Faculties Behavioural Intention Toward the Use of the Fourth Industrial Revolution Related-Technologies in Higher Education Institutions

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Abstract—The Fourth Industrial Revolution (4IR) has affected every aspect of our life, including education. Studies related to acceptance and adoption of 4IR related technologies in Higher education Institutions (HEIs) are limited. Therefore, this study aimed to investigate the acceptance of 4IR related-technologies by faculty members in HEIs. An online questionnaire was implemented based on the Unified Theory of Acceptance and Use of Technology (UTAUT) in a sample of 275 faculty members aged between 21 and 60 years old. The results showed that all the five constructs of the UTAUT model have significant impacts on the behavior intention with different degrees of influence: Performance Expectancy (43%), Facilitation Condition (27%), Effort Expectancy (21.5%), Social Influence, and Attitude toward using the technology are equally the same with (15.4%). Gender has only significant effects on Social Influence and Facilitation Condition, while age has only a significant impact on Social Influence. Furthermore, faculty members' acceptance of using 4IR technologies in teaching and learning is significantly higher among the younger group (less than 46 years old) than their counterparts (46 years old and above). However, there was no significant difference in the behavioral intention between male and female lecturers. The obtained results have added scientific evidence to the literature about faculty readiness to adopt IR-related technologies and lead to a better practical understanding of the factors that may incite or discourage them to use 4IR related-technologies in HEIs.

Keywords—Unified Theory of Acceptance and Use of Technology (UTAUT), 4IR related-technologies, higher education institutions, performance expectancy, behavioral intention

1 Introduction

The Fourth Industrial Revolution (4IR) has affected every aspect of our life, including industry, transportation, marketing, health care, and education. The history of 4IR can be traced back to the 1780s when the first industrial revolution arose in 1780 with the invention of steam power, which made human beings more productive. Then, the second industrial revolution emerged from the 1920s to the 1970s, which depended

on combustion engines, leading to manual labor automation [1]. The third industrial revolution is characterized by the development of computing and the internet, which transformed the world of work [2, 3]. Klaus Schwab launched the term 4IR in 2016 during the World Economic Forum, characterized by automation of knowledge and the emergence of cyber-physical systems (CPSs), blockchain, artificial intelligence, robotics, 3D printing, the Internet of Things (IoT), big data, sensors; virtual reality and augmented reality [4]. Lee et al. [5] stated that 4IR is "the development and application of techno-human smart systems capable of improving the efficiency and productivity of production systems as well as supporting a general improvement in the quality of life of individuals and communities" (p. 3).

This era had significant impacts on our lives, including education, health care, transportation, agriculture, energy, and commerce. Inevitably, 4IR leads to new jobs, innovative products, social changes, and different expectations. Therefore, the countries should prepare their nations to work and live in the 4IR era. Higher Education Institutions (HEIs) are considered the key players for such a shift since they are responsible for the educational process and preparing their graduates to deal with 4IR technologies and requirements. Penprase [3] requests the education sector to respond to the rapid advancement of technological innovation, which could be done by upgrading their programs and offering new ones to fulfill the demand for skilled graduates who can fit into this revolution [6]. Graduates should be well-informed, flexible, and able to unlearn and relearn, prepared to face the automation challenge and take advantage of opportunities associated with it. HEIs are expected to produce dynamic graduates with high-order thinking skills, problem-solving, and critical thinking skills [3].

Abu Mezied [7] in World Economic Forum asserted that for HEIs to deliver future generations with the right set of skills and knowledge, it is essential to reflect on how the delivery of education will be affected. It is no longer an option to keep doing things the old way; innovation and accepting change are prerequisites for survival in this era. The 4IR has affected teaching, research, and services/resources with virtual classrooms and laboratories, libraries, and even virtual teachers [8]. Butler-Adam [9] highlighted the implications of the 4IR in the education sector have to do with curricula, teaching, and learning – rather than with robotic tutors. However, the current knowledge regarding 4IR is still primitive and naïve to many sectors, including education [10, p. 2]. In addition, Mhlanga [11] asserted that the education sector is reluctant to adapt to the current technology transformation, including 4IR-related technologies. To the best of the researchers' knowledge, no research has explored faculty members' perceptions of integrating 4IR-related technologies in teaching and learning, especially in Oman, given that lecturers are the backbone of the educational process and play a crucial role in transforming it. Hence, it is imperative to investigate areas related to 4IR in HEIs so that the teaching-learning process can benefit from its opportunities. Therefore, the objective of this study is identify the UTAUT variables that influence faculty members' acceptance of 4IR related technologies integration in the teaching and learning.

