Global Business and Management Research: An International Journal
Vol. 14, No. 4s (2022)

Collagen Products Sourced from Recombinant Collagen-Like Protein: Acceptance Analysis

Jarita Duasa*, Mohamed Asmy Mohd Thas Thaker, Nurhasya Adibah Mohd-Radzman
Department of Economics, Faculty of Economics and Management Sciences, International Islamic University Malaysia, Malaysia

Corresponding Author's Email: jarita@iium.edu.my

Abstract
The growing concerns on the transfer of diseases from animal sources as well as limited sources of marine life to produce collagen led to the present study which aims to provide an alternative source to the available collagen market and to analyze the acceptance level of consumers on this new product of collagen. The technology acceptance level is evaluated among consumers on the new product introduced using recombinant collagen-like protein as its source. Using cross-sectional data, a total of valid questionnaires was collected to validate the proposed hypothesis within Technology Acceptance Model (TAM) by using the Partial Least Square (PLS) path modeling approach (a variance-based SEM technique). The results show a direct positive and significant relations between perceived usefulness and attitude toward, perceive ease of use and attitude toward, and attitude toward and behavioral intention of using the product sourced from recombinant collagen-like protein.

Keywords: Collagen, Consumers, Malaysia, Technology Acceptance Model (TAM).

Introduction

The sources of collagen and gelatin are recently being questioned by consumers due to a growing concern regarding the transfer of diseases from animal sources and the limited sources from marine animals. Collagen mainly exists in all connective tissues that includes the skin, bone, cartilage, tendon and blood vessels of animals (Aberoumand, 2012; Huo & Zhao, 2009; Liu et al., 2012). Collagen has been extracted from the skin and bones of some vertebrate species, such as bovine and swine. These sources have nonetheless, been restricted due to the outbreaks of bovine spongio form encephalopathy, foot and mouth disease, autoimmune and allergic reactions (Liu et al., 2007; Liu et al., 2012). Collagens from marine life origin or fish-based collagen (Fadzlillah et al., 2011; Riaz & Chaudry, 2004) have also been widely produced in the industry. These collagens are extracted from fish, sponges, jellyfish (Liu et al., 2007; Parenteau-Bareil et al., 2010) and sea cucumber (Abedin et al., 2013; Zhou et al., 2015). Nevertheless, the depletion of important marine sources isa serious concern due to the current uncontrolled reckless acts of some producers. Thus, the present study attempts to provide an alternative source of collagen namely, recombinant collagen-like protein, which could be widely accepted by consumers and provide sustainable production that preserves the environment and biodiversity, namely, recombinant collagen-like protein.

Studying the acceptance level of this new technology of developing recombinant collagen-like protein for collagen products among stakeholders is important to test the marketability of the products. There have been substantial studies with regards to acceptance level in other areas. Many academic researches focused on examining the determinants of technology acceptance and the utilization among users. Among different models that have been proposed, the technology acceptance model (TAM) (Davis, 1989; Davis et al., 1989) which is adapted from the theory of reasoned action (TRA) (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) appears to be the most widely accepted among researchers. The reason for its popularity is perhaps

because of its parsimony and the wealth of recent empirical support for it (Agarwal & Prasad, 2007). According to the TAM, adoption behavior is determined by the intention to use a particular system, which in turn is determined by the 'perceived usefulness' and 'perceived ease of use' of the system or technology. Perceived Usefulness (PU) is defined as "the degree to which an individual believes that using a particular system would enhance his or her productivity" (Davis, 1989). Meanwhile, Perceived Ease of Use (PEU) is defined as "the degree an individual believes that using a particular system would be free of effort" (Davis, 1989).
Thus, the current study aims to obtain insight on the acceptance level of consumers on the new product introduced using recombinant collagen-like protein as its source. The ability to evaluate the degree of acceptance among stakeholders will enable us to recommend the relevant policies and forecast potential marketability as well as profitability of the product in the future. To our knowledge, no previous research has adopted TAM in the study of acceptance level using recombinant collagen-like protein as the source of collagen, particularly in Malaysia. Thus, the current study is perceived to be an additional literature that could integrate TAM in this new technology of producing collagen which is very important in cosmetic and health industries.

