

Future skills and competencies for Industry 4.0 transformation: A Delphi study of the Ha'il region in Saudi Arabia



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ABSTRACT

Recent advancements in Industry 4.0 technology have introduced significant opportunities and challenges to various economic sectors. These new technologies demand the development of new skills and competencies. By 2030, the job market will require young engineers and leaders to possess different skill sets and operate in a new technological and managerial context. This is particularly relevant to the Saudi economy, which is influenced by the ambitious Saudi Vision 2030 and its associated programs, notably the National Industrial Development and Logistics Program (NIDLP). This study aims to identify and analyze the key forces driving changes in the Saudi labor market using the Delphi methodology. It predicts the essential skills future graduates will need in this changing professional landscape. Furthermore, the study evaluates how well the Saudi higher education system prepares students to acquire these necessary skills. By identifying potential deficiencies in the current educational structure, the research seeks to offer practical suggestions for future enhancements, ensuring graduates are equipped for the evolving job market demands. The outcomes of this Delphi study are particularly crucial for achieving the goals of Saudi Vision 2030, especially concerning Human Capital Development. The insights from this study help in developing a detailed national strategy for higher education reform.

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1. Introduction

The rapid technological advancements and the growing demand for automation and digitalization have led to a paradigm shift in the skills and competencies required by the workforce in Saudi Arabia. With Industry 4.0, companies are now seeking individuals who possess a unique set of skills and competencies to help them thrive in a constantly evolving environment. Future skills are becoming more important than ever, and it is crucial to identify and develop these skills to remain competitive in the job market.

It is widely accepted that skills and knowledge are vital factors for a country's economic growth and employability. According to [Bettioli et al. \(2020\)](#), companies that incorporate Industry 4.0 technologies can anticipate better performance and

chances to enter new markets. However, in order to fully benefit from these technologies, organizations must be open to modifying their business models and strategies for value creation. Yet, several studies have identified a lack of appropriate skills and knowledge as a common obstacle to the adoption of Industry 4.0 ([Zhifeng et al., 2019](#); [Maisiri et al., 2019](#); [Kazancoglu and Ozkan-Ozen, 2018](#)). [Tung et al. \(2020\)](#) have noted that insufficient technological expertise and knowledge to carry out Industry 4.0 projects are equally challenging. This skills gap issue is not unique to developing countries, as other regions such as Europe, Canada, and the USA have also been experiencing similar outcomes, as reported in various international and European reports ([Alhloul and Kiss, 2022](#); [Yusof et al., 2022](#); [Benayoune, 2022](#); [WEF, 2020](#); [Brunello and Wruuck, 2021](#); [Deming and Kahn, 2018](#); [Weaver and Osterman, 2017](#)).

Saudi Arabia is investing in various economic and social sectors to achieve ambitious goals through Vision 2030. This vision aims to increase non-oil revenue participation in GDP from 16% to 50%, requiring industrial organizations to optimize their operations through structured digital transformation. A key component of this vision is the

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National Industrial Development and Logistics Program (NIDLP), which aims to transform the kingdom into a world-class industrial powerhouse and global logistics hub, focusing on Industry 4.0 technologies.

The industrial sector in Saudi Arabia includes over 40 industrial cities with more than 7,600 factories, highlighting its significance and the need for digital transformation via Industry 4.0 technologies. According to the Industry 4.0 Investment Opportunities Report published in September 2020, the Saudi government is supporting this transformation with a \$453 billion fund for industrial, logistics, and energy projects. The high investment potential aims to attract leading Industry 4.0 players both nationally and internationally.

To facilitate this digital transformation, the government has launched initiatives and programs to build human capital in digital transformation and Industry 4.0 technologies. This includes specialized academic programs and research centers supported by various government bodies such as SDAIA, SAFCSF, and MOODON. These initiatives aim to enable the industrial sector to successfully implement Industry 4.0 technologies for cost reduction, process optimization, performance improvement, and operational excellence.

The report also highlights that Industry 4.0 is in the early stages of adoption in Saudi Arabia. However, the country's advanced IT infrastructure indicates market readiness for digital transformation. This environment is welcoming to new entrants and investors from academia, research institutions, and businesses who can develop tailored solutions for the Saudi industrial sector's needs.

To achieve these goals, the government has developed national strategic plans and programs for the industrial sector. However, this socio-economic transformation is occurring alongside rapid technological advancements of Industry 4.0, which require new skills, competencies, and job tasks in the global labor market, including in Saudi Arabia. This issue has sparked debates among policymakers, business leaders, scholars, and academics. Industry 4.0 is primarily driven by the smart factory concept, which relies on the connectivity of cyber-physical systems (CPS) through the Internet of Things (IoT), Internet of Systems (IoS), artificial intelligence, cloud technology, and big data (Manda and Ben Dhaou, 2019). Consequently, both the public and private sectors must equip their workforce with new competencies to meet the demands of this new industrial revolution.

