frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 04 March 2025
DOI 10.3389/feduc.2024.1487634

OPEN ACCESS

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RECEIVED 28 August 2024
ACCEPTED 15 November 2024
PUBLISHED 04 March 2025

CITATION
Almutairi YMN, Al-Saad AF, Elmelegy RI, Bakr AAH, Abdallah MAR and Almotairi KMN (2025) Fourth industrial revolution and higher education in the Kingdom of Saudi Arabia.
Front. Educ. 9:1487634.
doi: 10.3389/feduc.2024.1487634

Fourth industrial revolution and higher education in the Kingdom of Saudi Arabia

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This research is aimed at clarifying the effect of the industrial revolution on higher education institutions in the Kingdom of Saudi Arabia universities. This is accomplished by examining the Technology Acceptance Model (TAM) and Social Cognitive Theory (SCT) and acknowledging the relationship between content learning, learning opportunities, and instructional activities and the adoption of the industrial revolution. The research involved using a cross-sectional/descriptive and analytical method to analyze and investigate the effect of adopting the industrial revolution on university education institutions. In addition, it adopted a quantitative technique for analyzing the gathered data. A total of four hundred members of the academic staff were selected from the University of Hail (UoH) in Saudi Arabia. The results of the research revealed that there is a positive relationship between content learning, learning opportunities, content and instructional activities, and the adoption of the industrial revolution. Furthermore, there is a positive correlation between social impact and the fourth industrial revolution. The results confirmed that in order for the University of Hail to effectively respond to the challenges of the fourth industrial revolution and to prepare students for future jobs, the academic leaders must strive to improve the quality of teaching, learning, and research and make learning more relevant to the needs of the dynamic society.

KEYWORDS

fourth industrial revolution, technology adoption, universities, academic leaders, policy makers

Introduction

Technology played a vital role in the development of any country. Its importance can be felt in several sectors of the economy, including education, health care, oil and gas, hospitality, business, and security (Ford, 2015). The development of the world of work and continuous technological advancement have presented a great challenge to human capital development (de Pleijt, 2018). Additionally, the Fourth Industrial Revolution (4IR) has emerged as a result of technological breakthroughs. Thus, preparing students to use 4IR technologies is crucial to producing graduates who are informed, capable, and skilled. Since it can be difficult to guarantee that students are prepared to use 4IR technologies, it is necessary to comprehend the variables that affect preparedness in this area (Alshammari and Alshammari, 2024).

The fourth industrial revolution has brought a new wave to the global economy and raised many concerns for government, education institutions, industries, and the entire global

community (Zervoudi, 2020). The new wave created by the fourth industrial revolution has made it clear that new technologies such as artificial intelligence and robots will soon replace humans in the workplace (Menon and Fink, 2019; Peters, 2017; Schwab, 2016). In order to meet up with the numerous global challenges and meet the needs of societies, higher education institutions are restrategizing their policies in order to meet the technological demands of graduates and employers (Elayyan, 2021; Penprase, 2018).

Considering the future challenges of technology in societal and economic development, the Saudi Arabian government has made tremendous moves by creating the Centre for the Fourth Industrial Revolution (C4IR), establishing entrepreneur centers, and making technology compulsory across all levels of education in the Kingdom (Amuda, 2020; Abdulrahim and Mabrouk, 2020; Aljaber, 2018). Despite these laudable efforts by the government, the country is yet to meet the demands of employers and the international community in addressing the challenges posed on them by the fourth industrial revolution (Jamjoom, 2016; Alzube, 2012). Therefore, this research aims to examine the effects of the fourth industrial revolution on higher education institutions in the Kingdom of Saudi Arabia with the sole aim of providing possible solutions to some of the challenges posed by higher education, improving performance, and enhancing sustainable higher education development.

Theory and conceptual framework

In this research, an effort was made to examine two relevant theories. These are the Technology Acceptance Model (TAM) and Social Cognitive Theory (SCT). Each will be extensively discussed in the succeeding paragraphs.

The Technology Acceptance Model was introduced by Fred Davis (1989) for his doctoral proposal at the MIT Sloan School of Management. This model was developed by Davis in order to measure the adoption of new technology based on the attitude of customers. It is worthy to note that this model was developed during the time when computers were being introduced into the workplace. Davis aimed to investigate and predict the system use of information technology managers and vendors. It derives from the Theory of Reasoned Action (TRA). It was adjudged to be one of the most commonly used models in the field of technology (Taherdoort, 2018; Wu, 2009). It is an information system that describes shapes how users adopt and make use of technology (Marangunic and Granic, 2015). The model argued that a person's intent to use (acceptance of technology) and usage behavior (actual use of technology) are predicted by the person's perception of the usefulness of the technology (what the person will gain from using it) and the ease of use. In essence, this model centered on the perceptions of potential users of technology, claiming that their perceptions were influenced by perceived usefulness and ease of use (Chenng and Vogel, 2013). This model considers several factors, including the implementation process, user training, user participation in design, and system characteristics (Lin et al., 2011). It has numerous benefits. It emerged as an essential model for understanding and predicting human behavior toward potential rejection or acceptance of technology (Marangunic and Granic, 2015).

