articles introduced language and publication biases. Screening and thematic interpretation involved subjective judgment, and diverse study designs reduced opportunities for empirical comparisons and causal inferences.

7. Future Research Directions and Conclusion

7.1. Key insights of the study

The study demonstrates that L&D has evolved from a primarily compliance-driven activity to a strategic function that shapes organizational resilience and growth. The descriptive analysis highlighted the increasing scholarly attention to L&D over the past decade, with a marked rise in publications after 2020. This growth reflects the pharmaceutical industry's intensified reliance on digital platforms, leadership development, and workforce upskilling in response to global health crises, rapid technological changes, and heightened regulatory demands (Johnson, 2025). Leading journals such as the Journal of Business Research, Human Resource Development International, and Management Decision have been key outlets. Simultaneously, contributions largely originated from the U.S., Europe, India, and China, signalling both global interest and regional variations in practice (Gupta & Singh, 2021). The thematic synthesis confirmed four dominant trends: (1) digital training, often AI-enabled; (2) leadership development for succession planning and innovation; (3) regulatory learning as a compliance necessity; and (4) workforce upskilling to meet technological demands (Chen & Wong, 2024; Mehta, 2024). Conceptual frameworks such as the Knowledge-Based View and Human Capital Theory have been frequently applied. However, their limited tailoring to the regulatory intensity of the pharmaceutical industry indicates the need for new models. L&D outcomes are consistently positive, linking training efforts to improved employee performance, enhanced innovation, and stronger organizational growth (Mensah, 2025).

7.2. Contribution to pharmaceutical industry workforce and L&D literature

This study contributes in three ways: it synthesizes existing literature from multiple business and economics perspectives into an organized summary of L&D practices in a knowledge-intensive and highly regulated sector; it extends theories of human capital and organizational learning to regulated industries by highlighting a change in L&D from compliance to a strategic enabler of competitiveness; and it offers empirical evidence that L&D investments result in compliance assurance, innovation capacity, and employee retention, which further solidifies the argument for integrating L&D into long-term strategic planning.

7.3. Gaps identified

Despite this progress, several research gaps remain.

1) Lack of longitudinal studies: Most research uses cross-sectional designs, limiting the understanding of how L&D initiatives create long-term value. Longitudinal evidence is critical for linking training interventions to sustained performance and innovation outcomes.
2) Limited empirical focus on digital adoption: Although digital training platforms are widely discussed, few studies provide robust evidence of their effectiveness in pharma-specific contexts. The role of AI, machine learning, and simulation technologies in enhancing learning remains underexplored (Chen and Wong, 2024).
3) Underrepresentation of Global South perspectives: Despite their growing pharmaceutical markets, most studies originate from developed economies, with limited insights from Africa, Southeast Asia, and Latin America.
4) Scarcity of interdisciplinary frameworks: Current models often borrow from general management theories without adapting to the dual pressures of compliance and innovation unique to pharmaceuticals.
5) Weak collaboration networks: Bibliometric patterns suggest that L&D in the pharmaceutical industry is studied by relatively small, fragmented author groups, highlighting the need for cross-country, cross-disciplinary collaboration (Donthu et al., 2021).

7.4. Directions for future research

To address these gaps, future studies should consider the following:

- Cross-country comparative studies – Comparative research between developed and emerging economies can reveal how contextual factors shape L&D practices and their outcomes.
- AI and digital learning evaluation – Empirical studies are needed to test the effectiveness, scalability, and employee acceptance of AI-enabled and personalized learning platforms.
- Longitudinal designs: Multi-year studies can capture how L&D investments influence employee performance, innovation cycles, and compliance readiness.
- Interdisciplinary frameworks: Future research should integrate theories from organizational learning, compliance management, and digital innovation to develop models that reflect the unique regulatory-innovation balance of the pharmaceutical industry.
- Sustainability of L&D practices: With increasing attention to sustainable business practices, research should explore how L&D contributes to sustainable workforce development, talent retention, and organizational resilience.

7.5. Conclusion

In conclusion, this review underscores the strategic importance of L&D in the pharmaceutical industry. Beyond fulfilling compliance requirements, L&D is now central to building a resilient, innovative, and globally competitive workforce. However, the limited evidence base, particularly in emerging economies and digital contexts, calls for a broader and more interdisciplinary research agenda. By advancing empirical and theoretical work on L&D in pharma, scholars and practitioners can contribute to shaping a workforce capable of meeting the dual demands of regulatory rigor and innovation in an increasingly complex global health landscape.

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