In this research paper, we will present the results of a Delphi study aimed at identifying the most important future skills and competencies needed for success in Industry 4.0. The Delphi method involves a panel of experts who forecast future trends and identify emerging issues. This approach is effective for analyzing the skills and competencies required for the future workforce. The study leverages the

expertise of a diverse group of experts to provide a comprehensive understanding of the essential skills and competencies for the future of work. The findings will offer valuable insights for Saudi policymakers, employers, and educators, helping them to better prepare the workforce for future challenges. By identifying the necessary future skills and competencies, stakeholders can develop strategies to upskill and reskill the current workforce and prepare future generations for the rapidly evolving job market. This research is particularly relevant given the Saudi Arabian government's efforts to diversify its economy and transition to a more sustainable, knowledge-based economy. This paper will focus on examining and analyzing the critical future skills necessary for transitioning to an Industry 4.0 environment in the Hail region of Saudi Arabia, based on insights from well-established experts in industry and academia. The research aims to answer the following questions:

- What are the driving forces for change in Saudi Arabia, particularly in the Hail region?
- What critical future skills are required to transform Saudi Arabia's economy and workforce in response to Industry 4.0 technologies?
- How well are Saudi Higher Education Institutions prepared to support the development of these skills?

2. Research background and literature review

The implementation of new technologies is expected to have a significant impact on Industry 4.0 employment all over the world. With increased automation, digitalization, and robotization, the demand for manual labor in industrial production will decrease, resulting in a reduced number of people working in the manufacturing industry. However, the quality of the workforce will also change with the advent of new technologies. Fewer low-skilled, physically employed workers will be required, while there will be a greater need for qualified, intellectually skilled employees (Alhloul and Kiss, 2022). According to a survey conducted across 37 countries, the use of industrial robots results in a decline in routine work and less-educated employees (De Vries et al., 2020).

In the EU, approximately 80 million low-skilled workers may lose their jobs due to automation and robotization, while in the US, it is estimated that 47% of jobs could disappear (Ford, 2015). Along with the transformation and elimination of old jobs, new jobs, such as data scientists, will emerge, requiring different knowledge, abilities, and skills. This will result in an increased burden on education at all levels to develop new programs and provide the necessary training. According to the Future of Jobs Report 2020 by the World Economic Forum, approximately 50% of the global workforce will require reskilling by 2025 (Schwab and Zahidi, 2020). It should be noted that this estimate excludes

individuals who are currently unemployed. The successful implementation and management of Industry 4.0 technologies necessitate a workforce that possesses a high level of knowledge and creativity. However, employees who work in positions with lower levels of technological intensity face the threat of being replaced by artificial intelligence in the near future.

The impact of technological innovation on the labor market has been mixed, with both positive and negative effects. Intelligent machines are expected to replace some human jobs, resulting in job losses. According to [Molloy and Ronnie \(2021\)](#), there is a high likelihood that individuals who belong to the middle class and possess medium-level skills will be among the most affected by this trend. As a result, it is crucial to prioritize reskilling and upskilling the workforce to keep up with the rapid pace of digitalization ([Li, 2022](#)). In their research, [Mabe and Bwalya \(2022\)](#) used the Delphi study supported by systematic, targeted literature to identify the critical soft skills needed for information and knowledge management professionals in the context of Industry 4.0. Their study identified a total of 57 skills, but only 17 of them were unanimously recognized by experts. These competencies highlight the importance of not only technical skills but also soft skills such as Critical thinking, Collaboration skills, and Emotional intelligence. Similarly, [Anshari et al. \(2021\)](#), in their study of talent development, stated that the advanced technologies of the fourth Industrial Revolution would generate significant economic prosperity, leading to the emergence of numerous job opportunities. However, these jobs will demand individuals to possess skills that are closely linked to Information Technology (IT), decision-making, critical thinking, effective communication, innovation, and complex problem-solving.

In the same way, [Touahmia et al. \(2020\)](#) conducted a foresight study to identify skills and competencies needed for Saudi Arabia's job market in 2030. Their study identified ten future skills, including problem-solving, data analyzing, system thinking, and critical thinking. These skills are essential in the context of Industry 4.0 as they reflect the increasing importance of data analysis and decision-making. Other studies have also emphasized the importance of adaptability and flexibility in the context of Industry 4.0. For example, [Kořuh et al. \(2021\)](#) stated that one of the key competencies needed in the Fourth Industrial Revolution is the ability to effectively operate in varying circumstances and settings. [Mudzar et al. \(2022\)](#) revealed that the Fourth Industrial Revolution requires the workforce to possess advanced technical skills, cognitive abilities, and interpersonal skills. Attributes such as creative thinking, critical thinking, decision-making, negotiation, and persuasion are vital, as these are areas in which machines are deficient. [Alhosani et al. \(2021\)](#) found that future workers must have high-level technical skills, higher-order cognitive skills,

and human or interpersonal skills for the Industry 4.0 transition.

Similarly, [Kipper et al. \(2021\)](#) emphasized the importance of lifelong learning and continuous upskilling to remain competitive in the rapidly changing job market. Overall, the literature suggests that the future workforce needs a combination of technical and soft skills to be successful in Industry 4.0. The ability to adapt and learn quickly, critical thinking, creativity, collaboration, and ethical awareness are all essential skills and competencies that will become increasingly important in the Saudi future labor market. As Industry 4.0 continues to transform industries, policymakers, educators, and employers must work together to ensure that the workforce is equipped with the necessary skills and competencies to succeed in the future.