Literature Review

Previous studies have commonly used acceptance models such as the Technological Acceptance Model (TAM), Diffusion of Innovation (DOI), Unified Theory of Acceptance of Technology (UTAUT) model, Theory of Planned Behavior (TPB), Combined of TPB and TAM (C-TAM-TPB), Motivational Model, Social Cognitive Theory, Recommender System Adaption, and Compass Acceptance Model (CAM). Due to its robustness in predicting technology adoption in various contexts of technologies, TAM has received numerous empirical supports (McKinnon & Igonor, 2008; Park et al., 2009). Use of TAM is predicated on individuals having control over whether or not they use the system (Pearlson & Saunders, 2006). For the purpose of understanding system usage behavior, using TAM has the key benefit in providing a framework to investigate the effects of external variables on system usage (Hong et al., 2002). Despite that, several researchers explore whether the TAM's belief variables are mediators of the effect of external variables (Venkatesh, 2000; Venkatesh & Brown, 2001).
Studies on acceptance models have been conducted on various fields. In areas related to IT, user acceptance or intention to use was previously assessed with regards to that of; artificial intelligence (Alhashmi et al., 2019; Cai et al., 2022; Gado et al., 2022; Mohr & Kühl, 2021; Na et al., 2022), virtual reality (Capasa et al., 2022; Morelli et al., 2022; Sagnier et al., 2020; Zhang et al., 2022), digital library (Hong et al., 2002; Park et al., 2009), internet devices (Bruner & Kumar, 2005), internet usage (Jackson et al., 1997; Venkatesh & Davis, 2000), as well as internet banking and e-commerce (Duc et al., 2021; Gefen et al., 2003; Pavlou, 2014; Ramayah et al., 2002). In accepting e-commerce for instance, reducing perceived risks and consumer trust are found to be important (Gefen et al., 2003; Pavlou, 2014). Sciarelli et al. (2022) utilized an extended TAM approach to investigate the factors influencing entrepreneurs' adoption of blockchain technology in Italy. It was noted that extended TAM is expected to explain better in e-commerce environments compared to original TAM (Fayad & Paper, 2015). When the applicability of TAM was tested for predicting entrepreneurs' technology usage, Ndubisi et al. (2001) found it to be valid. Even a model based on transaction cost theory has been developed to study the consumer acceptance of products in electronic markets (Liang & Huang, 1998). From a study on the acceptance of IT among Saudis, Al-Gahtani et al. (2007) reported that subjective norm positively influences intention, but when the age and years of experiences using the computer increase, this influence is diminished. Huh et al. (2009) also studied the acceptance behavior of information system in hotels and concluded that if the key objective is to predict behavioral intention to use the system, TAM is preferable.

In the field of healthcare, Khan and Woosley (2011) conducted a comparison on the most suitable acceptance model for the health industry organization, Tao et al. (2019) examined the acceptance of health information portals among young internet users, whereas Alhashmi et al. (2019) investigated the critical success factors to adopt artificial intelligence in the healthcare sector in United Arab Emirates. Since patient acceptance is critical in order to implement or introduce a new technology in the healthcare system, previous studies have examined patient acceptance of electronic-health (Wilson & Lankton, 2004), e-consultations (Althumairi et al., 2022), virtual reality technology (Morelli et al., 2022), telemedicine (Ramírez-Correa et al., 2020), and voice smart care system (Jian et al., 2022). Meanwhile in the education sector, Szymkowiak and Jeganathan (2022) assessed the acceptance of peer-to-peer e-learning among Indian students. Mensah et al. (2022) examined college students' intentions to adopt e-learning system in China. Similarly, Zhou et al. (2022) used an extended TAM to analyze students' intention in using online education platform. Ramayah et al. (2003) incorporated motivational variables in TAM to explain internet usage among students of institutions of higher learning. Ho et al. (2013) investigated the acceptance behavior of mobile phone messaging to enhance the interaction between parent and teacher. TAM was also applied by Ramayah and Aafaqi (2004) in predicting e-library usage with the aid of self-efficacy.

Acceptance models are also used in the studies of technology of non-communication and information areas. In an assessment on consumer acceptance of nutritionally enhanced vegetable, Colson et al. (2011) found that consumers are willing to pay more for fresh produce product with labels indicating the enhanced level of antioxidants and vitamin C. In another study which focused on the effects of socio-demographic factors, Engle and Kouka (1995) analyzed consumer acceptance on canned bighead carp. The probabilities estimated showed that canned bighead carp competes more favorably with canned tuna than with canned salmon. Besides this, a study on public acceptance of biotechnology and genetically modified food in food production revealed that there is general optimism about biotechnology and support for its use in plants, but its approval for its use in animals is more limited (Hossain et al., 2002). Acceptance model is also used to consider the movement characteristic especially in left-turn gap acceptance. The results show that drivers tend to accept short lags/gaps between near side pedestrians compared to far side pedestrians. Drivers tend to accept short lags and being conservative about short gaps (Alhajyaseen et al., 2013). In terms of new product acceptance, Mahajan and Wing (1985) concluded from their analysis using the acceptance model that, further research on the mentioned areas can make diffusion models acceptable and viable tools to study the diffusion of an innovation. There has also been a study which looked into community acceptance and adoption of decentralized water systems (Mankad & Tapsuwan, 2011). The study focused on social science literature pertaining to alternative forms of household water, with an emphasis on decentralized water acceptance. They discovered that within the social science literature there appears to be a skewing towards focusing on acceptance of centralized alternative water such as recycled and desalinated water system. Having said this, none of previous research has adopted TAM in the study of acceptance level of using recombinant collagen-like protein as a source of collagen in Malaysia. Thus, the current study is perceived to be an additional literature that could integrate TAM in this new proposed technology for collagen product.

