

Human Capital, Skills Shortages, and Workforce Readiness in Saudi Arabia: A Comparative Analysis Across Healthcare, ICT, and Manufacturing

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Abstract: Readiness of the workforce has become an important issue in Saudi Arabia in light of Vision 2030, which is fast-tracking economic diversification and digital transformation and job localization. This study examines how human capital and skills shortages differ across healthcare, information and communication technology (ICT), and manufacturing, while identifying structural challenges shared across these sectors. A PRISMA-guided systematic literature review and comparative thematic synthesis were conducted using 26 studies identified through the review process. The analysis combined inductive theme development with theoretically informed interpretation drawing on Human Capital Theory and, where relevant to technology adoption, the Technology Acceptance Model. The synthesis indicates that workforce-readiness challenges take different forms across the three sectors. The main constraints on healthcare are the capacity of the professional workforce, development of competence and long training and credentialing paths. ICT faces a different challenge, as rapidly changing technologies shorten the relevance of existing digital competencies and increase the need for continuous reskilling. In manufacturing, persistent gaps are associated particularly with the alignment of technical and vocational education and training (TVET) with workplace competency requirements. Across the sectors, education–employment misalignment, employer–education coordination, and institutional capacity to respond to changing skill requirements emerge as recurring concerns. These findings suggest that workforce readiness in Saudi Arabia cannot be understood solely as a question of labour supply. Rather, common structural pressures operate through distinct sectoral mechanisms. The review provides a comparative basis for designing sector-sensitive workforce-development policies while identifying areas in which the existing evidence remains limited.

Keywords: workforce readiness, human capital, skills shortages, Vision 2030, Saudi Arabia, TVET, digital readiness, skills mismatch, Industry 4.0.

Type: Research paper



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1. Introduction

Development of human capital has been considered a key element in the implementation of Saudi Vision 2030 regarding diversification of the economy, digitalization, employment localization, and the shift towards a knowledge economy (Abubakar et al., 2024; Ahmed, 2025; Brahimi et al., 2024; Kingdom of Saudi Arabia, 2017). The mentioned reforms increased the need for a workforce that could effectively adapt to new labor market conditions. Despite significant efforts aimed at the development of education, training, Saudization, and workforce development, Saudi-based studies continue pointing out challenges related to the matching of educational outcomes and workforce competencies to employer demands (Abdullateef et al., 2023; Abubakar et al., 2024; Al-Youbi et al., 2020; Bindawas, 2024). However, the identified challenges are likely to be of different nature in different sectors. The issue of workforce readiness in healthcare is associated with the professional training capacity, occupational specialization, and continuing reliance on foreign health workers in certain fields (Al-Hanawi et al., 2019; AlRuthia et al., 2018; Sheikh et al., 2019). The issue in ICT relates to quickly changing digital skills and constant reskilling in connection to the evolution of technologies (Alrwais, 2023; Bousrih et al., 2022). Manufacturing presents another configuration when workforce readiness is closely linked to technical and vocational education and training (TVET), competence development, and matching of training and employer demands (Baqadir et al., 2011; Haviland & Robbins, 2021).

Healthcare, ICT, and manufacturing were purposely selected to provide institutional variety within a single national policy framework. Healthcare is a professionally regulated field where workforce depends on specialized education, certification, and relatively lengthy training process. ICT is a technology-driven industry that might face the need for skills development faster than education programs and standard training periods allow. Manufacturing is a sector with another kind of environment where the readiness of the technical workforce is tightly interconnected with TVET, workplace skills, and the match between employers and education institutions. By analyzing these sectors, the analysis will be able to check if the challenges of national workforce development vary according to sectoral institutions and skill development frameworks.

Workforce readiness does not only consist of mere presence of employees. It refers to the possession of skills that correspond to changing job requirements and the ability of organizations to develop such skills in view of the technological advancement and changes in work methods. Evidence related to Saudi Arabia

shows the persistent issues of skills mismatch, employability, workforce capacity, and the relationship between education and labor market requirements.