Furthermore, the social cognitive theory was proposed by Albert Bandura. The theory is widely used in numerous fields, including education, medicine, communication, business, technology, and psychology (Tougas et al., 2015; Bandura, 2011; Bandura, 2004). The Social Cognitive Theory originated in the 1960s as the Social Learning Theory. It was later transformed into the Social Cognitive Theory by Bandura (1989), wherein Bandura argued that learning occurs in a social context with a dynamic and reciprocal interaction between person, environment, and behavior (Bandura, 2011). This theory stressed the importance of measures that can change or modify behavior (Rana and Dwivedi, 2015). Further, it argued that the individual is not only shaped by inner or environmental forces alone but is also self-regulating, self-developing, and proactive (Bandura, 2004; Bandura, 2001). As a result, the social cognitive theory proposed three factors that influence behavioral decisions. These factors include the environment, the individual personality, and the behavioral factor. Environmental factors include social factors, which are external to the individual physically. Moreover, individual personality refers to any cognitive, personality, and demographic aspect characterizing a person, while behavioral factors include performance, usage, and adoption issues (Bandura, 2011). The Social Cognitive Theory has a number of advantages. It helps in enhancing knowledge sharing among people (Al Muqrin and Mutambik, 2021), information seeking (Middleton et al., 2018), promoting interest, goal selection (Blanco, 2011), and reforming behavior (Bandura, 2009).

This theory and model have a great relationship with the subject of discussion. Adopting and responding to technology use in higher education depends on many factors, which these theories have explained. The behavior of users, their readiness, their environment, and their personality play a significant role. Therefore, the researchers developed the following conceptual framework for better understanding of the research (Figure 1):

As stated in the conceptual framework of the research above, when lecturers adopt technological devices in the course of instruction, it will control learning, enhance the opportunities for students and staff, and impact the content of instruction and activities and social development. The end result of these interactions among these variables is that it will help secure a brighter and more rewarding future for students, especially in the world of work. It will also help enhance the digital economy, where graduates will be productive, and enhance sustainable development. Based on this conceptual framework, the following hypotheses will be tested during this research:

> *H1*: There is a significant relationship between control learning and the adoption of the industrial revolution in higher education institutions.

There exists no significant relationship between control learning and the adoption of the industrial revolution in higher education institutions.

> *H2*: There is a significant relationship between learning opportunities and the adoption of the industrial revolution in higher education institutions.

There exists no significant relationship between learning opportunities and the adoption of the industrial revolution in higher education institutions.

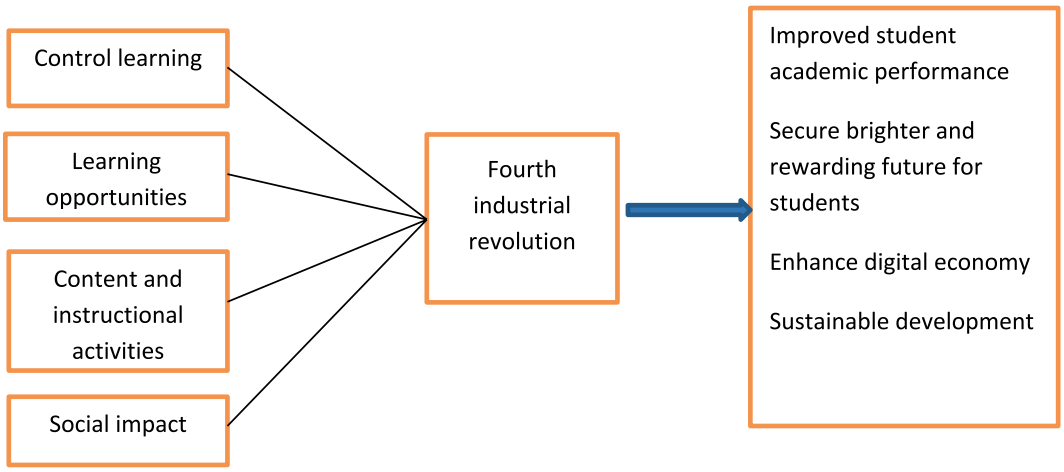

FIGURE 1
Conceptual framework of the research.

> *H3*: There is a significant relationship between content and instructional activities and the adoption of the industrial revolution in higher education institutions.

There is no significant relationship between content and instructional activities and the adoption of the industrial revolution in higher education institutions.

> *H4*: There is a substantial relationship between social impact and the adoption of the industrial revolution in higher education institutions.

There exists no significant correlation between the social impact and the adoption of the industrial revolution in higher education institutions.

Literature review

The fourth industrial revolution

There is no general consensus on the definition of the term industrial revolution (Maynard, 2015). However, an effort will be made in this section to provide a preview of some of the definitions of the term for better understanding. According to the Cambridge Dictionary (2017), the industrial revolution refers to the period of time when work began to be done more by machines in factories rather than by hand at home. In addition, Belvedere et al. (2012) conceived the term industrial revolution as a progression in science and technology that aims at enhancing industrialization globally. The industrial revolution has had a significant influence on public policies, such as funding, research, areas of action, and innovations, across different countries (Liao et al., 2017).