2 Theoretical background and hypotheses development

Various theoretical models have been established to describe user technology acceptance and adoption. However, in 2003, Venkatesh, Morris, Davis, and Davis synthesized these technology adoption models, and they proposed a new model called the Unified Theory of Acceptance and Use of Technology (UTAUT). UTATU has synthesized eight theoretical frameworks into a unified model that describes the user acceptance and implementation of technology in an organization [12, 13]. These models are the Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), the Motivational Model, a combined Technology Acceptance Model and Theory of Planned Behaviour (C-TAM/TPB), the Theory of Planned Behaviour (TPB), the Model of Personal Computer Utilization, Social Cognitive Theory, and Innovation Diffusion Theory [14]. The current study used UTAUT as a framework to investigate the acceptance and adoption of the 4IR technologies since it is the most comprehensive framework in the field of technology acceptance [15, 16, 17, 18]. Therefore, the researchers believe that UTAUT can provide a basis for exploring the readiness and acceptance of faculty members to adapt 4IR related technologies, especially that this model has not yet been widely used to evaluate the adoption of 4IR related technologies in higher education contexts [19].

UTATU consists of eight constructs: performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FCs), attitude toward using technology (ATUT), and behavioral intention to use technology (BI). In the established hypothetical model, PE, EE, SI, FCs, and ATUT (Independent Variables) affect BI (Dependent Variable), which is considered the nearest representation for actual use behavior [20]. The UTAUT model proposes four direct predictors: PE, EE, SI, FCs, and ATUT of an individual's BI to use technology [12]. Gender and age impact PE, EE, SI, FCs, and ATUT. Specialization/background has been added as a moderator in this study. The following explains the theory base, and the hypotheses are ultimately derived.

2.1 Performance expectancy (PE)

PE is defined as "The capability of the technology to provide benefits and enhance the performance to the user according to his/her expectations [12, p. 447]". Adapting PE to educational context advocates those users will find the technology beneficial because it enables them to conduct teaching-learning activities more quickly and efficiently. In this research, PE is demonstrated by the belief of teachers that using IR-related technologies will contribute to their teaching performance. Several studies have shown that PE significantly affects the intention to use a particular technology. For instance, Romero-Rodríguez [21] investigated 587 Spanish university lecturers' acceptance to use the Internet of Things (IoT). They found that PE has significantly affected the BI to use IoT, while gender and age did not affect their intention. AbuShanab and Pearson conducted another study [22] that applied the UTAUT model to investigate the critical factors that affected Internet banking adoption in Jordan. The researchers used a questionnaire that was distributed to 940 customers from three Jordanian banks. They concluded that

PE significantly affects BI. Arain et al. [23] utilized UTATUT to investigate students' acceptance of mobile learning in higher education by distributing a questionnaire to 900 students. The results show that PE has a statistically significant impact on students' BI. Al-Maroof and Al-Emran [24] examined the factors affecting Google classroom acceptance among undergraduates in a private university in Oman.

She found that PE positively influences students' BI towards using google classroom. In addition, many studies have shown that PE significantly affects users' BI [e.g., 25, 26, 22, 27, 28]. However, other studies have shown that PE did not influence BI. For instance, Lin [29], in her study of 320 students' intention to use E-books, found that PE did not impact their intention. Therefore, it seems that there is a discrepancy in the literature regarding the relationship between PE and BI. In the original UTAUT model, age and gender play a moderating role in the relationship between PE and BI. According to several research, age was proven to moderate the links between PE and behavioral intention to use technology. For instance, it has been found that the influence of performance expectancy was more substantial for younger people [30]. In addition, some research results have shown that PE is a more significant concern for males than for females [12, 30]. For this reason, the present study strives to test the following hypotheses:

Hypothesis 1 (H1): Performance expectancy significantly affects behavioral intention to use 4IR related technologies.
Hypothesis 2 (H2): Gender is a factor that significantly affects the performance expectancy of 4IR related technologies.
Hypothesis 3 (H3): Age is a factor that significantly affects the performance expectancy of 4IR related technologies.

2.2 Effort expectancy (EE)

EE is defined as "user expectations about the ease of using technology [12 p. 450]. It includes three constructs: perceived ease of use, the complexity of use, and ease of use. In this study, EE was related to faculty members' ease of using the 4IR related technologies. EE and its impact on people's usage of new technologies have been tested in several studies and have been found to have a significant influence. For instance, Salloum and Al-Emran [25] found that EE significantly affects students' acceptance of e-payment at HEIs. In addition, Tsourela and Roumeliotis [31] found strong relationships between EE and BI in technology-based services.

Similarly, Awwad and Al-Majali [32] investigated the students' intention to use electronic library services in public Jordanian universities. Their study revealed that EE has a statistically significant impact on the students' BI. On the other hand, Wu et al. [28] investigated the customers' willingness to adopt 3G mobile telecommunication services in Taiwan, and their study revealed that EE has not significantly influenced the customers' BI. Venkatesh et al. [12] reported that gender and age play an essential role in the relationships between the EE and BI. For example, it has been found that females are more worried about ease of use than males [30, 29]. Hence, the current study aims to test the following hypotheses:

Hypothesis 4 (H4): Effort expectancy significantly affects behavioral intention to use 4IR related technologies.
Hypothesis 5 (H5): Gender is a factor that significantly affects the effort expectancy of 4IR related technologies.
Hypothesis 6 (H6): Age is a factor that significantly affects the effort expectancy of 4IR related technologies.