Methodology

Sample and Measurement Scales

In assessing the level of acceptance on the 'proposed alternative source of collagen product' to the households or consumers, a face-to-face survey is conducted on a target sample of 1,000 respondents spreading across northern, southern, eastern and middle regions in Peninsular Malaysia (see Appendix). The number of respondents for each region is determined using

proportional stratified sampling method. Before the survey is conducted, a pilot study was held to validate relevancy of the survey questions. The survey is conducted by selected enumerators and closely monitored by the researchers. Data were collected from respondents regardless of their age, educational background, income level, ethnicity, religion and gender. The respondents were asked on all these demographic information, except their names, and these variables are used later as control variables in our analysis of data. A total of 2000 questionnaires were distributed as a part of a survey among consumers in all selected regions. Of these, 1446 completed responses were returned and analyzed.

For the survey, a structured questionnaire was developed. The questionnaire had two distinct sections. Demographic details of respondents, including age, gender, educational background, income level and others were sought in the first section. The second section consisted of eight items to measure 'perceived usefulness', thirteen items to measure 'perceived ease of use', nine items to 'attitude towards using recombinant collagen-like protein' and nine items to measure 'behavioral intention to use recombinant collagen-like protein. Respondents were asked to rate all items on a five-point Likert-type format anchored between strongly disagree (indicated by 1) and strongly agree (indicated by 5).

Technology Acceptance Model (TAM) and Hypotheses

Analysis of the survey data collected from consumers is conducted by using Technology Acceptance Model (TAM). TAM is a theoretical model that explains and predicts the user behaviour in information technology and it is considered an influential extension of theory of reasoned action (TRA). TAM provides a basis with which one traces how external variables influence belief, attitude, and intention to use. Two cognitive beliefs posited by TAM are: perceived usefulness and perceived ease of use. According to TAM, one's actual use of a technology system is influenced directly or indirectly by the user's behavioural intentions, attitude, perceived usefulness of the system, and perceived ease of the system. TAM also proposes that external factors could affect intention and actual use through mediated effects on perceived usefulness and perceived ease of use. Figure 1 depicts the TAM (Davis, 1989).

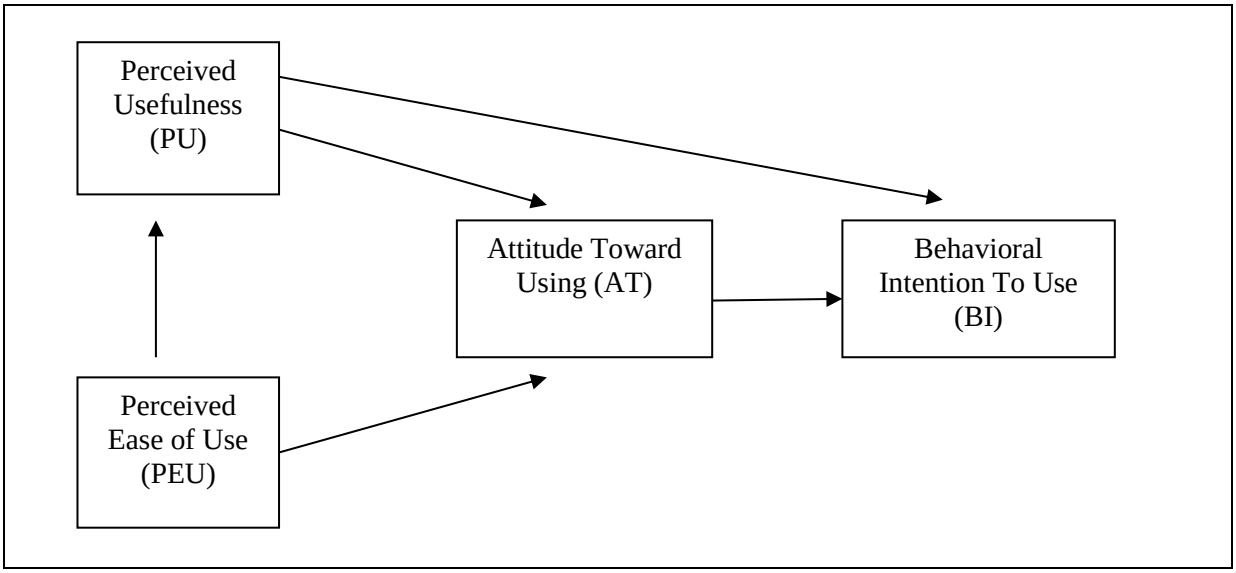

Figure 1: Technology Acceptance Model (TAM)