Commenting on the industrial revolution, Schwab (2016) argued that the first industrial revolution suggested the use of steam power and water to automate production. The second industrial revolution projected the use of electric power to mechanize production. The third industrial revolution argued that information technology and electric technology are crucial for mechanizing production. The fourth industrial revolution was based on the third industrial revolution, which claimed that the digital revolution was essential for automating production. In addition, the fourth industrial revolution is characterized by a fusion of technologies blurring among digital, biological, and physical sciences. Moreover, products and technologies such as artificial intelligence, cyber security, cloud computing, robotics, the internet of things, block chains, machine learning, and others formed the features of the fourth industrial revolution (Elayyan, 2021; Menon and Castrillon, 2019).

The fourth industrial revolution has many benefits and has also posed challenges to the global community. Exploring its positive side, the fourth industrial revolution has the potential to accelerate global income levels, open up new markets, enhance the quality of life, and foster economic growth (Schwab, 2016). In addition, it has the potential of empowering small and medium enterprises (Menon and Fink, 2019) and fostering industrialization globally (Carl, 2009). Additionally, the fourth industrial revolution was adjudged to foster sustainable development in various aspects of human development, such as health care, clean and renewable energy, education, green environment, agriculture, business, transportation, and others (Min et al., 2019). In contrast, the fourth industrial revolution has presented a great challenge to the global community. Undoubtedly, the emergence of the fourth industrial revolution will result in a disruption of the labor market, claiming that automation will substitute labor across the globe (Jarosz et al., 2020). Therefore, workers will be displaced by machines (Schwab, 2016). New technologies should be incorporated into teaching and learning as a measure of responding sharply to the wave (Jarosz et al., 2020).

The fourth industrial revolution and higher education

The fourth industrial revolution has had a profound effect on education. According to a study by Becker et al. (2011), it was found

that the industrial revolution had serious effects on learning and education. Knowledge and information services have contributed to a paradigm shift in economic growth and development across the globe (Binkley et al., 2012). Moreover, within the era of the Fourth Industrial Revolution, we are living in a technologically advanced society, and students and teacher educators must be adequately prepared to succeed within this progressive society (Teaching and Learning in the 21st Century by Naidoo (2021)).

Arguably, innovation and technology have led to a new paradigm in education, curriculum design, curriculum implementation, and content delivery and have made technology a must for every workforce to learn and imbibe (Nor Azizah et al., 2019; Kivunja, 2015). In light of this, Peters (2017) emphasized that education in the present day must adopt modern technologies in curriculum instruction and content delivery in order to produce a saleable workforce who can compete favorably in the changing world of work. Moreover, Elayyan (2021) and Gleason (2018) stressed that the advent of the fourth industrial revolution has an impact on learning opportunities. By incorporating various technologies such as cloud computing, artificial intelligence, cyber security, robotics, and other digital devices, students learn various technologies in their curriculum. With these technologies, they will be able to change their lives for good, get befitting jobs, reduce unemployment among graduates, and enable them to contribute meaningfully to the economic and social development of their countries (Elayyan, 2021; Waghid et al., 2019; Al Lily et al., 2018; Kivunja, 2015).

Clearly, the Fourth and Fifth Industrial Revolutions have brought about uncertainty and shifting demands, which universities are finding difficult to handle, especially when it comes to lifelong learning and worker upskilling. Universities must reconsider their responsibilities and shift their institutional mindsets in order to adapt. They can achieve this by using tools like digital micro-credentials (Lang, 2023).

Furthermore, the fourth industrial revolution has a great impact on the content and instructional activities. Aprianti and Sahid (2020) found that the fourth industrial revolution has reshaped teaching and instructional activities for teachers by encouraging them to be more committed to educational ethics, influencing learning outcomes, applying non-bias evaluation, and enhancing their professional competences. These teachers were required to improve their skills and technical abilities in order to respond positively to the demands of the fourth industrial revolution (Afrianto, 2018; Rojewski and Roger, 2017; Tasir et al., 2012).

Moreover, the fourth industrial revolution does not only limit its contributions to the teaching and learning environment alone, but also has an effect on social development. Once graduates from higher education institutions leave their respective institutions, it is expected that they will join society and contribute to the economic development of their country. Disruptive technologies, such as artificial intelligence, block chain, robotics, and 3D printing, are transforming the global social, economic, and political system in an unpredictable manner, ultimately impacting the way of life of people (Menon and Fink, 2019; World Economic Forum, 2018). Another impact of the fourth industrial revolution on social development is that it provides valuable suggestions on how to improve and meet the social needs of citizens for sustainable economic and social development (Mulgan, 2021).

Naidoo (2021) affirms that 21st century teaching and learning concepts emphasize "globalization and internationalization," which calls for a change in the educational setting. Critical skills are imperative for both teachers and students to succeed in the educational environment of the twenty-first century. Teachers must employ cutting-edge teaching strategies that give students the chance to participate in activities that promote teamwork, communication, critical thinking, creativity, and problem solving if they want their pupils to acquire these abilities.