2.3 Social influence (SI)

SI refers to "the degree to which an individual perceives that important other (family and friends) believe he or she should use the new system." [12, p. 451]. SI describes how individuals perceive that important people believe they should use the new technologies. For instance, Salloum et al. [25] conducted a study on E-learning usage among 280 students in two universities in the UAE. They found that SI significantly impacted students' intention to use e-learning systems. Likewise, Wu et al. [28] found that SI positively influenced customers' usage of 3G mobile telecommunication services in Taiwan. Šumak et al. [33] found that SI significantly impacts students' BI to use e-learning systems. Cheng et al. [34] found that SI is a strong predictor of the BI of customers in using internet banking.

In contrast, Joo et al. [35] investigated the users' acceptance of mobile learning in South Kora, and they found no influence of SI. Similarly, Magsamen-Conrad et al. [36] did not find significant evidence of SI affecting BI. Tibenderana and Ogao [37] found SI insignificant in predicting BI to utilize electronic Library services in Ugandan Universities. Lin [29] also found that SI did not impact students' intention to use e-books in China. Hence, a conclusion can be drawn that the literature has found heterogeneous findings related to the relationship between SI and BI. Age and gender were proven to moderate the links between SI and BI [38, 12]. For instance, some research studies found that social influence was more significant for older people than younger counterparts [12, 14]. Moreover, it has been found that females are more worried about others' opinions than males, so SI significantly impacts females more than males when it comes to using new technologies [34, 29]. Consequently, the hypotheses related to the SI and moderating variables of age and gender are the following:

Hypothesis 7 (H7): Social influence significantly affects behavioral intention to use 4IR related technologies.
Hypothesis 8 (H8): Gender is a factor that significantly affects the social influence of 4IR related technologies.
Hypothesis 9 (H9): Age is a factor that significantly affects the social influence of 4IR related technologies.

2.4 Facilitating conditions (FCs)

FCs refer to "the expected level of organizational and technical infrastructure that can support technology use" [12, p. 453]. In other words, it describes the degree to which an individual believes that an organizational and technical structure exists to support the use of the new technologies. Several studies analyze the relationship between

FCs and the adoption of new technologies. For instance, Khechine et al. [30] found that FCs greatly impacted students' acceptance of a webinar system (Elluminate) in blended learning at Laval University in Quebec-Canada. In addition, Raman & Don [39] investigated the acceptance and usage of moodle of 320 undergraduate students from the University Utara in Malaysia. He found that facilitating conditions such as recourses and services are critical predictors of students' BI towards using Moodle. Likewise, Salloum et al. [25] also found that FCs played a significant role in students' BI to use e-learning systems. Holzmann et al. [19] investigated 103 high school teachers' utilization of 3D printing, and the results showed that FCs significantly affect the adoption of novel technology like 3D printing. In addition, age and gender are considered to be moderating roles in the relationship between FCs and BI. It has also been found that older people attach more importance to facilitation conditions in the job context [12, 30] than younger people. Hence, the current research aims to test the following hypotheses:

Hypothesis 10 (H10): Facilitating conditions significantly affect behavioral intention to use 4IR related technologies.
Hypothesis 11 (H11): Gender is a factor that has a significant effect on facilitating conditions of 4IR related technologies.
Hypothesis 12 (H12): Age is a factor that has a significant effect on facilitating conditions of 4IR related technologies.

2.5 Attitude toward using technology (ATUT)

ATUT is defined as "an individual's overall affective reaction to using a system" [12, p. 453]. In the research context, attitude toward using technology refers to the tendency of teachers to use 4IR related technologies in their teaching activities. Sumak and Sorgo [33] stated that ATUT is about an individual's thinking and feelings about technology usage. Macedo [40] studied 278 Portuguese older adults BI to use Information and Communication Technologies (ICT). He found that participants who perceived ICT as exciting and fun have a stronger intention to adopt ICT. Holzmann et al. [19] relate ATUT to the liking, enjoyment, and fun that teachers associated with using technology (p. 264). Holzmann et al. [19] found that ATUT is the third predictor that has a significant positive impact on teacher BI to use 3D printing. Similarly, Hwang and Lee [41], through a meta-analysis of advanced UTAUT variables in the ICT industry, found that attitude and perceived enjoyment had a high effect on users' acceptance of ICT. It has been found that young people have a more positive attitude towards technology than older people [12]. For this reason, the present study strives to test the following hypotheses:

Hypothesis 13 (H13): Attitude toward using technology significantly affects behavioral intention to use 4IR related technologies.
Hypothesis 14 (H14): Gender is a factor that significantly affects attitude toward using the technology of 4IR related technologies.
Hypothesis 15 (H15): Age is a factor that has a significant effect on attitude toward using the technology of 4IR related technologies.