Although there is a growing body of research on the future of work, there is limited research on the skills needed in the Saudi labor market. This issue has become increasingly pressing due to the dynamics of the job market and the global economy. As the Kingdom of Saudi Arabia aims to achieve its ambitious Vision 2030 goals and become a leader in the region's technology sector, it is crucial to identify the future skills and competencies needed in the context of Industry 4.0. The Saudi Ministry of Education is supporting research to anticipate future skills needs, allowing for strategic responses to bridge the gap between supply and demand.

3. Research methodology

The present study aims to identify the skills and competencies needed to transition to Industry 4.0 in Saudi Arabia, with a particular focus on the Hail region. Data for this study were collected using the Delphi technique. According to [Jones \(2018\)](#), "The Delphi technique is a widely used and accepted method for gathering data from respondents within their domain of expertise." It is an exploratory methodology that enables consensus development among geographically diverse individuals with expertise and experience in a subject or phenomenon. The primary goal of a Delphi study is to build reliable consensus from an expert panel's opinions using a series of questionnaires and controlled feedback from each round ([Jones, 2018](#)). [Young \(2012\)](#) noted that Delphi studies typically involve three rounds of data collection. In the first round, the research team develops questions based on existing knowledge from open literature. The second round allows participants to provide opinions on the responses from the first round. The third round builds on the previous two rounds to reach a consensus on the topic. The Delphi technique is used to generate reasonably accurate forecasts about future outcomes in specific areas of knowledge. Ideally, each successive round narrows the range of answers to converge on a central topic ([Young, 2012](#); [Jones, 2018](#)). This study adopts a three-round Delphi strategy.

3.1. Panel selection

Selecting the appropriate expert panel for a Delphi study is crucial to the study's success, as it directly impacts the quality of the results (Jones, 2018). The Delphi technique is used to gather expert opinions in a relatively short period of time, requiring that the experts be well-informed and knowledgeable about the specific research topic. Practical methods for identifying expert panel members for a Delphi study include personal networks of subject matter experts, memberships in professional organizations, and recommendations from professional networks. Diversity in background and expertise is beneficial as it enhances a deep understanding of the research topic. Delphi panel experts should be competent in the area of knowledge related to the target topic and should possess expertise recognized by society and their professional peers (Young, 2012; Jones, 2018).

3.2. Size of panel

Previous research indicates that a Delphi panel may consist of as few as three experts or as many as 100 or more (Young, 2012; Jones, 2018). Most studies use a panel of 8-16 members, though there is no clear link between the number of panel members and the quality of the results. The quality of a Delphi study is determined by the expertise of the panel members rather than their number. Experts must meet four criteria to be considered for the panel: (i) knowledge and experience with the issues under investigation; (ii) capacity and willingness to participate; (iii) sufficient time to participate in the Delphi; and (iv) effective communication skills. Panel members' commitment is usually indicated by their response rate in each successive round (Keil et al., 2002). While properly selected experts provide valuable insights, they are often very busy and may not fully engage throughout the entire Delphi process.

For this study, a two-round Delphi technique was chosen, involving a targeted sample of experts from national and international universities, industries, and government agencies. All selected experts had over 15 years of experience in academia, industry, and business. The initial panel included 27 experts: 10 established academics (37%) and 17 engineering and management leaders from prominent Saudi industries and businesses (Aramco, Sabic, STC, etc.). These experts have proven experience with the digital transformation of businesses in Saudi Arabia and are familiar with the Hail region through previous collaborations with the research team at the University of Hail.

A survey instrument was developed after an extensive literature review focusing on future skills and job demand in the context of industrial digitization both globally and locally. Key factors driving change in businesses within the framework of Industry 4.0 technologies were identified, resulting in a list of 57 skills and competencies

required at local and global levels. The analysis highlighted four global driving forces crucial for shaping the future job market, particularly in the Saudi context, aligning with Saudi Vision 2030. The survey questionnaire was developed and administered online to the panel of experts who consented to participate in the study.

Table 1 shows the number of experts who participated in the two rounds of the Delphi study. Initially, 50 experts from academia, industry, and businesses with recognized expertise in digital transformation and engineering management were invited to participate. An introductory email explaining the research and requesting consent was sent to these experts. Of the initial 50, 27 agreed to participate in the first round. In the second round, 12 experts participated, as shown in Table 1. The authors believe this number is sufficient for the Delphi study due to the high quality of expertise among the participants, who are leaders in their fields and knowledgeable about the Saudi industrial context. Similar panel sizes have been reported in published literature (Jones, 2018; Young, 2012).