Human Capital Theory (HCT) is the main theoretical framework for analyzing these differences since it connects the investments in education, training, and skills development to productivity (Becker, 1993). However, human capital development alone cannot fully explain the issue of worker readiness in the situations where technical demands change fast. Therefore, Technology Acceptance Model (TAM) can serve as an additional framework for explaining information related to technology acceptance, particularly the perception of usefulness and ease of use. Organizational readiness and digital frameworks are considered contextual factors that affect technology adoption rather than TAM components. The application of two frameworks in this way allows investigating both skill development and particular circumstances of technology adoption without assuming that a single theoretical framework explains the workforce issues in all three sectors.

Against this background, the following three questions are explored: RQ1: What are the deficiencies of human capital and skills that affect worker readiness in the healthcare, ICT, and manufacturing sectors within the Saudi Arabian context? RQ2: What structural and institutional factors that affect worker readiness are common for the three sectors, and what factors are unique for specific sectors? RQ3: How can the revealed cross-sector patterns be explained with Human Capital Theory and, if necessary, the Technology Acceptance Model in view of the technology adoption evidence?

As a result, the research provides the comparative analysis of workforce preparedness data in healthcare, ICT, and manufacturing in terms of Saudi Vision 2030. Instead of assuming that labor unpreparedness happens due to one particular reason, the study analyzes common structural pressures and many ways how they manifest in different sectors. The goal of the results is to facilitate discussions of workforce development related to the vision 2030 and its broad aims of productive employment and innovation stated in Sustainable Development Goals 8 and 9.

The structure of the paper is as follows. Section 2 explores the "Literature Review on Workforce Preparedness, Skill Deficiencies, and Human Capital Advancement". Section 3 discusses the methodology of the systematic review including PRISMA-based study selection and thematic synthesis. The interdisciplinary results are explored in relation to theoretical and practical aspects in Section 4.

2. Literature Review

Development of human capital, skill gaps, and workforce preparedness are closely associated with Saudi Arabia's initiatives to align education and employment with the objectives of Vision 2030. The main problem of Saudi labor market is the presence of workforce shortage and unemployment among Saudis at the same time, which implies that the problem might be caused by mismatch between the qualifications of workers and expectations of the employers rather than by general labor shortage. In the field of healthcare, the problem is illustrated by the current need for foreign specialists and the limitations of the local professional labor capability (Al-Hanawi et al., 2019; AlRuthia et al., 2018). The

data on the GCC region also reveals problems in terms of training capacity of health professionals (Sheikh et al., 2019), but regional information is used here only as additional evidence of the conditions in Saudi Arabia.

In addition, other studies reveal that insufficient skills, both technical, digital, and interpersonal, have considerable impact on employability preparedness. Studies conducted in Saudi Arabia have demonstrated that the preparedness of students does not always meet the expectations of employers, and also indicate that digital sectors fail to train the required competencies in their employees. The importance of digital skills and continual development is emphasized by the processes of digital transformation and Industry 4.0 (Alrwais, 2023; Bousrih et al., 2022). Worldwide studies also reveal problems of adjusting the educational and training systems to new technologies (Alao & Brink, 2022; Bano et al., 2022; Formunyam, 2020; Guàrdia et al., 2021; Krishantoro, 2019; Mbithi et al., 2021). However, these studies are derived from the experience of countries other than Saudi Arabia and are thus considered as comparative data, rather than indicators of the conditions in Saudi Arabia. The transferability of the findings should be treated cautiously owing to the differences in the educational systems, labor market structure, industrial conditions, and labor regulations among countries.

Comparison of the existing literature reveals another feature, common for all the sectors: the necessity of the responsiveness of the education and training systems to changes in the occupational requirements. Saudi Arabian studies on graduates' employability and educational transformation reveal the persisting problem of misalignment between education and employment (Abdullateef et al., 2023; Bindawas, 2024). However, the effects of such misalignment are different in institutions. Thus, the same general problem of workforce development leads to different types of unreadiness in various sectors.

Numerous constraints persist within the current body of knowledge. A significant portion of the information is cross-sectional and concentrates on certain industries, professions, or educational environments, complicating direct comparisons across sectors. The foundation of evidence is geographically diverse, integrating research particular to Saudi Arabia with studies from the GCC and broader international contexts. While global studies may reveal similar principles, it cannot be directly applied to Saudi Arabia without accounting for institutional and labor market disparities. Current research offers little information regarding whether workforce-readiness obstacles in healthcare, ICT, and manufacturing stem from shared structural constraints or from unique institutional circumstances within each sector.