Based on TAM framework, the present study comes out with the following hypotheses:

Hypothesis 1: 'Attitude' towards using product sourced from recombinant collagen-like protein is significantly (positively) affecting the consumers 'behavioral intention' to use the product

source from recombinant collagen-like protein.
Hypothesis 2: There is a significant (positive) influence of 'perceived ease of use' on the 'attitude' to use the product sourced from recombinant collagen-like protein.
Hypothesis 3: There is a significant (positive) influence of 'perceived ease of use' on 'perceived usefulness' of the product sourced from recombinant collagen-like protein.
Hypothesis 4: There is a significant (positive) influence of 'perceived usefulness' on the 'attitude toward' to use the product sourced from recombinant collagen-like protein.
Hypothesis 5: There is a significant (positive) influence of 'perceived usefulness' on the 'behavioral intention' to use the product sourced from recombinant collagen-like protein.
Hypothesis 6: Mediator variables significantly affect the relationship between two constructs (in specific, perceived usefulness is a mediator variable between perceived ease of use and attitude toward; attitude toward is the mediator variable between perceived ease of use and behavioral intention; and attitude toward is the mediator variable between perceived usefulness and behavioral intention)

Data Analysis Technique

Data collected in the present study are analyzed using Partial Least Square – Structural Equation Model (PLS – SEM), the quantitative approaches, which can be used when the measurement of variables have a different scale (Hair et al., 2017). PLS - SEM was used to analyze the direct effect of exogenous variables on the endogenous variables. Smart PLS software is used to analyze the SEM indices. One advantage of using this method lies in its ability to deal with real challenges in the nature of data such as data noise, missing data and skewness (Dhir et al., 2020).

Results and discussion

The returned responses from the survey, that is 1446, were analyzed using SmartPLS version 3.2.7. The choice of SmartPLS was made on the basis of its ability to measure causal relationships among all latent constructs simultaneously, while dealing with measurement errors in the structural model (Farooq, 2016; Hair et al., 2017). The advantages of PLS include minimal restrictions on measurement scales, sample size and residual distributions (Chin et al., 2003).
The sample of consumers has an average of 30 years of age, and the majority (63.4 per cent) is male. The proportion of single respondents is slightly higher (57 per cent) than married/divorced respondents (43.1 per cent). Almost 75 per cent of respondents are Malays and therefore, as expected, Muslims are with the bigger percentage (91.8 per cent). From the total sample size, 16 per cent are non-citizen while the rest (84 per cent) are Malaysian. The non-citizen is mainly those who are studying and working in the country. Looking at the respondents' education level, more than 80 percent of them have higher level of education, with diploma, first degree or post-graduate degrees.
As of occupation, less than 10 per cent are self-employed. Those employed in public sector is 28.7 per cent while those employed in private sector is only 11.6 per cent. Since the rest of respondents are consist of retirees, unemployed, students and homemakers (52.1 per cent), we expect that they fall under the category of lower income brackets. Observing data on monthly income earned, about 38.5 per cent of the respondents earned less than RM500 per month. 25.7 per cent of them earn between RM500 and RM2000, 13.4 percent earn between RM2000 and RM3000, while 22.4 per cent earn more than RM3000 per month. Although we could see substantial difference of income level among consumers in study, careful inferences should be taken as a proper computation should exclude those who are not in labour force such as students, retirees and homemakers. Thus, diverse demography of respondents in the current study is expected to help understand the relations projected and generalize the findings.

Diversity in background of respondents could increase generalizability of the findings in the consumers context.