Table 1: Experts panel of the Delphi study

Category of expert	Initialization	Round one	Round two
Academic	20 (40%)	10 (37%)	4 (33.3%)
Industry and Business	30 (60%)	17 (63%)	8 (66.7%)
Total	50 (100%)	27 (100%)	12 (100%)

The experts, each with a minimum of 15 years of experience, provided insights crucial for understanding the Saudi labor market's dynamics in response to global changes. Utilizing the SurveyMonkey platform, a popular tool for online data collection, we conducted surveys that required experts to rate their agreement with statements concerning the identified driving forces on a 5-point Likert scale. This methodological approach, including the use of Cronbach's alpha (Cronbach, 1951) for reliability estimation, ensured that our measurement instruments were robust and reliable. The recruitment and admission of experts to the Delphi panel were achieved through direct communication channels, including telephone calls and emails. This direct engagement approach ensured a high level of participation and commitment from the panel experts, providing a comprehensive and nuanced understanding of the driving forces of change relevant to the future of work in Saudi Arabia, particularly in alignment with the strategic objectives of the 2030 Vision.

3.3. Instrumentation

Based on an extensive literature review, the research team developed a survey instrument to be validated by three prominent experts in the field. The survey initially contained three parts:

1. Part I: Focuses on the driving forces that shape the dynamics of change in Saudi Arabia. It assesses the relevance period of these driving forces (Never,

Relevant today, within the next 5 years, within 10 years, within 15 years).

2. Part II: Identifies the future skills needed in Saudi Arabia and the readiness of Saudi higher education to support these skills. Skills are categorized into three types:

- **Technological Skills:** Skills supporting the digital transformation related to Industry 4.0, including established technologies like web development and UI/UX design and emerging fields like blockchain, IoT, AI, and cloud computing.
- **Basic Digital Skills:** Skills needed to participate actively in a digitized world, both professionally and socially, such as digital literacy, digital learning, and collaborative work.
- **Classical Skills:** Skills gaining importance in the future work environment, like adaptability, creativity, emotional intelligence, and perseverance.

3. Part III: Explores future scenarios of the higher education system concerning Industry 4.0 technologies and Saudi Vision 2030. This part will not be presented in this paper.

All parts of the survey used a 5-point Likert scale to rate the importance of the items, with "5" meaning

extremely important and "1" meaning totally unimportant.

The content validity of the survey was tested by a panel of three experts (two professors and one industry professional) with experience in industry and skills development. They were asked to:

- Ensure each statement is clear and understandable.
- Suggest improvements or changes to the statements.
- I recommend additions or deletions of the survey items.
- Propose ways to enhance any part of the survey.

Based on their feedback, the survey was revised and administered online through SurveyMonkey to the Delphi panel (Table 1).

The quantitative Delphi methodology, with the participation of highly informed and qualified experts, is crucial for understanding the future skills and competencies necessary for Industry 4.0 transformation in the Hail region of Saudi Arabia. It also helps shape the future scenarios of the higher education system in the country. Fig. 1 shows the steps adopted in the study: (a) Initialization, panel formation, and survey design, (b) two-round Delphi study, and (c) Final evaluation and analysis.

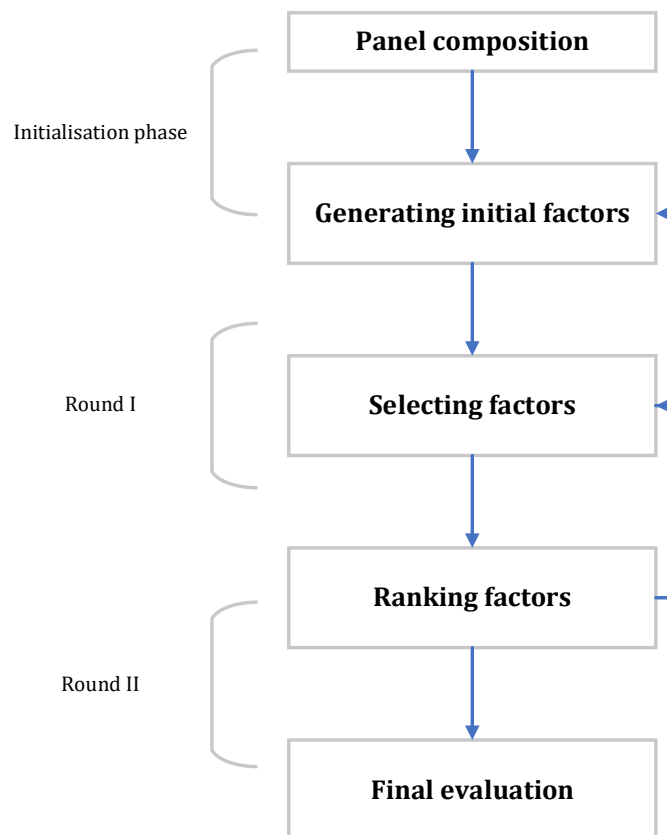


Fig. 1: The Delphi methodology adopted in the study

4. Results and discussion

In this section, we discuss the results of the Delphi study, following the three steps shown in Fig. 1. The primary objectives were to identify the future

skills and competencies needed for the digital transformation of Saudi businesses in general, and specifically in the Hail region, from the perspective of subject matter experts (SMEs) with insights from leading industries and academic institutions. We will

focus on the final results obtained from the second round of the Delphi panel, reflecting the views of 12 prominent experts from academia and industry.