The above presentation has made it clear that adoption of the industrial revolution is a must in the higher education system across the globe. In order to make our education system more effective, there is an urgent need for policymakers, government, teachers, parents, and other stakeholders in education to rise, reflect upon the claims of the fourth industrial revolution, and adopt technology maximally in the instruction process in our education institutions (Mulgan, 2021; Reaves, 2019; Philips et al., 2017; Schwab, 2016; Kivunja, 2015).

Methodology

Research design

The research used cross-sectional/descriptive and analytical methods to analyze and investigate the effect of adopting the industrial revolution on university education institutions. In addition, it adopted a quantitative technique in analyzing the gathered data. This combination of the two techniques helped the researchers investigate the effect of the fourth industrial revolution and higher education in the Kingdom of Saudi Arabia.

Research population and sample

The population in this research study consists of 427 members of academic staff at the University of Hail. A total number of 400 individuals, including 320 males and 80 females with diverse experiences and academic degrees, from eight colleges situated at the University of Hail, namely the College of Medicine, the College of Arts, the College of Computer Science and Engineering, the College of Dentistry, the College of Nursing, the College of Public Health and Health Informatics, the College of Pharmacy, and the College of Science, participated in the research. This sample was chosen randomly selected. The following table shows the characteristics of the research sample (Table 1).

Based on the information provided in Table 2, it was found that 320 (80%) of the respondents are male while the remaining 80 (20%) are female. This shows that there are more male faculty members than females at the University of Hail. Also, the table shows that 27 (6.8%) of the respondents have worked between 0 and 5 years in their respective universities, 251 (62.7%) of the respondents have worked between 6 and 10 years, while the remaining 122 (30.5%) have worked with Saudi Arabian universities for over 10 years. Finally, the table shows that 31 (7.7%) of the respondents are lecturers in Saudi Arabian universities, 177 (44.3%) are in the rank of assistant professor, 156 (39%) are in the rank of associate professor, and the remaining 36 (9%) are in the professorial rank at the University of Hail, Kingdom of Saudi Arabia. Finally, 45 (11.25%) of the faculty members are lecturers from the College of Arts, 50 (12.50%) are faculty members from the College of Computer Science and Engineering, 40 (10%) are faculty members

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TABLE 1 Demographic information of respondents.

Item	Frequency	Percentage
Gender		
Male	320	80
Female	80	20
Total	400	100
Year of experience		
1–5 years	27	6.8
6–10 years	251	62.7
Above 10 years	122	30.5
Total	400	100
Rank		
Lecturer	31	7.7
Assistant professor	177	44.3
Associate professor	156	39.0
Professor	36	9.0
Total	400	100
College		
Art	45	11.25
Computer Sciences & Engr.	50	12.50
Dentistry	40	10.0
Education	50	12.50
Medicine	45	11.25
Nursing	35	08.75
Public Health	40	10.0
Pharmacy	40	10.0
Sciences	55	13.75
Total	**400**	**100**

TABLE 2 Item-total statistics.

S/N	Item	Cronbach's alpha if item deleted
1	Cut or decrease spending on education	0.763
2	Raise awareness on social issues and problems	0.773
3	Raise students' healthcare by using block chain	0.781
4	Enhance social values	0.776
5	Increase job opportunities in educational field	0.787

from the College of Dentistry, 50 (12.50%) of the sampled population are lecturers in the College of Education, and 45 (11.25%) of the sampled faculty members are lecturing in the College of Medicine. Moreover, 35 (8.75%) of the sampled faculty members are working in the College of Nursing, 40 (10%) of the sampled faculty members are lecturing in the College of Public Health, another 40 (10%) are lecturing in the College of Pharmacy, and the remaining 55 (13.75%) are faculty members from the College of Science. Next, the researchers went further to test the hypotheses set for this research, as reported below:

Research tool

A questionnaire of academic staff was conducted to gain insight into the effect of the fourth industrial revolution and higher education in the Kingdom of Saudi Arabia. It was adopted from the study of Elayyan (2021) on the future of education according to the fourth industrial revolution and the study of Aprianti and Sahid (2020) on the relationship between teachers' competency and the fourth industrial revolution. The questionnaire was adapted to universities in the Kingdom of Saudi Arabia. It was divided into six sections of A to F. Section A centers on the demographic information of the respondents, while sections B to F relate to questions on the fourth industrial revolution and higher education. In all, the adopted questionnaire consists of five dimensions, including 40 items.

The data were collected from April 2024 to June 2024 using a web application. The prepared questionnaire contained multiple-choice questions that were calculated based on a three-point scale (agree, neutral, and disagree). Some statistical techniques were used for the statistical analysis of the data compiled through surveys. Moreover, the research purpose and procedures were explained to the participants, and informed consent was obtained upon enrollment.