Table 1: Distribution of Respondents by Demographic Variables

Item		Frequency	Valid Percent
Gender	Male	528	36.6
	Female	915	63.4
Ethnicity	Malay	1075	74.7
	Chinese	86	6.0
	Indian	48	3.3
	Bumiputra	10	0.7
	Others	221	15.3
Citizenship	Malaysian	1209	84.0
	Non-Malaysian	230	16.0
Religion	Muslim	1284	91.8
	Non-Muslim	114	8.2
Marital Status	Single	821	57.0
	Married	593	41.2
	Divorced	27	1.9
Educational Level	No education	19	1.3
	Primary education	11	0.8
	Secondary education	172	11.9
	Diploma/pre-university	311	21.6
	First Degree	679	47.2
	Postgraduate education (Master/PhD)	248	17.2
Occupation	Public sector	413	28.7
	Private sector	167	11.6
	Self-employed	108	7.5
	Housewife/homemaker	41	2.8
	Retired	25	1.7
	Unemployed	60	4.2
	Student	625	43.4
Monthly income	≤ RM500	529	38.5
	RM501 –RM1,000	125	9.1
	RM1,001 – RM1,500	112	8.2
	RM1,501 – RM2,000	115	8.4
	RM2,001 – RM2,500	89	6.5
	RM2,501 – RM3,000	95	6.9
	> RM3,000	308	22.4

Measurement Model

The outer loading for each indicator was used to test the convergent validity and it reflects a positive correlation between one to other indicators in measuring the same construct (Hair et al., 2017). The outer loading of more than 0.7 implies that the indicator is acceptable. The outer loading value between 0.4 and 0.7 should be considered if it could be increasing the Average Variance Extracted (AVE) (Hair et al., 2017). Thus, the indicators which have less than 0.6 outer loading are deleted. Table 2 displays the outer loading for all indicators for each construct. Another criterion in the validity test is the convergent validity using the value of Average Variance Extracted (AVE). Average variance extracted (AVE) should ideally be more than 0.5 (Chin, 1998; Hock and Ringle, 2006). The AVE value more than 0.5 indicates that the construct explains more than a half of variance of indicators (Hair et al., 2017). Results in Table 2 display that the AVE for each variable is more than 0.5 and therefore consistent with the required

criteria. We need to also ensure that the instruments are reliable based on composite reliability and Cronbach's Alpha. Hair et al. (2017) explained that composite reliability (CR) and Cronbach's Alpha (CA) were used to test the construct reliability. According to Hair et al. (2017), the instruments are reliable if the composite reliability value more than 0.7 and the Cronbach's Alpha is more than 0.5. Based on both criteria in reliability test, the results show that the measurements of variables which are used in this study are reliable.

Table 2: Convergent Validity

Items	Factor loading
Attitude Toward (AT): CR = 0.923 , CA = 0.902 , AVE = 0.631	
AT22	0.786
AT23	0.836
AT24	0.832
AT25	0.826
AT26	0.803
AT29	0.710
AT30	0.761
Behavioral Intention (BI): CR = 0.944 , CA=0.934 , AVE=0.654	
BI31	0.772
BI32	0.802
BI33	0.797
BI34	0.815
BI35	0.823
BI36	0.835
BI37	0.787
BI38	0.821
BI39	0.822
Perceived Ease of Use (PEU): CR = 0.934 , CA=0.923 , AVE=0.52	
PEU9	0.704
PEU10	0.746
PEU11	0.724
PEU12	0.735
PEU13	0.712
PEU14	0.693
PEU15	0.711
PEU16	0.724
PEU17	0.743
PEU18	0.738
PEU19	0.751
PEU20	0.712
PEU21	0.674
Perceived Ease of Use (PEU): CR = 0.934 , CA=0.923 , AVE=0.52	
PU1	0.737
PU2	0.772
PU3	0.782
PU4	0.798
PU5	0.740
PU6	0.789
PU7	0.778
PU8	0.770

Notes: CR = Composite Reliability; CA = Cronbach's Alpha, AVE = Average Variance Extracted.

Table 3: Discriminant Validity (Heterotrait-Monotrait Ratio of Correlations)

	AT	BI	PEU	PU
AT				
BI	0.847			
PEU	0.766	0.743		
PU	0.728	0.726	0.803	

Once the test of convergent validity is conducted, the discriminant validity is tested. In many previous studies, Fornell and Larcker (1981) criterion has been used to test discriminat validity. However, there are criticisms on this criterion as it is not able to detect the lack of discriminant validity in common research situations (Henseler et al., 2015). Henseler et al. (2015) suggested an alternative approach to access discriminant validity using heterotrait-monotrait ratio of correlations (HTMT) which is having better performance by means of a Monte Carlo simulation. The discriminant validity using this new method is conducted and the results are shown in Table 3. If the HTMT value is greater than 0.85 (Kline, 2011) or 0.90 (Gold et al., 2001), it implies that there is a problem of discriminant validity. Since the current results show that all the values passed the HTMT0.90 (Gold et al., 2001) and the HTMT0.85 (Kline, 2011), the discriminant validity has been ascertained and therefore each construct which developed in this study is absolutely different. Based on these results, the measurement model of this study has adequate convergent validity and discriminant validity.