To evaluate the reliability of the questionnaire used in the Delphi study, statistical measures were calculated and are presented in Table 2. The Cronbach's Alpha values for the two main constructs (Driving Forces for Change and the Importance of Future Skills) are well above the accepted threshold of 0.70, indicating a high level of internal consistency among the questionnaire items. This suggests that the items are well-correlated and reliably measure the intended constructs. Additionally, the Spearman-Brown Prophecy scores of 0.72 and 0.77 further affirm the instrument's reliability, indicating that the questionnaire remains reliable even when split into two halves, each measuring the same construct. The

Split-Half (odd-even) Correlation coefficients of 0.56 and 0.62, while lower than the other reliability measures, still show a moderate level of consistency between the two halves of the questionnaire. This discrepancy may be due to the nature of the items or variations in expert responses, which is common in Delphi studies that rely on expert opinions.

The mean scores of the test, with lower standard deviation values, indicate less variability in the experts' responses and suggest a consensus among the panel. The statistics in Table 2 demonstrate the robustness and reliability of the Delphi study instrument, confirming that it effectively captured a coherent set of expert opinions. This strong internal consistency supports the instrument's effectiveness in collecting valid and reliable data for the study's purposes.

Table 2: Reliability tests statistics

Statistics	Agreement on driving forces	Importance rating of future skills
Cronbach's alpha	0.71	0.78
Spearman-Brown prophecy	0.72	0.77
Split-Half (odd-even) correlation	0.56	0.62
Mean for test	16.67	96.75
Standard deviation for test	2.49	3.27

4.1. The driving forces of change

The analysis of the literature on future skills and future job demand reveals many important factors that influence the job market globally and at the national level. The literature review allows the research group to identify four driving forces of change that are fundamentally important and are shaping the future of work globally and at the Saudi national level within the context of the 2030 Vision. These were identified as: (a) The Fourth Industrial Revolution, and its disruptive technologies (AI, Big data analytics, Robotics, Cybersecurity, etc.), will fundamentally alter the future of production and employment in the Saudi market; (b) The socio-cultural transformation in Saudi Arabia, brought about by globalization, the increasing accessibility of knowledge and spread of social media, and this trend is driving a fundamental shift in the mindset of emerging Saudi generations, including the social acceptability of new forms and models of employment; (c) Geo-economic Reordering: Manifested by the integration of global data flows and regional connections, these changes form the most visible pattern of structural change in the long-term operating environment with profound consequences for the labor markets at the international and national levels; and (d) Sustainability Requirements: The growing impact of environmental change and its long-term consequences in terms of both challenges and opportunities in relation to the future of work will affect the Saudi job market. The panel of experts was asked to rate the level of their agreement on the driving forces of change in the Saudi context and the period in which the driver may first occur and become relevant. They were also asked to cite other driving forces that can affect the future landscape of

work in 2030 globally and in Saudi Arabia. The results of the Delphi panel presented in Fig. 2 indicate the following insights:

- Socio-cultural transformation in Saudi Arabia: is the first driving force that received the highest level of agreement among the experts, with 92.31% agreeing or strongly agreeing. It highlights the significant role of socio-cultural factors in shaping the future of the job market in Saudi Arabia. This finding highlights the recognition that technological advancements alone are not sufficient. The socio-cultural landscape of Saudi Arabia, which is undergoing significant transformation, plays a crucial role in the successful adoption and integration of Industry 4.0 technologies. This includes aspects such as education reform, workforce development, and societal attitudes towards technology and innovation. The transformation is also reflective of changing demographics and the increasing role of youth and women in the workforce, aligning with the objectives of Saudi Vision 2030.
- The Fourth Industrial Revolution: This received substantial agreement (84.62%), indicating a strong consensus on its importance as a driving force in the context of Saudi Vision 2030. The results indicate that technological advancements are at the forefront of driving change. This revolution encompasses the integration of technologies like artificial intelligence, robotics, the Internet of Things (IoT), and quantum computing. For Saudi Arabia, embracing these technologies is not just about economic advancement but also about remaining competitive in a rapidly evolving global landscape.
- Sustainability requirements also garnered significant consensus (84.62%), reflecting a

growing awareness of environmental challenges and the need for sustainable practices. This aligns with global trends where sustainability is increasingly becoming a core component of corporate and national strategies. For Saudi Arabia, this means incorporating sustainable practices in its industrial development, ensuring that the advancement of Industry 4.0 is in harmony with environmental stewardship and resource conservation.

- Geo-economic reordering: This aspect, while still receiving considerable agreement (76.92%), had relatively more mixed responses, indicating varying opinions on its impact in the Saudi market.
- These findings highlight the recognition that technological advancements alone are not sufficient to drive the country's economic

development. The socio-cultural landscape and the sustainability requirements of Saudi Arabia, which is undergoing significant transformation and development, play crucial roles in the successful adoption and integration of Industry 4.0 technologies. This includes aspects such as education reform, workforce development, and societal attitudes towards technology and innovation. The transformation is also reflective of changing demographics and the increasing role of youth and women in the workforce, aligning with the objectives of Saudi Vision 2030. It has to be mentioned here that these results stress the importance of the vision realization programs such as the NDILP, Quality of Life (QoL), and Human capital development launched by the Saudi government.