3 Methodology

3.1 Research model

For this study, we relied on the UTAUT model for many reasons. First, this model has not yet been widely used to evaluate the adoption of 4IR related technologies in HEIs. Second, this model needs to be validated in different environments to consolidate its empirical basis, especially in education. Third, for many years, through testing its implications in various fields such as whether it was applied to the educational setting [29, 25], Telcommnucation services [28], e-governance [42], banking [22], tourism [43], this new model was proven to give a better-explained variance of the intention to use technologies than previous models. Therefore, it assists decision-makers in making well-informed decisions by explaining the factors that impact users' intention to accept new technologies.

From the UTAUT model, we retained its six primary constructs (one dependent variable and five independent constructs) and two moderating variables [12]. The previous section has explained the definitions of these variables and their hypotheses. However, we have added specialization/background as a moderating variable to enhance the explanatory ability of the model to determine the factors that affect faculty members' acceptance of 4IR related technologies. Therefore, we assume that the faculty members' backgrounds will significantly impact the five psychological constructs of the UTAUT model. The research model is depicted in Figure 1.

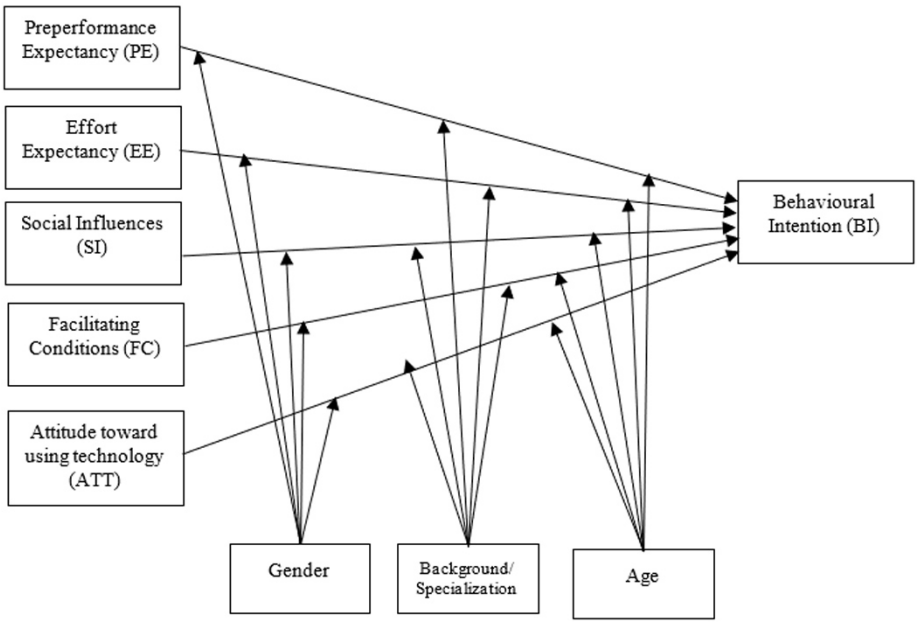

Fig. 1. The research model

3.2 Data collection tool

In this study, the questionnaire was used to determine the factors that influence the acceptance and adoption of IR-related technologies in teaching and learning in HEIs in Oman by utilizing the UTAUT model. Several other researchers employed this technique to study the adoption of various information technology tools in teaching and learning [e.g., 26, 35, 23, 21]. The questionnaire was divided into different parts. Part one was about participants' demographic information: their institution type, gender, age, years of experience, specialization, and educational level. Part two of the questionnaire contained UTAUT model statements that measure the faculty members' acceptance of IR-related technologies. The UTAUT constructs were measured using a five-point Likert scale (from strongly agree to strongly disagree).

3.3 Procedure and participants

To ensure ethical considerations, we obtained permission from HEIs, and a research ethics form was completed and approved. The study used convenience sampling. Accordingly, the participants were invited to participate in the survey via an e-mail, where information related to the purpose of the study was provided to the participants who were ensured the anonymous processing of the data. The participants' informed consent was obtained before they participated in the online questionnaire, and they were assured that they could withdraw from the study at any time. The questionnaire link using 'Google forms' was sent to all HEIs in Oman and the data collection lasted from 4th September to 4th December 2020.

The sample of faculty members comprises of 160 male (57.6%) and 118 female (42.4%), aged between 21 and 58 years (M = 35.18; SD = 6.97). 64% (N = 179) of the participants are less than 46 years old, and 36% are 46 years old and more (N = 99). They are teaching courses related to Information Technology, Engineering, Medicine, Business, agriculture, and social sciences in public and private HEIs in Oman. Majority (79%) of the participants have more than 10 years' experience (220), 15% have 6–10 years of working experience (42), and only 16 participants have 5 years or less of working experience. 44% of the participants are Ph.D. holders (120), and 57% are master holders (158).