Structural Model

As suggested by Ramayah et al. (2016), coefficient of determination, R2, is used to observe the goodness fit of the structural model. According to Hair et al. (2011), coefficient of determination and the level of significance of the path coefficients (beta values) can be captured by R2. The current statistic of R2 for the structural model is 0.604, suggesting that 60 percent of the variance of behavioral intention to use the product sourced from recombinant collagen-like protein can be explained by perceived ease of use, perceived usefulness and attitude towards.

Furthermore, in order to assess the statistical significance of path coefficients, the current study has calculated the path coefficients of the structural model and performed bootstrap analysis (re-sampling = 500). Results are presented in Table 4. It is revealed that perceived usefulness and perceived ease to use has a positive relationship with attitude toward using the product sourced from recombinant collagen-like protein with b = 0.299 ($p < 0.01$) and b = 0.485 ($p < 0.01$), respectively. In addition, perceived easy to use has a positive relationship and direct effect with perceived usefulness with b = 0.741 and significant at one percent level. Similarly, attitude toward has a positive and significant relationship with behavioral intention with b = 0.778 and perceive usefulness has a positive and significant relationship with behavioral intention with b = 0.275. Thus, H1, H2, H3, H4 and H5 are fully supported through the tests. Observing the size of path coefficient (standard beta), it could be noticed that the direct effect of 'behavioral intention' (0.778) indicates that increasing 'attitude toward' by one point would increase the behavioral intention index by 0.778 points. This size of beta is the highest among other betas. Nonetheless, the direct effect of 'perceived easy to use' on 'perceived useful' also marks high value of beta with 0.741. All these results imply the importance of these constructs in the model.

Table 4: Results of Hypotheses Testing (Direct Relationship)

Hypothesis	Direct relationship	Path coefficient (std beta)	Std. error	t-statistic (p-value)
H1	AT -> BI	0.778	0.014	54.59 (0.000)
H2	PEU -> AT	0.485	0.031	15.54 (0.000)
H3	PEU -> PU	0.741	0.015	48.07 (0.000)
H4	PU -> AT	0.299	0.032	9.48 (0.000)
H5	PU -> BI	0.275	0.025	10.92 (0.000)

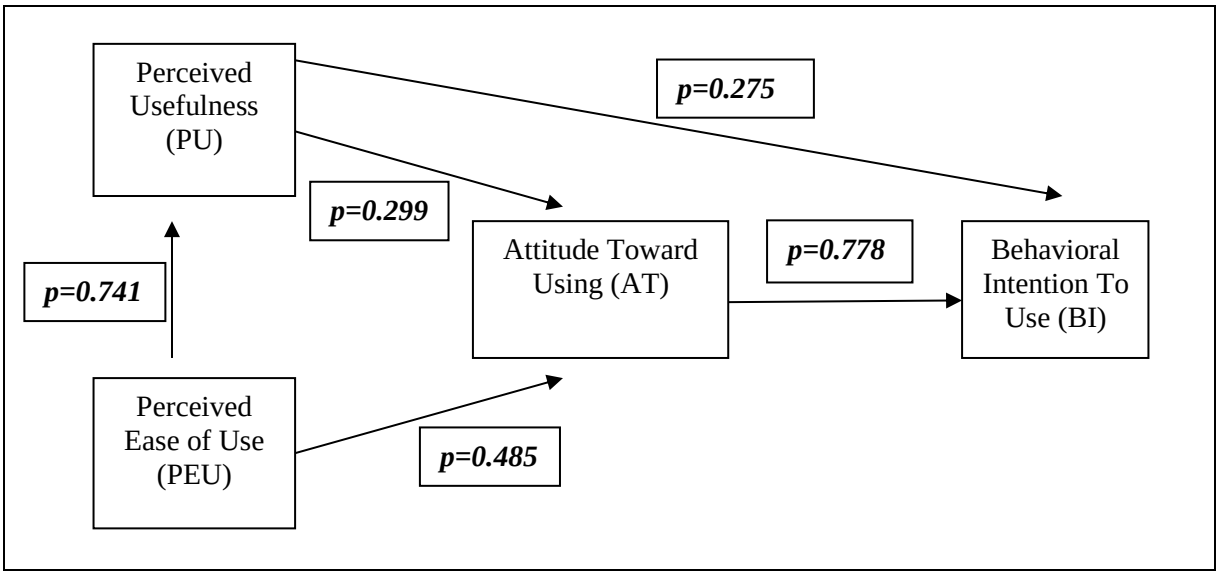

Figure 2: Path Coefficients of Technology Acceptance Model (TAM)