Reliability and validity of the research tool

For the reliability test, Cronbach's alpha was used to verify the internal consistency of the scale. It was conceived as one of the most commonly used indicators of internal constituency (Pallant, 2011). According to Hair et al. (2010), the term internal consistency of scale refers to the degree to which the items that make up the scale hang together. DeVellis (2003), however, argued that the value of the Cronbach's alpha coefficient of a scale should be above 0.7. Below is a result of the reliability test for the items in the survey questionnaire:

As indicated in Table 3 above, the value of the Cronbach's Alpha in the reliability statistics for control learning is 0.782. This value is in accordance with the recommended value of 0.7 suggested by Pallant (2011). A close investigation of the item total statistics table in Table 4 indicated that none of the item exceeds 0.782. This therefore, suggests a good internal consistency reliability of the scale. So, it can be concluded that these seven items passed the test of reliability. Therefore, the seven items were retained. Next, the researchers examined the reliability of the items under learning opportunities further, as reported below (Table 5):

Table 6 shows that there are nine items under learning opportunities. This variable has a Cronbach's alpha of 0.763 which exceeds the recommended values. Also, the items listed under the total statistics for learning opportunities loaded flawlessly well below 0.763. This indicated good internal consistency and reliability for the scale. Therefore, the nine items under Learning Opportunities will be retained because they passed the test of reliability internal consistency. The research further examined the reliability of content and instructional activities, as presented in Tables 6, 7.

Table 8 shows that there are nine items under content and instructional activities with a Cronbach's alpha of 0.810. This value surpasses the recommended value of 0.7. Similarly, Table 7 shows the result of the Crobach's alpha if item deleted for each of these nine items categorized under content and instructional activities. Considering the result in Table 7, it was found that none of the items exceeded 0.810. This shows very good internal consistency of the

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TABLE 3 Item-total statistics.

S/N	Item	Cronbach's alpha if item deleted
1	Decrease lecturers' attendance in the university	0.742
2	Keep the humanity interaction between lecturers and students.754	0.754
3	Increase classroom management	0.716
4	Help to verify students' files anywhere by block chain	0.757
5	Improve decisions toward students by using artificial intelligence	0.762
6	Keep students' activities and duties for a longtime by using cloud computing	0.755
7	Keep students' data safely by using cyber security	0.717

TABLE 4 Reliability statistics for control learning.

Cronbach's alpha	*N*
0.782	7

TABLE 5 Reliability statistics for learning opportunities.

Cronbach's alpha	*N*
0.763	9

TABLE 6 Item-total statistics.

S/N	Item	Cronbach's alpha if item deleted
1	Increase the experiences exchanged	0.711
2	Provide more learning resources and database	0.725
3	Allow learning anytime and anywhere	0.719
4	Support more opportunities in individual learning	0.732
5	Support more opportunities in social learning	0.757
6	Enhance global learning	0.749
7	Achieve long-life learning	0.760
8	Extend the learning platforms instead of the typical school	0.755
9	Produce nano-robots which will help improve students' motivation toward learning	0.749

TABLE 7 Reliability statistics for content and instructional activities.

Cronbach's alpha	*N*
0.810	9

reliability scale. It, therefore, implies that all nine items under content and instructional activities shall be retained. The research further examined the reliability test for social impact, as reported in Tables 8, 9.

Considering the result of the reliability test presented in Tables 2, 9, it was found that the five items under social impact have a

TABLE 8 Item-total statistics.

S/N	Item	Cronbach's alpha if item deleted
1	Ensure commitment to educational ethics	0.803
2	Modifies instructional strategies	0.807
3	Change the courses learning outcomes	0.789
4	Adopt the integrated curricula	0.799
5	Allow robots to teach inside the classroom instead of lecturers	0.805
6	Apply non-bias evaluation	0.781
7	Understand more and more instructional content	0.806
8	Allows e-applications and mobiles to dominate education	0.800
9	Introduce new concepts in the courses like smart cities, medical technology etc	0.792

TABLE 9 Reliability statistics for social implications.

Cronbach's alpha	*N*
0.790	5

TABLE 10 Reliability statistics for adoption of 4th IR Learning.

Cronbach's alpha	*N*
0.815	10

Cronbach's alpha of 0.790. Also, none of the five items in Table 9 load above 0.790. This shows good internal consistency of the reliability scale. Therefore, all five items passed the test of reliability and will be retained. Subsequently, the research examines the reliability of the items under the adoption of the fourth industrial revolution, as shown in Tables 2, 10.

As indicated in Table 11, it was found that there are 10 items under adoption of the fourth industrial revolution with a Cronbach's alpha value of 0.815. Table 10 shows the result of the Cronbach's alpha if an item is deleted for each of these 10 items. A careful consideration of this table shows that all 10 items passed the test of reliability because they showed good internal consistency and reliability. Having fulfilled this condition, the researchers retimed these 10 items.

In addition, the survey questionnaire used in this research was validated using factor analysis. Below is the result of the validity:

The 40 items of the industrial revolution and higher education in the Kingdom of Saudi Arabia were subjected to Principal Component Analysis (PCA) using the Statistical Package for Social Science (SPSS) version 26. Prior to performing PCA, the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of 0.3 and above. The Kaiser-Mayer Olkin value was 0.669, exceeding the recommended value of 0.6 (Kaiser, 1970, 1974), and Bartlett's test of sphericity reached statistical significance at 0.000, supporting the factorability of the correlation matrix. In addition, the principal component analysis revealed the presence of five components with eigenvalues exceeding 1, explaining 18.50, 15.42, 13.71, 10.04, and 7.01% of the variance, respectively. An investigation into the scree plot revealed

TABLE 11 Item-total statistics.