3.4 Data analysis

In this study, we used SPSS v23 to measure the constructs' validity, reliability, and exploratory factor analysis (EFA). AMOS v26 was used to conduct Structural Equation Modelling (SEM) and Confirmatory Factor Analysis (CFA). AMOS is a powerful tool to evaluate moderation relationships and group analysis [44]. The sample adequacy was ensured using the Kaiser-Meyer-Olkin (KMO) and the Bartlett test. Here the KMO measure is greater than 0.6 (0.918), and the Bartlett test is statistically significant (0.000). Hence, the sample is adequate [45].

4 Results

This section presents the findings related to the research objectives and hypotheses.

4.1 Descriptive analysis and interpretations

Table 1 shows the means, standard deviations, and differences based on gender, which indicates that female lecturers obtained higher scores in three constructs of the UTAUT model (Performance Expectancy, Effort Expectancy, and Social Influences). In comparison, male lecturers got higher scores in the other three constructs (facilitating conditions, attitudes, and behavioral interns). However, none of these differences were significant based on the t-test.

Table 1. Mean, standard deviation, and independent t-test results of scores based on gender

Construct	Male		Female		*t*	*df*	*p*
	Mean	SD	Mean	SD			
Performance Expectancy (PE)	4.28	0.56	**4.33**	0.57	−0.661	276	0.509
Effort Expectancy (EE)	3.85	0.63	**3.88**	0.66	−0.356	276	0.722
Social Influences (SI)	3.53	0.74	**3.55**	0.68	−0.234	276	0.815
Facilitating conditions (FC)	**3.35**	0.86	3.22	0.92	1.158	276	0.248
Attitude (ATT)	**3.88**	0.60	3.75	0.52	1.889	276	0.059
Behavioural intention (BI)	**4.01**	0.65	3.92	0.66	1.084	276	0.279

Table 2 presents the means, standard deviations, and differences based on age, indicating certain distinctions. The age group less than 46 years old obtained the highest mean scores in almost all constructs (PE, EE, SI, ATT, and BI). While lecturers aged 46 years old and above only excelled in FC. Significant differences were established in the PE ($p = 0.051$), EE ($p = 0.006$), SI ($p = 0.003$), and ATT ($p = 0.044$) constructs. Thus, the degree of acceptance of university lecturers to use 4IR technologies is high for the younger group.

Table 2. Mean, standard deviation, and independent t-test results of scores based on age group

	Less than 46 Years Old (N = 179)		46 Years Old and Above (N = 99)		*t*	*df*	*p*
	Mean	SD	Mean	SD			
Performance Expectancy (PE)	**4.35**	0.54	4.21	0.61	1.960	276	**0.051**
Effort Expectancy (EE)	**3.94**	0.64	3.72	0.63	2.780	276	**0.006**
Social Influences (SI)	**3.64**	0.69	3.37	0.73	3.023	276	**0.003**
Facilitating conditions (FC)	3.28	0.92	**3.31**	0.82	−0.266	276	0.796
Attitude (ATT)	**3.88**	0.54	3.73	0.61	2.022	276	**0.044**
Behavioural intention (BI)	**4.00**	0.61	3.92	0.73	1.025	276	0.306

On the other hand, means, standard deviations, and differences based on backgrounds/specializations of the faculty members showed certain distinctions (Table 3). It is evident that lecturers with IT or Engineering backgrounds reported significantly higher mean scores in all constructs (PE, EE, SI, FC, ATT, and BI) than lecturers with different fields such as Language, Business Studies, Nursing, and others.

Table 3. Mean, standard deviation, and independent t-test results of scores based on background

	Non-ITEng-Related (N = 169)		**ITEng-Related (N = 108)**		***t***	***df***	***p***
	Mean	**SD**	**Mean**	**SD**			
Performance Expectancy	4.22	0.59	**4.42**	0.51	−2.903	275	**0.004**
Effort Expectancy	3.79	0.67	**3.97**	0.59	−2.334	275	**0.020**
Social Influences	3.39	0.74	**3.77**	0.62	−4.421	275	**0.000**
facilitating conditions	3.18	0.92	**3.49**	0.80	−2.929	275	**0.004**
Attitude	3.71	0.59	**4.00**	0.49	−4.248	275	**0.000**
Behavioural intention	3.88	0.68	**4.13**	0.56	−3.086	275	**0.002**

Regarding convergent validity and reliability of the instrument, the composite reliability (CR) values of the constructs were above 0.7 for the majority of the constructs and the average variance extracted (AVE) was above 0.5 in all of them (Table 4), which are deemed acceptable according to Hair et al. (2017). The reliability values of Cronbach's alpha coefficient were adequate in all constructs (0.7). Hence, construct reliability was confirmed. Most of the item's loadings are over the recommended value of 0.70; therefore, factor loads were adequate.