Mediation Effect

Mediation effect could be defined as a situation when a third mediator variable intervenes between two other related constructs (variables). In other words, a change in the exogenous construct causes a change in the mediator variable, which, in turn, results in a change in the endogenous construct in the model. Thereby, a mediator variable governs the nature (i.e., the underlying mechanism or process) of the relationship between two constructs. The test on mediation provides the analysis of strength of the mediator variable's relationships with the other constructs which substantiate the mechanisms that underlie the cause-effect relationship between an exogenous construct and an endogenous construct. Detail analysis of systematic mediator in PLS-SEM is provided by Hair et al. (2017), Nitzl et al. (2016) and Cepeda et al. (2017).

Table 5: Results of Hypotheses Testing on Mediation (Indirect Relationship)

Hypothesis	Indirect relationship	Standard beta	Standard error	t-statistics	Confidence Interval (CI)	
					LL	UL
H1	PEU -> AT	0.242	0.024	9.933	0.203	0.299
H2	PEU -> BI	0.612	0.016	37.316	0.577	0.64
H3	PU -> BI	0.197	0.02	10.074	0.166	0.244

Notes: LL = lower level, UL = upper level.

In this study, we develop three hypotheses on mediation from the current model. In the first hypothesis, H1, perceived usefulness is a mediator variable between perceived ease of use and attitude toward and it is expected that this mediator is significantly intervening between these two constructs. In hypothesis two, H2, attitude toward is the mediator variable between perceived ease of use and behavioral intention and in hypothesis three, H3, attitude toward is the mediator variable between perceived usefulness and behavioral intention. Based on bootstrapping analysis, all three indirect effects (standard beta), b=0.242, b=0.612 and b=0.197 are significant with t-values of 9.933, 37.316 and 10.074, respectively (t-values > 1.96, two-tailed, $p < 0.05$). The indirect effects 95% boot Confidence Interval (CI) bias corrected: (LL=0.203, UL=0.299), (LL=0.577, UL=0.64), and (LL=0.166, UL=0.244) do not straddle a zero in between indicating there is mediation effect (Preacher and Hayes, 2004; Preacher and Hayes, 2008). Thus, these results indicate that the mediation effects are statistically significant and support the hypotheses. The results are shown in Table 5.

Table 6: Results of Total Effect (Direct Effect Plus Indirect Effect)

Relationship	Mediator variable	Standard beta	Standard error	t-statistics	p-values
AT -> BI	-	0.595	0.017	57.067	0.00
PEU -> AT	PU	0.689	0.016	41.598	0.00
PEU -> BI	AT	0.612	0.015	37.316	0.00
PEU -> PU	-	0.73	0.031	47.564	0.00
PU -> AT	-	0.331	0.033	10.59	0.00
PU -> BI	AT	0.474	0.026	18.04	0.00

Table 6 displays the total effect when the mediator is considered in the relationship of two constructs. The total effect is the addition of direct effect (path coefficient) and indirect effect (standard beta) in each mediation hypothesis. The results show betas for total effect in all hypotheses are significant at 1 percent level. The total impact of 'perceived ease of use' (0.689) implies that one-unit change in this construct would improve the 'attitude toward' index by 0.689. This total impact has been computed by summing up the direct effect on attitude towards and indirect impact on 'perceived usefulness'. As for total effect of 'perceived ease of use' on 'behavioral intention', the mediating variable of 'attitude toward' significantly improves the strength of relationship (0.612), while total effect of 'perceived usefulness' on 'behavioral intention', the mediating variable of 'attitude toward' significantly improves the strength of relationship by 0.474. While computing the summation of direct and indirect effects of the determinants, we found that in most cases, the mediators improve the behavioral intention to use the product sourced from recombinant collagen-like protein.

Importance-Performance Map Analysis (IPMA)

Furthermore, we extend the analysis using importance-performance map analysis (IPMA) from the standard path coefficient estimates in more practical way following Ringle and Sarstedt (2016). Also known as importance-performance matrix, IPMA extends the results of the estimated path coefficient (importance) by adding a dimension that considers the average values of the latent variable scores (performance). In detail, the IPMA contrasts the unstandardized total effects (importance) in the structural and the average values of the latent variable scores on a scale from 0 to 100 (performance) in a graphical representation. Ringle and Sarstedt (2016) stated that the IPMA's objective is to identify predecessors which have a relatively low performance but high importance for the target constructs. These become major and high priority improvement areas with the goal to in turn increase the performance of the selected key target construct in the Partial Least Square (PLS) path model.