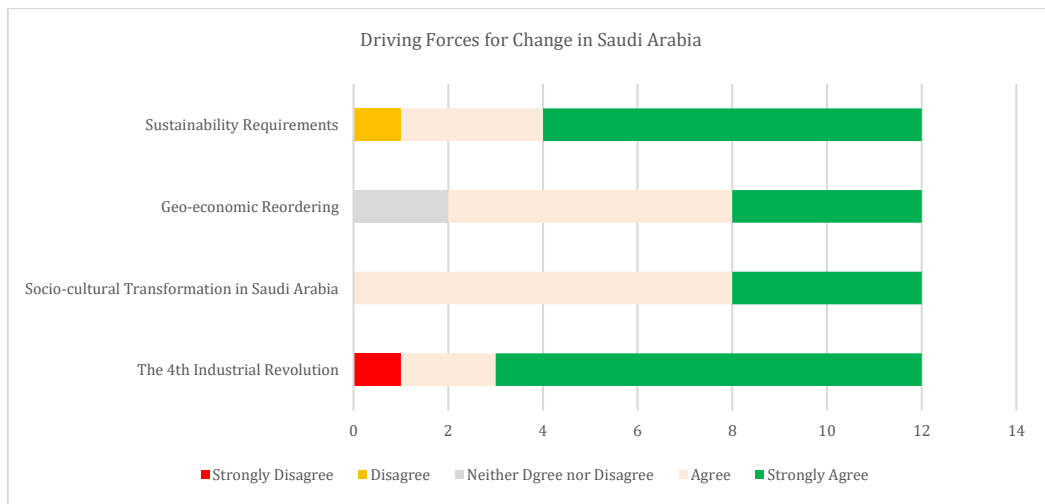


Fig. 2: Driving forces in Saudi Arabia according to the panel of experts

The experts were asked to provide their perspectives on when each of the four driving forces would become relevant. There was a clear consensus that all four driving forces are relevant today or will be within the next five years: the Fourth Industrial Revolution (61.54%), Socio-cultural Transformation (84.62%), Sustainability Requirements (76.92%), and Geo-economic Reordering (84.62%). These insights, illustrated in Fig. 3, offer an understanding

of the expected timelines for each driving force's relevance in the context of Saudi Vision 2030 and Industry 4.0 advancements in Saudi Arabia. The data indicates a strong current and near-term relevance for all four forces, with varying emphasis over the next 15 years. This information is valuable for strategic planning and prioritization for decision-makers and stakeholders involved in Saudi Arabia's technological and socio-economic development.

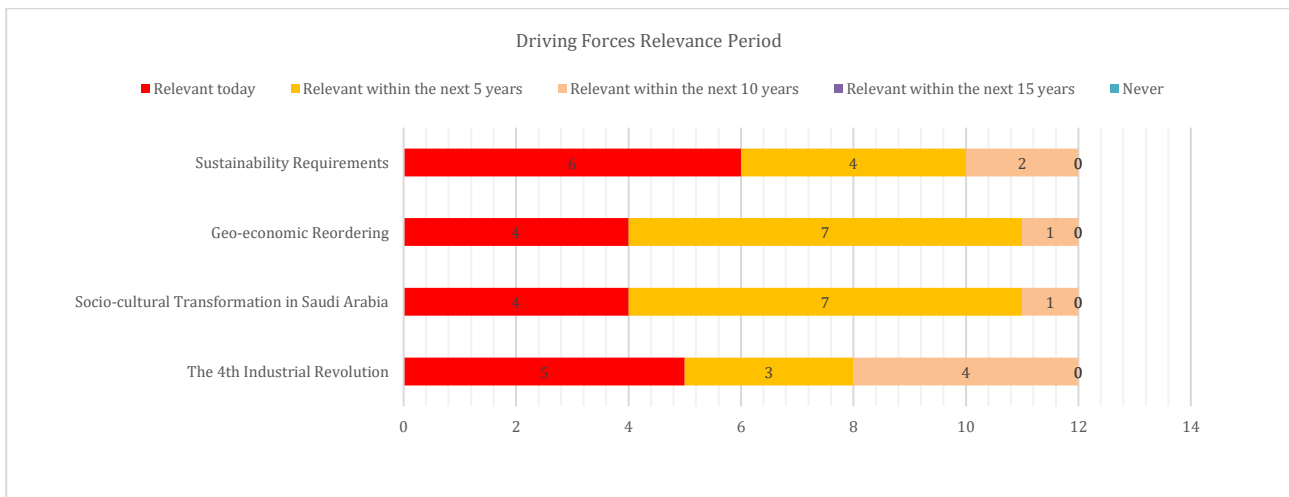


Fig. 3: Period in which the driving forces for change become relevant

4.2. Future skills needed by the Saudi job market

As discussed earlier, Saudi Arabia's ambitious journey towards economic diversification and technological advancement through Saudi Vision 2030 and the NIDL highlights the importance of developing future skills. The Delphi study presented here, based on the perceptions and opinions of a panel of experts, identified the critical skills needed for the successful implementation of Industry 4.0 technologies in Saudi industry, particularly in the Hail region, amidst a changing and challenging job market. Table 3 classifies these skills into technological skills, basic digital skills, and classical skills, along with statistics measuring their importance.