Table 4. Convergent validity measures and reliability

Construct	**Item**	**Factor Loading**	**Composite Reliability (CR)**	**Average Variance Extracted (AVE)**	**Discriminant Validity Measures**	**α**
Performance Expectancy	PE1	.776	0.89	0.61	0.78	0.93
	PE2	.826				
	PE3	.789				
	PE4	.791				
	PE5	.738				
Effort Expectancy	EE1	.736	0.70	0.50	0.65	0.80
	EE2	.859				
	EE3	.698				
Social Influences	SI1	.866	0.74	0.50	0.69	0.82
	SI2	.836				
	SI3	.738				

(Continued)

Table 4. Convergent validity measures and reliability *(Continued)*

Construct	Item	Factor Loading	Composite Reliability (CR)	Average Variance Extracted (AVE)	Discriminant Validity Measures	α
facilitating conditions	FC1	.796	0.89	0.70	0.81	0.93
	FC2	.807				
	FC3	.834				
	FC4	.831				
Attitude	ATT1	.590	0.71	0.62	0.79	0.75
	ATT2	.667				
	ATT3	.731				
	ATT4	.699				
Behavioural intention	BI1	.858	0.60	0.70	0.80	0.83
	BI2	.858				

For the discriminant validity analysis, the square root of AVE was taken to correlate the latent constructs. Table 5 shows the correlation matrix between the variables and the square roots of their corresponding AVE values. The square root of any AVE value is greater than the value of all inter-construct linked with the variable. Hence, divergent validity is deemed adequate (Hair et al., 2017).

Table 5. Discriminant validity measures

	Performance Expectancy	Effort Expectancy	Social Influences	Facilitating Conditions	Attitude	Behavioral Intention
Performance Expectancy	**0.777**					
Effort Expectancy	.557**	**0.646**				
Social Influences	.349**	.600**	**0.692**			
Facilitating conditions	.088	.366**	.655**	**0.812**		
Attitude	.569**	.569**	.566**	.422**	**0.785**	
Behavioural intention	.571**	.516**	.493**	.327**	.660**	**0.799**

Note: **Correlation is significant at the 0.01 level (2-tailed).

4.2 Multigroup path analysis results

To evaluate the moderating impact of gender differences, the multi-group test executed the strength of the path coefficients. PE has a significant positive relationship on BI (male $\beta = 0.32$, $p < 0.001$; female $\beta = 0.43$, $p < 0.001$), EE has a significant positive relationship on BI (male $\beta = 0.21$ $p < 0.001$; female $\beta = 0.25$, $p < 0.001$), SI has a significant positive relationship on BI (male $\beta = 0.11$, $p = 0.02$; female $\beta = 0.23$, $p = 0.001$), FC has a significant positive relationship on BI (male $\beta = 0.32$, $p < 0.001$; female $\beta = 0.19$, $p = 0.002$), and ATT has a significant positive relationship on BI (male $\beta = 0.38$,

$p < 0.001$; female $\beta = 0.51$, $p < 0.001$). The r2 value is 0.537, which means the predicted variables influencing the dependent variables about 54%.

To evaluate the moderating impact of age differences, the multi-group test executed the strength of the path coefficients. PE has a significant positive relationship on BI (less than 46 years $\beta = 0.41$, $p < 0.001$; 46 years and above $\beta = 0.43$, $p < 0.001$), EE has a significant positive relationship on BI (less than 46 years $\beta = 0.21$, $p < 0.001$; 46 years and above $\beta = 0.26$, $p < 0.001$). SI has a significant positive relationship on BI only for the age group less than 46 years ($\beta = 0.19$, $p < 0.001$), and there is no significant impact for the aged 46 years and above ($\beta = 0.07$, $p = .332$). FC has a significant positive relationship on BI (less than 46 years $\beta = 0.21$, $p < 0.001$; 46 years and above $\beta = 0.43$, $p < 0.001$), and ATT has a significant positive relationship on BI (less than 46 years $\beta = 0.39$, $p < 0.001$; 46 years and above $\beta = 0.48$, $p < 0.001$). The r2 value is 0.455, which means the predicted variables influence the dependent variables about 45%.

To evaluate the moderating impact of faculty background, the multi-group test executed the strength of the path coefficients. PE has a significant positive relationship on BI (ITEng related $\beta = .383$ $p < 0.001$; non-ITEng related $\beta = 0.462$, $p < 0.001$), EE has a significant positive relationship on BI (ITEng related $\beta = .239$ $p < 0.001$; non-ITEng related $\beta = 0.2$, $p < 0.001$). SI has a significant positive relationship on BI (ITEng related $\beta = .119$ $p = .049$; non-ITEng related $\beta = 0.179$, $p = .001$). FC has a significant positive relationship on BI (ITEng related $\beta = .29$ $p < 0.001$; non-ITEng related $\beta = 0.242$, $p < 0.001$), and ATT has a significant positive relationship on BI (ITEng related $\beta = .494$ $p < 0.001$; non-ITEng related $\beta = 0.41$, $p < 0.001$). The r2 value is 0.487, which means the predicted variables influencing the dependent variables about 49%.