This research tackles that deficiency by performing a comparative theme synthesis and a systematic literature review in accordance with PRISMA. Consequently, the conclusions on the Saudi labor market are predominantly based on evidence particular to Saudi Arabia, but GCC and wider international data are utilized carefully for comparative and contextual analysis. In the expansive framework of Vision 2030, the synthesis therefore tackles the universal and sector-specific factors influencing workforce preparedness for healthcare, ICT, and manufacturing.

3. Research Method

This section outlines the methodological approach of the research about workforce preparedness and skill gaps in healthcare, ICT, and manufacturing in Saudi Arabia. The study is built upon systematic literature review with thematic and theoretical analysis according to PRISMA 2020 guidelines. Human Capital Theory (Becker, 1993) and Technology Acceptance Model (Davis, 1989) will be used to evaluate organizational preparedness, flexibility, and digital transformation.

The Lens.org database was used to identify the peer-reviewed articles in business, management, workforce studies, and social sciences published between 2018 and 2026. The following keyword pairs were used: “human capital,” “skill gaps,” “workforce preparedness,” and “skill mismatch.” The PRISMA 2020 protocol (Page et al., 2021) was used in the process of identification, screening, eligibility, and inclusion. The total of 26 peer-reviewed articles were identified for the analysis.

The collected data comprised publication year, geographical context, methodological framework, thematic focus, and main findings. Geographical context was preserved throughout the synthesis to distinguish Saudi-specific findings from those found within the context of the GCC or international contexts. This structured collection directed the topic analysis and comparative synthesis of the reviewed literature.

Coding and theme generation took place in the shared spreadsheet with version control, and analytical diaries were kept to document interpretative decisions.

The coding followed the hybrid approach of thematic synthesis incorporating deductive and inductive approaches as suggested by Thomas and Harden (2008). Two reviewers independently classified the articles (n=26). The systematic codebook was developed deductively based on the two theoretical foundations: codes based on Human Capital Theory included such categories as congruence of education and labor market, adequacy of training, and skill deterioration; codes from Technology Acceptance Model included such categories as utility of emerging technologies, perceived user-friendliness, organizational preparedness, and digital infrastructure.

Additionally, inductive codes were generated during the multiple readings of the corpus: intensity of employer and education cooperation, relevance of TVET curricula, intensity of localization, and AI literacy. Hence, each article was coded at three levels: (1) descriptive codes identifying surface-level content (who, where, when); (2) analytical codes highlighting sector-specific barriers and facilitators; (3) theory-based codes connecting empirical findings to the two theoretical frameworks. Intercoder reliability was calculated on a 20% random sample (six articles) with the use of Cohen's Kappa; disagreements were resolved via structured discussion till consensus was reached, and afterwards the agreed-upon codebook was applied to the whole corpus. The initial codes were then grouped into descriptive themes and later synthesized into analytic themes across the three sectors described in Section 4.

Thematic synthesis took place in three stages: (1) initial coding of concepts from the literature review; (2) identification of descriptive themes; and (3) development of analytical themes explaining patterns, inconsistencies, and gaps