The results in Table 3 show that technological skills are paramount for the future success of Saudi Vision 2030 and the NIDL, emphasizing technological innovation and digital transformation. Skills like "Complex Data Analytics" and "Conception and Administration of Networked IT Systems" are deemed essential in a data-driven world and crucial for digital infrastructure, with over 75% rating them as Very Important. The focus on "Development of Smart Hardware/Robotics" and "Web Development" aligns with NIDL's emphasis on advanced manufacturing and digital technologies, fostering a competitive edge for local industries in the global economy.

Basic digital skills are also considered crucial by the panel of experts, as the transformation of the Saudi economy relies on digital literacy and agility. Skills such as "Digital Literacy," "Collaboration," and "Agile Working" are rated as Very Important or Important by over 75% of experts, supporting NIDL's goal of creating a technologically skilled Saudi workforce. "Digital Learning," "Digital Interaction," and "Digital Mindset" are critical for fostering a culture of continuous learning and adaptation, essential for maintaining relevance in a rapidly evolving global market.

Despite the technological shift driven by Industry 4.0, classical skills remain fundamental. The results show that "Creativity and Critical Thinking" (rated 100% Very Important) are necessary to drive innovation, supporting the creative and entrepreneurial spirit championed by Saudi Vision 2030. Similarly, "Adaptability" and "Entrepreneurial Thinking and Self-Initiative" are crucial for navigating the socioeconomic transformations envisioned. While "Emotional Intelligence," "Self-Management," and "Perseverance" were rated less important in the Saudi context, they still underpin the human element in a technology-driven world, ensuring that economic progress is balanced with social and cultural considerations. Additionally, most experts added three other critical skills: "Leadership and Social Influence," "Active Learning and Learning Strategies," and "Cognitive Flexibility."

Table 3: Future skills importance statistics

Future skills	Mean	Standard deviation	Mode	Rank
A - Technological skills (Average: 4.64)				
Complex data analytics	4.75	0.43	5	3
Development of smart hardware/Robotics	4.58	0.64	5	5
Web development	4.33	0.62	4	8
User-centric designing (UI/UX)	4.67	0.47	5	4
Conception and administration of networked IT systems	4.92	0.28	5	2
Blockchain technology development	4.75	0.43	5	3
Tech translation	4.50	0.65	5	6
B - Basic digital skills (Average: 4.68)				
Digital literacy	4.67	0.47	5	4
Collaboration	4.67	0.47	5	4
Agile working	4.75	0.43	5	3
Digital learning	4.75	0.43	5	3
Digital interaction	4.42	0.64	5	7
Digital ethics	4.75	0.43	5	3
Future digital mindset	4.75	0.43	5	3
C - Classical skills (Average: 4.63)				
Complex problem-solving	4.58	0.64	5	5
Creativity and critical thinking	5.00	0.00	5	1
Emotional intelligence	4.17	0.90	5	9
Entrepreneurial thinking and self-initiative	4.75	0.43	5	3
Adaptability	4.75	0.43	5	3
Perseverance	4.58	0.64	5	5
Self-management	4.58	0.64	5	5

4.3. Readiness of the Saudi higher education to support future skills

The readiness of Saudi higher education to support future skills was assessed in this Delphi study, with the results shown in Figs. 4A, 4B, and 4C. Overall, Saudi institutions are moderately ready to support future skills. The most supported technological skills are "Web Development" and "Conception and Administration of Networked IT

Systems." All basic digital skills (such as digital literacy, collaboration, and agile working) and classical skills are supported at a moderate level by these institutions. However, skills like "Creativity and Critical Thinking," "User-Centric Designing," "Blockchain Technology Development," and "Development of Smart Hardware/Robotics" are perceived by the panel of experts to be poorly supported.