Table 6. Hypothesis testing results

Hypothesis	Relationship	Path Coefficient	CR	P Values	Results
H1	PE –> BI	0.428	10.336	***	**Supported**
H2	gender_ –> PE	0.141	1.165	0.244	Rejected
H3	age –> PE	−0.061	−1.025	0.305	Rejected
H4	EE –> BI	0.215	5.203	***	**Supported**
H5	gender_ –> EE	0.042	0.344	0.731	Rejected
H6	age –> EE	−0.103	−1.732	0.083	Rejected
H7	SI –> BI	0.154	3.715	***	**Supported**
H8	gender_ –> SI	0.154	3.715	***	**Supported**
H9	age –> SI	−0.196	−3.328	***	**Supported**
H10	FC –> BI	0.267	6.455	***	**Supported**
H11	gender_ –> FC	0.154	3.715	***	**Supported**
H12	age –> FC	0.052	0.872	0.383	Rejected
H13	ATT –> BI	0.154	3.715	***	**Supported**
H14	gender_ –> ATT	−0.232	−1.927	0.054	Rejected
H15	age –> ATT	−0.089	−1.492	0.136	Rejected

Note: ***Correlation is significant at the 0.01 level (2-tailed).

The results of the path analysis supported eight hypotheses out of the 15 initially established; the hypotheses that were not supported were rejected (Table 6). The relationships that supported the hypothesis of having a significant effect on behavioural intention of faculty members to integrate 4IR-related technologies in teaching and learning were performance expectancy (H1), effort expectancy (H4), social influence (H7), facilitating condition (H10), and attitude toward using technology (H13). The data also shows that the most significant constructs to influence the behavior intention in our study are the Performance Expectancy (43%), and Facilitation condition (27%), effort expectancy (21.5%); while Social Influence and Attitude toward using the technology are equally the same with (15.4%).

Gender has only significant effects equally on Social Influence (H8) and Facilitation condition (H11). Age has only a significant impact on Social Influence (H9). The overall model influencing behavioral intention (R2 = 53%).

5 Discussion

The acceptance of using and adapting any technology is a complex process depends on various factors that impact human's willingness to accept or reject technology implementation. Based on this belief, this study examined faculty members' perceptions to integrate 4IR-related technologies in teaching and learning following the UTAUT framework. Hence, this research has investigated the impact of the Performance Expectancy, Facilitation Condition, Effort Expectancy, Social Influence, and Attitude toward using the technology on the faculty behavior intention to use 4IR-related technologies in teaching and learning. Furthermore, it has examined the impact of the participant's details such as age and gender on their behavior intention.

To do so, the UTAUT model has been used as a framework which has been used by many researchers to determine the level of acceptance of using technology [e.g. 26, 23, 35, 32, 46].

Based on the results of the t-test related to gender, female lecturers obtained higher scores in three constructs of the UTAUT model (PE, EE, and SI) while male lecturers scored higher in the other three constructs (FC, ATT, BI). However, none of these differences were significant.

Results from this study also showed that participants less than 46 years old obtained higher mean scores in almost all the constructs (PE, EE, SI, ATT, and BI) than those aged 46 years old and above. The t-test shows that those differences were significant for all the constructs except for the SI. This indicates that the adoption of IR-related technologies by the lecturers aged 46 and above depend on their confidence and ability to use them, rather than other beliefs and opinions. Moreover, this result indicates that the adoption of IR-related technologies is a personal and individual matter and it is not affected by closed ones such as family and friends. Based on the t-test, a conclusion can be drawn that the degree of acceptance of faculty members to use 4IR technologies is high for the younger group. In this sense, a line is established that coincides with other studies that have applied the UTAUT model and in which age was presented as a moderating variable on acceptance technology [12, 30, 21, 25].

The study also found that faculty members with IT or Engineering backgrounds reported significantly higher mean scores in all constructs than lecturers with backgrounds in different fields such as Language, Business Studies, Nursing, and others. No previous study has examined the impact of the faculty background on technology adoption; however, one study conducted in Thailand by Puriwat and Tripopsakul [47] studied the effect of educational background on the readiness levels of 132 graduate students. They found that education background significantly affects students' preparedness for 4IR and their readiness to use it. To elaborate, they found that graduate students with a Science background have better preparedness for 4IR than students with a background in Social Sciences and business. This indicates that HEIs need to have an interdisciplinary approach to ensure that their faculty members and students can use IR-related technologies in learning and teaching. This can be achieved by embedding technology in all programs and not only restricting it to IT-related.