S/N	Item	Cronbach's alpha if item deleted
1	I use learning aids such as projectors, virtual reality, computer and others	0.784
2	I use computer laboratory that has internet access	0.797
3	I have skill related to digital technology	0.806
4	I demonstrate effective facilitation skills in the use of technology	0.802
5	I use online applications in learning methods	0.791
6	I use software such as Microsoft Office in the teaching and learning process	0.808
7	I search website as a reference	0.810
8	I provide information on applications that can be downloaded onto smartphones to help improve students search for information	0.812
9	I use open learning media on the internet to improve student performance	0.811
10	I control the use of digital technology by students	0.810

that there was a clear break after the sixth component. Using Catell's (1966) scree test, it was decided to retain six components for further investigation. The five-component solution accounted for 64.68% of the variance.

Data administration, collection, and analysis

The adapted questionnaire was distributed to members of academic staff at two different public universities in the Kingdom of Saudi Arabia via their email addresses and physical contact. Researchers observed the COVID-19 protocol and used the online option as an alternative means of reaching more respondents. In total, 600 questionnaires were distributed across various faculties at these two public universities in the Kingdom. Out of this, 400 questionnaires were filled out correctly and returned to the researchers. Since this number can represent the entire population conveniently, the researchers went ahead with the research. In addition, simple percentage and Pearson Correlation Coefficient were used to analyze the data collected from the respondents. Pearson Correlation Coefficient enables researchers to examine relationships between variables (Pallant, 2011). Therefore, this research examined how the fourth industrial revolution would affect teaching and learning in higher education institutions in the Kingdom of Saudi Arabia universities. A detailed report will be presented in the next heading.

Findings

This section presents the analysis of the data collected from the respondents as presented below:

Findings related to hypothesis 1

> *H1*: There is a significant relationship between control learning and the adoption of the fourth industrial revolution in higher education institutions.

The relationship between control learning and adoption of fourth industrial revolution in higher education institutions was investigated using Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure that there is no violation of the assumptions of normality, linearity and homoscedasticity. There was a strong positive correlation between control learning and adoption of fourth industrial revolution in higher education institutions with $r = 0.578$, $n = 400$, $p < 0.005$. Therefore, the researcher accepted the alternative hypothesis that states that there is a significant relationship between control learning and adoption of the fourth industrial revolution in higher education institutions and fail to accept the null hypothesis.

As indicated in Table 12 above, the number of respondents sampled in this study is 400. It further revealed that there is a positive relationship between control learning and adoption of fourth industrial revolution. The strength of the relationship between these two variables is large because it corresponds with the argument of Cohen (1988) who stressed that correlation value (r) between 0.50 to 1.0 is large.

These findings confirm that the fourth industrial revolution contributes to improving decisions toward students by using artificial intelligence, decreasing lecturers' attendance in the university, keeping the humanity interaction between lecturers and students, helping to verify students' files anywhere through block chain, and preserving students' activities and duties for a long time by using cloud computing.

Findings related to hypothesis 2

> *H2*: There exists a significant relationship between learning opportunities and the adoption of the fourth industrial revolution in higher education institutions.

The relationship between learning opportunities and the adoption of the fourth industrial revolution in higher education institutions was investigated using the Pearson product–moment correlation coefficient. Preliminary analyses were performed to ensure that there is no violation of the assumptions of normality, linearity, and homoscedasticity. The findings can be found in the following table.

As shown in Table 13, there was a significant positive correlation was observed between learning opportunities and the adoption of the fourth industrial revolution in higher education institutions, with $r = 0.563$, $n = 400$, and $p < 0.005$. Therefore, the researchers accepted

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TABLE 12 Correlation.

	Control learning	Fourth industrial revolution
Control learning: Pearson correlation	1	0.578**
Sig. (2 tailed)		0.000
N	400	400
Fourth industrial revolution: Pearson correlation	0.578**	1
Sig. (2 tailed)	0.000	
N	400	400

TABLE 13 Correlation.

	Learning opportunities	Fourth industrial revolution
Learning opportunities: Pearson correlation	1	0.563**
Sig. (2 tailed)		0.000
N	400	400
Fourth industrial revolution: Pearson correlation	0.563**	1
Sig. (2 tailed)	0.000	
N	400	400

an alternative hypothesis, which states that there is a significant relationship between learning opportunities and the adoption of the fourth industrial revolution in higher education institutions, but failed to accept the null hypothesis.

These findings confirm that the fourth industrial revolution helps to achieve long-life learning, support more opportunities in social learning, extend the learning platforms instead of the typical school, enhance global learning, produce nanorobots, which will help improve students' motivation toward learning, and support more opportunities in individual learning.

Findings related to hypothesis 3

> *H3*: There is a significant relationship between content and instructional activities and the adoption of the fourth industrial revolution in higher education institutions.