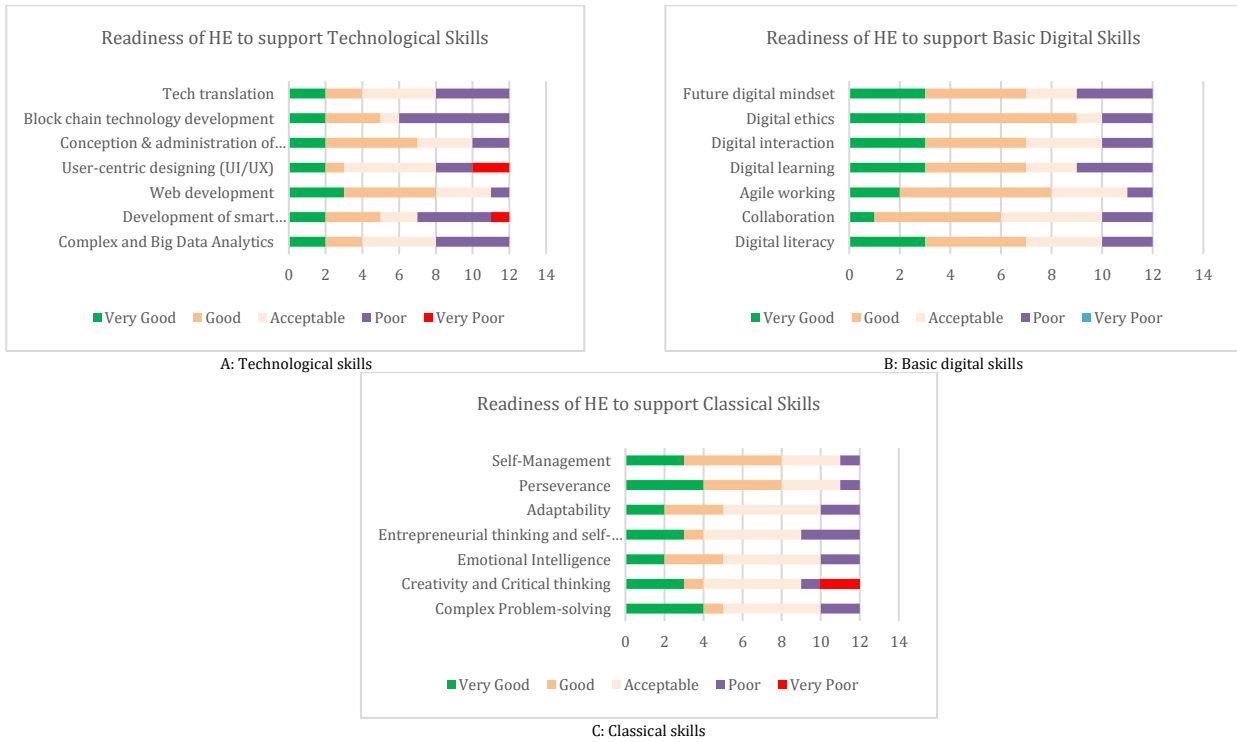


Fig. 4: Readiness level of the Saudi higher education to support future skills

These results reflect a mixed level of readiness for the set of skills, indicating areas where Saudi Higher Education institutions are well-prepared and areas needing significant improvement and development. In general, technological and digital skills show variability in readiness, while classical skills generally turn out to be at acceptable levels of readiness. These insights can guide educational policymakers and institutions in Saudi Arabia to enhance their curricula and resources to better support the development of future skills, aligning with the needs of the future workforce that would support the achievement of the Saudi Vision 2030 goals and NIDL both at the national level and the local at Hail region.

The present results identified the required skills for transformation to Industry 4.0 in the Hail region in Saudi Arabia through the Delphi study. It is important to note that these skills are similarly identified in other contexts of developing countries, such as Europe, Northern America, and the US, as reported in various international and European reports and research (Yusof et al., 2022; Benayoune, 2022; WEF, 2020; Brunello and Wruuck, 2021; Deming and Kahn, 2018; Weaver and Osterman, 2017). The authors believe that the future skills identified in this Delphi study are not just isolated competencies but interconnected elements of a broader skills ecosystem. For Saudi Arabia, investing in these skills means building a strong workforce capable of driving the country's economy toward its ambitious Vision 2030 goals. This requires a combined effort involving educational reforms, industry partnerships, and continuous professional development, ensuring that the workforce is equipped for both present and future challenges. This research supports the Mohammad Bin Salman

Foundation's emphasis on the important role higher education institutions should play in preparing future Saudi leaders with Industry 4.0 skills and competencies, contributing to the national economy as envisioned in Saudi Vision 2030.

5. Conclusions

This paper presents the results of a Delphi study involving a panel of experts from academia and industry with specific knowledge and experience in the Saudi job market. The research aimed to identify and assess the importance of the skills needed for the future Saudi job market to cope with the changes and disruptions brought by Industry 4.0 technologies and the social and economic challenges targeted by Saudi Vision 2030. The study concluded that technological skills, basic digital skills, and classical skills are critically important for Saudi Arabia's future market. The study also identified gaps in Industry 4.0 skills that academic institutions need to address to have a real impact on the job market. This is reflected in the varying readiness levels of higher education institutions to support these skills through academic teaching and extracurricular activities, such as engineering students' clubs and competitions for innovation and critical thinking. The findings of this Delphi study are relevant to both the Hail region and Saudi Arabia as a whole within the context of Saudi Vision 2030 and the NIDL. These strategic frameworks aim to reduce the national economy's dependence on oil and diversify its economic sectors. The emphasis on socio-cultural transformation and sustainability suggests that the vision's success relies not only on technology adoption but also on a strong focus on human capital development within a well-developed

skills ecosystem. Saudi higher education institutions and human capital development organizations must invest in these future skills through programs and initiatives that translate human capital into a robust workforce capable of driving the nation toward its ambitious Vision 2030 and NIDLP goals. This requires a synergistic and holistic approach involving curriculum reforms, industry collaborations, and continuous professional development, ensuring that the workforce is prepared for future technological advancements, socio-cultural transformations, and other disruptions.

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Compliance with ethical standards

Ethical considerations

This study was conducted following ethical guidelines. All participants provided informed consent, and their confidentiality was maintained. The research protocol was approved by the Ethical Review Board of the University of Ha'il, Saudi Arabia.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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