The configuration of the UTAUT model via the path analysis showed that eight hypotheses were supported out of the 15 initially proposed at the beginning of the research. Firstly, PE positively affects BI to use IR-related technologies (H1), and that definitely reflects the perceived benefits obtained from implementing IR-related technologies. The same result has been indicated by previous studies using the same UTAUT model [39, 19, 25]. This suggests that the faculty members' performance expectancy might be increased by focusing on the usefulness of these technologies for teaching and learning. In other words, if the advantages and benefits of IR-related technologies were demonstrated and promoted to the faculty members in different HEIs in Oman, their acceptance and use in educational contexts would most likely increase. Similarly, the study results confirmed that EE and SI directly and significantly impact the faculty members' behavioral intention to use them in their teaching (H4 & H7). This means that the faculty members will likely integrate these technologies if they demand little effort and less time to accomplish their teaching than traditional teaching methods. When they find these technologies engaging and easy to use, they would consider it, and their BIs toward using them are enhanced. Therefore, the decision-makers of HEIs should provide the staff with training opportunities to be more acquainted with these technologies and boost their capabilities implement them in their teaching and learning activities.

In addition, the results show that FCs significantly impact the BI of faculty members to accept technologies in their teaching (H10). This result ties well with previous studies wherein FCs significantly impact users' acceptance of new technologies [19, 25, 29]. This is to say facilitating conditions include HEI digital infrastructure, internet connectivity, labs, electronic devices, technical support services, and other available services that would help faculty members adopt and use 4IR related-technologies. Therefore, HEIs need to improve facilitating conditions in terms of technological and human resources to enhance and increase the adoption of IR-related technologies. Concerning the attitude toward using technology, it was shown to significantly influence behavioral intention (H13), which is consistent with previous research [32, 33, 35]. This suggests that the adoption of IR-related technologies depends on the faculty members' attitude to use them. Therefore, HEIs need to develop a positive attitude among faculty members towards using IR-related technologies by organizing professional development

programs and encourage them to build positive attitudes towards integrating them in teaching and learning. This research model explained 53% of the variance in BI.

Moreover, in this study, gender was found to have a significant impact only on Social Influence (H8) and Facilitation Condition (H11), while age has a significant effect only on Social Influence (H9). This was in accordance with the findings of other studies [12, 23, 29].

6 Research implications

This study provides some important practical insights into the acceptance of 4IR related technologies. The findings of this study offer a deeper understanding of the critical factors influencing the adoption of these technologies in the higher education sector. Therefore, the study findings provide valuable suggestions for policymakers and leaders in HEIs, of factors that play an essential role in enhancing faculty members' acceptance of 4IR related technologies, which affects the teaching performance and efficiency. Second, the HEIs need to provide the necessary and up-to-date digital infrastructure (hardware, software, and technical support) to increase the faculty members' acceptance of integrating 4IR related-technologies in teaching and learning. This is because if universities remain updated with the latest technological resources, faculty can incorporate them effectively to enhance their teaching quality and innovation. Third, the outcomes from this research can guide the university policymakers to increase faculty knowledge and skills of these technologies and how to implement them in teaching and to learn through training programs. With the popularity of online training due to the COVID-19 pandemic, faculty members should be encouraged to take online courses and attend webinars on how to implement IR-related technologies in teaching and learning. In addition, a high level of collaboration and cooperation between all HEIs and other partners from international HEIs and industries is a fundamental factor in speeding up the adoption process of 4IR-related technologies.

Finally, the empirical findings of this study could inform stakeholders in making effective decisions to integrate 4IR-related technologies in higher education by designating a strategic objective for it within the strategic plan of the HEI. This include developing processes and policies, providing adequate resources and infrastructure, outsourcing consultancy, and ongoing professional development for the faculty members.

7 Conclusion

This study applied the UTAUT model to explain the key factors that affect faculty members' acceptance of the 4IR related technologies in higher education in Oman. The results showed that all the five constructs of the UTAUT model have significant impacts on the behaviour intention with different degrees of influence: Performance Expectancy (43%), Facilitation Condition (27%), Effort Expectancy (21.5%), Social Influence, and Attitude toward using the technology are equally the same with (15.4%). Gender has only significant effects on Social Influence and Facilitation Condition, while age has

only a significant impact on Social Influence. Furthermore, faculty members' acceptance of using 4IR technologies in teaching and learning is significantly higher among the younger group than their counterparts. However, there was no significant difference in the behavioral intention between male and female lecturers.

Future studies could incorporate other constructs for the UTAUT model, such as how the staff experience influences acceptance and use of IR-related technologies, as only the gender and age variables were investigated in this study. This study consisted of only 278 participants; this number might have limited our findings to some extent. Further research should determine additional factors that may influence the acceptance and usage of 4IR related technologies in HEIs. Furthermore, this study collected the data over a single period; therefore, future studies can conduct a longitudinal study which will provide a deeper understanding of the acritical factor of UTAUT on the acceptance of IR-related technologies. Future studies could use qualitative approaches to discover the factors that affect the implementation of 4IR-related technologies in teaching and learning, such as focus groups or individual interviews with various stakeholders, including decision-makers, HEIs leaders, faculty members, and students, to explore other new factors that could affect the adoption of these technologies.

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