The relationship between content and instructional activities and the adoption of the fourth industrial revolution in higher education institutions was investigated, and findings can be shown as follows:

The findings in Table 14 confirm that there is a positive correlation between content and instructional activities and the adoption of the fourth industrial revolution with a *p*-value less than 0.05.

There was a significant positive correlation was observed between content and instructional activities and the adoption of the fourth industrial revolution in higher education institutions, with $r = 0.621$, $n = 400$, and $p < 0.005$. Therefore, the researcher accepted the alternative hypothesis and failed to accept the null hypothesis. These findings confirm that the fourth industrial revolution contributes to understanding more instructional content, allowing robots to teach inside the classroom instead of lecturers and e-applications and mobiles to dominate education, modifying instructional strategies, ensuring commitment to educational ethics, adopting the integrated curricula, and allowing robots to teach inside the classroom instead of lecturers.

TABLE 14 Correlation.

	Content and instructional activities	Fourth industrial revolution
Content and instructional activities Pearson correlation	1	0.621**
Sig. (2 tailed)		0.000
N	400	400
Fourth industrial revolution: Pearson correlation	0.621**	1
Sig. (2 tailed)	0.000	
N	400	400

Findings related to hypothesis 4

> *H4*: There is a significant relationship between social impact and the adoption of the industrial revolution in higher education institutions.

The relationship between social impact and adoption of fourth industrial revolution in higher education institutions was investigated using Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure that there is no violation of the assumptions of normality, linearity and homoscedasticity. There was a strong positive correlation between social impact and adoption of fourth industrial revolution in higher education institutions with $r = 0.649$, $n = 400$, $p < 0.005$. As a result, the researcher accepted the alternative hypothesis which states that there is a significant relationship between social impact and adoption of the fourth industrial revolution in higher education institutions and fails to accept the null hypothesis.

Based on the information provided in Table 15 above, it was found that the strength of the relationship between social impact and adoption of fourth industrial revolution in higher education institutions is large. This corroborates with the view of Cohen (1988) who argued that correlation value (r) between 0.50 to 1.0 is large.

These findings confirm that the fourth industrial revolution helps to increase job opportunities in the educational field, increase job opportunities in the educational field, raise students' healthcare by using block chains, raise awareness on social issues and problems, and decrease spending on education.

TABLE 15 Correlation.

	Social impact	Fourth industrial revolution
Social impact: Pearson correlation	1	0.649**
Sig. (2 tailed)		0.000
N	400	400
Fourth industrial revolution: Pearson Correlation	0.649**	1
Sig. (2 tailed)	0.000	
N	400	400

Discussion

The findings from the first hypothesis revealed that there is a positive relationship between content learning and the adoption of the fourth industrial revolution in higher education institutions. This result revealed a very strong correlation with $r = 0.578$. It implies that the evolution of the fourth industrial revolution has an impact on teaching and learning in higher education institutions. As proposed by the fourth industrial revolution, technologies like cloud computing, robotics, artificial intelligence, and others will affect the education sector greatly. This is happening in universities today. Today, technologies are adopted in teaching and learning, reshaping curriculum content, keeping students' data and files, facilitating students' activities, enhancing effective classroom management, promoting students-teacher relationships, and keeping students' attendance in classes across various disciplines. The era of the COVID-19 pandemic shows us how these technologies have helped various higher education institutions reach out to many students without stress. This finding corroborates with the positions of Peters (2017) and Kivunja (2015), who argued that the evolution of the fourth industrial revolution will have a great impact on education, teaching, and learning in various institutions globally.

Secondly, adoption of the industrial revolution in higher education institutions has a positive relationship and effect on learning opportunities with $r = 0.563$ and a p-value of.000. It was also observed that the strength of the relationship is strong. The introduction of robotics, cloud computing, cyber security, and artificial intelligence in education have influenced teaching and learning tremendously. They helped in exposing students and lecturers to new challenges. With these technologies, people can conduct research, and learning can take place anywhere, at any time. Also, these technologies enhance personalized, long-life learning and open doors of opportunities for students, lecturers, policymakers, and management of higher education institutions. Students tend to learn better and retain what they have learned when they are exposed to various technological devices. This will serve as an added advantage to them and improve their chances of getting better jobs in the future. This finding was supported by the studies of Elayyan (2021), Waghid et al. (2019), and Al Lily et al. (2018), who found that adoption of the fourth industrial revolution and adoption of technology in education will enhance learning opportunities.

Also, the finding revealed that there is a positive relationship between content and instructional activities and the adoption of the fourth industrial revolution in higher education institutions. This was made clear with an r value of.621 and a p-value of.000. This positive relationship revealed that adoption of technologies like cyber security, artificial intelligence, cloud computing, and robotics into higher education institutions will enhance the commitment of academic staff and students to educational ethics, bring out a change in the learning outcome, enable universities to adopt integrated curricula, implement non-bias evaluation, adopt various e-learning platforms, and introduce new concepts in courses taught across various disciplines. Once higher education institutions imbibe these in their content and instructional activities, they will be able to produce the right candidates and graduates who will meet the challenges of the fourth industrial revolution. This result corresponds with the findings of Elayyan (2021) and Aprianti and Sahid (2020), who found that the fourth industrial revolution has a connection with the content.