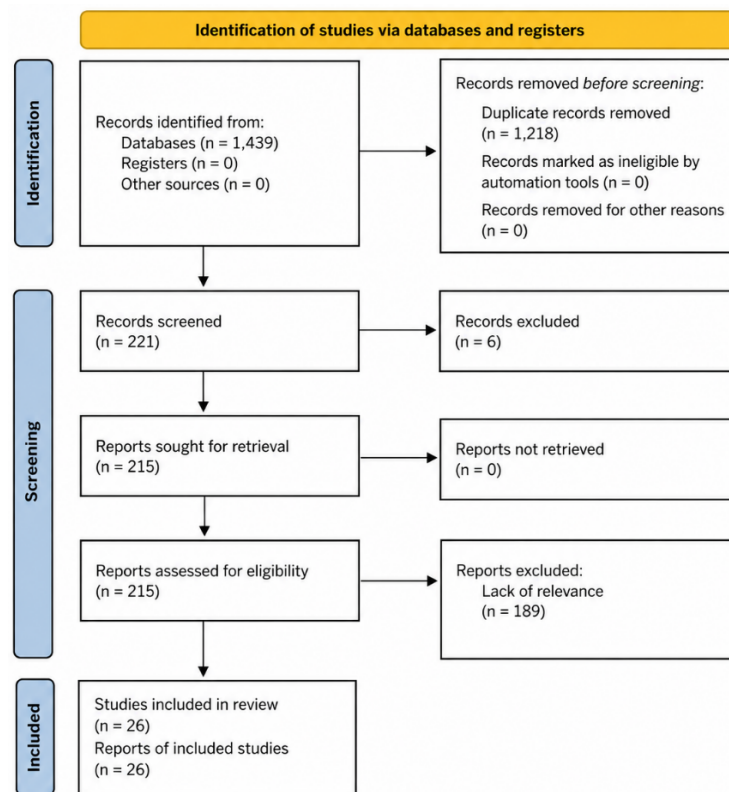
in the literature on workforce preparedness and skills shortages. Table 1 shows Inclusion and exclusion criteria employed in this present study. Note. Criteria were applied sequentially across the identification, screening, and eligibility stages of the PRISMA protocol shown in Figure 1.

The analytic themes that structure the results section in Section 4 are: (1) education-labor market mismatch; (2) employer-education collaboration deficits; (3) digital and AI readiness gaps; (4) TVET reform underperformance; and (5) localization and Saudization-policy interaction effects.

There are three constraints related to the methodology of the paper that require discussion. First of all, the literature review depends on papers stored in the Lens.org database for the years ranging between 2018 and 2026; otherwise, those relevant articles which can be found only in other databases (PubMed for clinical workforce and IEEE Xplore for technical ICT workforce) will be missed. The second issue is that the evidential base is mainly cross-sectional and correlational in nature, which makes it impossible to draw causal inferences about sectoral inequalities. Finally, there are limitations in terms of inclusion criteria as the articles should be written in English; it may imply that some sources written in Arabic, referring to the Saudi policy, may not be included into the analysis. Pre-2018 sources used for the analysis (such as Baqadir et al., 2011) were not subject to the date criterion because they were considered as seminal theoretical sources about TVET and employer alignment, similar to Becker (1993) and Davis (1989).

Table 1: Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Publication type	Peer-reviewed journal articles	Book chapters, grey literature, theses
Language	English	Non-English publications
Date range	2018–2026	Publications prior to 2018, except seminal theoretical works cited for conceptual grounding
Thematic relevance	Studies addressing human capital, skills shortages, workforce readiness, and/or skills mismatch	Studies without direct relevance to the core research themes
Sectoral/contextual scope	Studies in labor market, education, or workforce development contexts	Studies focused exclusively on unrelated disciplines (e.g., pure engineering, hard sciences)
Publisher information	Full publisher details available	Documents lacking identifiable publisher information

Figure 1: PRISMA 2020 Flow Diagram For Study Selection

4. Results and Discussion

The systematic review of 26 studies identified both shared and sector-specific determinants of workforce readiness across healthcare, ICT, and manufacturing. Five themes structured the comparative synthesis: education–labor market mismatch, employer–education collaboration, digital and AI readiness, TVET–workplace alignment, and localization-related workforce dynamics. Table 2 summarizes how these themes are expressed across the three sectors and identifies the principal evidence supporting each sectoral pattern. In this table GCC = Gulf Cooperation Council; ICT = Information and Communications Technology; TVET = Technical and Vocational Education and Training; GIS = Geographic Information Systems; AI = Artificial Intelligence.

Table 2: Summary Of The Key Findings By Sector

Criterion	Inclusion	Exclusion	
Healthcare	Clinical workforce shortages; pharmacy workforce deficit (100,000 shortfall by 2030); AI literacy gap; soft skills in patient communication	Underdeveloped competency-based curricula; dependence on expatriate professionals; limited health professional training capacity in GCC	Al-Hanawi et al., 2019; AlRuthia et al., 2018; Chatzichristos et al., 2025; Sheikh et al., 2019
ICT / Digital Technology	AI and digital skills deficit; Industry 4.0 and 5.0 readiness gap; GIS graduate shortage (67% employer difficulty); digital manufacturing skills	Educational systems not aligned to pace of technological change; psychological barriers to technology adoption; lack of digital upskilling infrastructure	Alrwais, 2023; Bousrih et al., 2022; General Authority for Statistics, 2024
Manufacturing	Industry 4.0 technical skills; TVET graduate quality mismatch; soft skills deficit (problem-solving, teamwork, critical thinking)	TVET reform underperformance; employer-education disconnect; inadequate competency-based curriculum design; rapid automation outpacing training systems	Bano et al., 2022; Baqadir et al., 2011; Haviland & Robbins, 2021

The main divergence between the two issues, however, is in the speed and the way demands for skills change. Health care challenges are mainly structural as the preparedness of the workforce depends on the possibilities for professional training, specialization, credentialing needs, and the continuous reliance on expatriates in some specialties. All of these characteristics make quick solving of the labor shortages hard as professional skills depend on specialist training and limited entry into the profession.

Information and communication technology face a more flexible challenge as the development of technology can quickly change requirements for competence and increase the need for continuous digital retraining (Alrwais, 2023; Bousrih et al., 2022). The analysis shows the difference in the timeframes of policy-making with the necessity for continuous strategizing of workforce-pipeline and skill improvement in health care and constant systems of skill refreshing in ICT that should be able to adjust to the changes brought by the advancements of technology. These differences show that workforce readiness problems should not be considered as one problem even if the sectors operate under the same Vision 2030 policy frame.

Industry 4.0 policy framework includes both ICT and manufacturing; however, the sources of the shortage of labor are different. For ICT sector, the problem is mainly intellectual and aspirational as employees and their supervisors have to continuously improve their skills and the psychological resistance to new technologies (as defined by the Technology Acceptance Model) affects the readiness for it. For the manufacturing industry, the problem is mainly structural and educational as the reforms of vocational education and training do not produce enough graduates who meet the employers' demands for technical and analytical skills as the adoption of automation technologies happens faster

than the updating of the curriculum. Comparing the two, the obstacles of ICT readiness appear before training (in the readiness and ability to learn new skills of the employees) while the challenges for manufacturing readiness arise after training (in the curriculum of TVET and the cooperation of educational institutions and employers). Subsidies for upskilling can help more in ICT while reforms in TVET-employer cooperation will be more efficient in manufacturing. The reviewed evidence associates readiness constraints particularly with the interface between TVET provision and workplace competency requirements (Baqadir et al., 2011; Haviland & Robbins, 2021). Unlike healthcare, where professional pipelines constrain the speed of workforce expansion, or ICT, where competencies may become obsolete rapidly, manufacturing readiness depends substantially on whether technical training is translated into competencies that correspond to production environments. The comparative implication is that similar symptoms of skills shortage may arise from different institutional bottlenecks: training capacity in healthcare, skill-renewal speed in ICT, and training–workplace alignment in manufacturing.

While each of the three sectors experiences workforce shortage problems, the problems differ greatly from one sector to another not only in nature but also in terms of reasons behind the workforce shortage problems. For example, the healthcare sector is primarily characterized by quantitative workforce shortages alongside competence-based workforce shortage problems. However, the ICT sector has dynamic digital competence shortage problems arising from technology-related challenges. On the other hand, the manufacturing sector suffers from systemic TVET problems. Despite the above variations, however, a number of common structural patterns do arise out of the analysis of literature. Firstly, in all sectors analyzed there is clear evidence of a mismatch between educational output and workforce needs. Secondly, technological change is proceeding faster than adaptation by the workforce is possible. Thirdly, policies seem to emphasize growth over competency development. Collectively, the findings suggest that workforce unreadiness in Saudi Arabia is increasingly systemic rather than sector-specific, requiring integrated policy responses rather than isolated interventions.