Research implications

This research focuses on the analysis of the effect of the fourth industrial revolution on higher education by focusing on the University of Hail as one of the university education institutions in the Kingdom of Saudi Arabia. While this analysis represents a sample, there are some implications that can be shown as follows:

Practical implications

This research has some implications for higher education leadership, policy, and management. First, it can be inferred from the findings that technology usage has a great effect on teaching and learning. It shows that higher education leadership and policymakers in this era of digital age must respond actively to the call of technology and adopt it meaningfully in order to achieve the desired result. Therefore, they must strive to improve the quality of technology usage in instruction delivery in higher education institutions across the Kingdom. As a result, academic leaders must incorporate beneficial technologies into the curriculum of universities in a manner that will give the graduates a chance of getting viable employment in the industry (Elayyan, 2021).

Furthermore, the challenges of the fourth industrial revolution can be overcome with strategic, systemic plans and collaboration with industries. Universities must liaise with various industries and incorporate the latest technology and global trends in the teaching and learning process. Once these higher education institutions arranged with industries and exposed their students to events happening in various industries right from the university, these students will be aware of this development and will be able to cope with the trend upon successful completion of their programs. Thereby, the rate of graduate unemployment will reduce, and the graduates will be able to contribute to the economic development of their nation.

Moreover, the finding has implications for the behavior of students and faculty members. The attitude of students and faculty members toward technology accepting and using technology and other devices, is crucial in achieving the goals of the government. Some people may not want to adopt technology. Therefore, policymakers should promulgate laws and introduce policies that will make all academic staff, students, and non-academic staff adopt technology in their day-to-day activities. With this, students will learn more and get exposed to some technology that

will influence their employability upon successful completion of their programs. This corresponds with the findings of Aprianti and Sahid (2020), Reaves (2019), and the World Economic Forum (2018), who argued that technology will improve effective teaching and learning. In addition, the challenges of the fourth industrial revolution cannot be overcome by mere introduction of technology but with systemic monitoring and evaluation of the teaching, learning, and research processes. So, there should be monitoring teams that will ensure that the policies introduced are strictly adhered to by staff and students. There should be reward and punishment for those who implement these policies effectively and defaulters. This will serve as a lesson to all and enable others to act in a manner that will promote the interest of the kingdom and move it toward a greater height. This corresponds with the positions of Elayyan (2021), Penprase (2018), Peters (2017), and Schwab (2016), who argued that policymakers must be proactive in dealing with the challenges of the fourth industrial revolution.

Social implications

The research provides an overview of how the fourth industrial revolution affects higher education and investigates the relationship between the adoption of the fourth industrial revolution and content learning, learning opportunities, content, and instructional activities and the adoption of the industrial revolution. The findings show that the advanced educational tools and technologies provide crucial impacts for society as they help to adapt to continuous improvement and change. In addition, there is a positive relationship between social impact and the fourth industrial revolution, as it enhances social values, supports social awareness, and facilitates the employment of graduates who are able to utilize the fourth industrial revolution technologies.

Therefore, the researchers recommend using the advanced technologies to support the capacity of universities and to encourage academic staff to use them in developing classroom management, keeping students' data safely by using cyber security, increasing the experiences exchanged, allowing online and blended learning, and providing more learning resources and databases, and adopting the integrated curricula, applying non-bias evaluation, and changing the course learning outcomes.

In addition, future studies should focus on investigating the impacts of the fourth industrial revolution on transferring to current trends of learning such as blended, virtual, lifelong learning, smart, and digital learning. Its effect on the abilities of the academic staff to use advanced learning styles in teaching should be examined. Moreover, researchers need to clarify the impacts of the revolution on the quality of university education and innovative scientific research in the universities and how it contributes to improving the research key performance indicators.

Conclusion

This research examines the effect of the fourth industrial revolution on higher education by highlighting its effects by controlling learning, enhancing learning opportunities, improving content and instructional activities, and ensuring social development. This implies that the claim that the fourth industrial revolution will have a significant impact on higher education institutions is real. In order to curb its negative effect on students and society, the government, academic leaders, educational agencies, policymakers, students, philanthropists, and other stakeholders must swiftly respond by uniting to enhance the quality of teaching, learning, and research across all the universities in the Kingdom of Saudi Arabia. If all the measures proposed in this research are systematically reviewed and rigorously implemented in all public higher education institutions, the standard of teaching, learning, and research will improve, and universities in the Kingdom of Saudi Arabia will be among the top sources of education for foreigners.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by University of Hail Saudi Arabia. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

YA: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. AA-S: Formal analysis, Writing – original draft. RE: Data curation, Investigation, Writing – original draft. AB: Conceptualization, Methodology, Writing – original draft. MA: Formal analysis, Project administration, Validation, Writing – review & editing. KA: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This research was funded by the Scientific Research Deanship at the University of Ha'il, Kingdom of Saudi Arabia, (Grant number RG-20 206).

Acknowledgments

The researchers acknowledge the support of the Scientific Research Deanship at the University of Ha'il, Kingdom of Saudi Arabia (Grant number RG-20 206).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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