Two findings cut against the conventional narrative that increased education spending automatically improves workforce readiness. First, in ICT the problem is not the accessibility of education but the speed at which formal education can respond to technological change; the surprising finding is therefore that higher enrolments in ICT degrees do not appear to reduce reported employer skill gaps. Secondly, within the manufacturing industry, despite the abundant discourse on TVET reform in Vision 2030 documents, the shortcomings in the realm of soft skills and work-integrated learning have persisted throughout the period under review, suggesting that the reform has been limited to policy statements rather than changes in the curricula and assessment procedures. The third, albeit less conspicuous, finding is that while the healthcare industry is the most regulated of the three, it is also predicted to face the most substantial numerical shortfall (approximately 100,000 pharmacy and clinical positions by 2030) thus shifting the definition of preparedness from one of skills to one of capacity planning.

A comparison across sectors does not help establish a clear hierarchy in terms of the level of worker preparedness as healthcare, ICT, and manufacturing experience different demand conditions, training periods, and institutional constraints. On the one hand, ICT stands out with its fast-changing nature and constant digital re-training requirements, while manufacturing preparedness depends on TVET success and on the relationship between employers and institutions of education. On the other hand, healthcare has its peculiar set of factors affecting preparedness, namely professional workforce capabilities, specialized training paths, and competency development. The value of the synthesis does not lie in comparing the industries in terms of their preparedness but rather in understanding the specific mechanisms limiting preparedness and the institutional capabilities necessary to resolve them.

Cross-sector findings refute the postulates of Human Capital Theory (HCT) about the positive correlation between education, training, and skill development investments and the potential of the workforce in terms of productivity. The analysis shows that the effects of investments in these areas depend on the match between skills acquired and industry requirements. In healthcare, such a match is influenced by specialized professional training and development paths (Al-Hanawi et al., 2019; AlRuthia et al., 2018; Sheikh et al., 2019); in information and communication technology, by the fast pace of changes affecting competence demands (Alrwais, 2023; Bousrih et al., 2022); in manufacturing – by the congruence of TVET and industry requirements (Baqadir et al., 2011; Haviland & Robbins, 2021). The Technology Acceptance Model (TAM) provides a narrower complementary perspective where readiness involves engagement with new technologies, particularly through perceived usefulness and perceived ease of use (Davis, 1989). Its explanatory role is therefore more directly relevant to technology-adoption dimensions of workforce readiness than to constraints arising primarily from professional workforce capacity or TVET–employer alignment.

These sectoral differences have practical implications for workforce policy under Vision 2030. Moreover, there is further evidence that demonstrates the importance of training among the employees with regard to quality improvement in the Saudi service setting (Khodhari & Brahimi, 2026). A uniform workforce-development strategy is unlikely to address constraints that arise through different institutional mechanisms. Healthcare requires sustained professional workforce planning and competency development (Al-Hanawi et al., 2019; AlRuthia et al., 2018; Sheikh et al., 2019); ICT requires recurrent digital reskilling mechanisms capable of responding to rapid technological change (Alrwais, 2023; Bousrih et al., 2022); and manufacturing requires stronger alignment between TVET provision and workplace competency requirements (Baqadir et al., 2011; Haviland & Robbins, 2021). Cross-sector coordination remains important, particularly in strengthening employer–education collaboration, but intervention design should reflect the specific mechanism through which workforce readiness is constrained in each sector.

5. Conclusion

This study investigates the impact of human capital and skills shortages on workforce readiness within the framework of Vision 2030 in healthcare, ICT and manufacturing sectors of Saudi Arabia. Comparative synthesis revealed common structural pressures across the three sectors, in particular education–employment misalignment and limits of employer–education coordination. Moreover, it showed that these pressures are realized thru sector-specific institutional mechanisms. This study aims to synthesize these sectoral patterns into a single comparative framework, instead of treating workforce-readiness problems as homogeneous across the Saudi labor market. The findings have policy implications for a combination of sector-specific, institutionally and competency-sensitive interventions, as well as national coordination in workforce development strategies. This comparative framework should be further developed in future research by incorporating additional longitudinal evaluations of workforce-development interventions, primary empirical evidence, and Vision 2030 priority sectors.

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