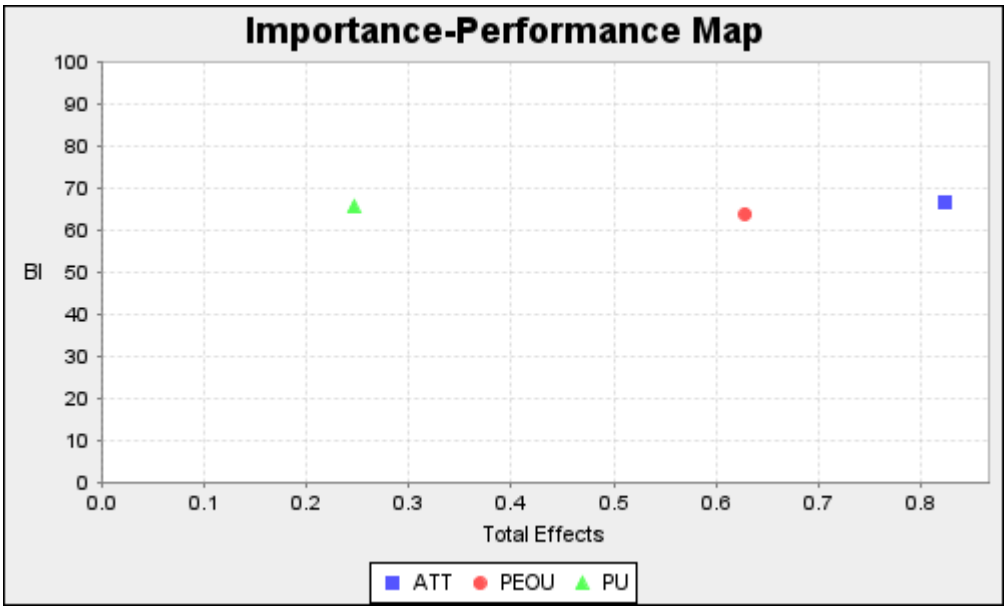

Figure 3: Importance-Performance Map Analysis

Table 7: Importance-Performance Map Analysis Statistics

Variable	Importance (Total Effect)	Performance (Index Values)
AT	0.824	66.785
PEU	0.628	63.799
PU	0.246	65.729

In this study, the behavioral intention of using the product sourced from recombinant collagen-like protein is a target construct, which is predicted by three predecessors (perceived ease of use, perceived usefulness and attitude towards) as shown by Figure 1. The results of IPMA are displayed in Table 7 and illustrated in Figure 3. The IPMA reveals that the construct attitude toward has high performance and also an important variable in the prediction of behavioral intention of using the product sourced from recombinant collagen-like protein. Meanwhile, perceived usefulness already has high in performance but low importance compared to perceived ease to use and attitude toward.

Discussion of Results

The findings in this study simply reveal that the behavioral intention of using the product sourced from recombinant collagen-like protein is depending on perceived usefulness and perceived easy to use from the consumers' perspectives. We found that perceived usefulness and perceive ease of use have positive effect on attitude toward using the product sourced from recombinant collagen-like protein and similarly, attitude toward is positively related to behavioral intention of using this product. Perceived usefulness is the perception that the subject will help a user to achieve his or her goals. The perceived usefulness of the product sourced from recombinant collagen-like protein could be traced among consumers as it can reduce the problem of less collagen in body due to age factor, promote healthy food development, enhance innovation in health and cosmetic industries, solve the problem of unavailable halal collagen in my country, support the national economy by increasing economic activity in the halal industry, increase consumers' confidence, and help government to promote more economic activities to local manufacturers. This finding is consistent to findings of Mohd Thas Thaker (2018), Venkatesh and Morris (2000), Abbasi et al. (2011), and Cheng et al. (2006) using similar method to analyze new models and technologies. This collagen product in nature with alternative source producing it is expected to create a positive

attitude toward and finally the intention of using it among consumers.

Perceived ease of use is defined as the degree to which a person believes that easy-to-use the model or subject was associated with greater intent to use it (Davis, 1989). Thus, the easier to use the product sourced from recombinant collagen-like protein, the more consumers attracted to use and buy it. Perceived ease of use of the product implies high confidence obtained from the product and assist consumer to make better selection of healthy products. Besides, it assists them to boost their religious awareness and more skilful in dealing with halal elements in everyday life. Nonetheless, confusion, wrong decision, and frustration on the choice of collagen products could be overcome with the selection of current product which is environmentally friendly and syariah compliance. The importance of 'perceived ease of use' contruct in determining intention is also found in studies of Davis (1989), Mohd Thas Thaker (2018), Yi et al. (2003) and Gefen et al. (2004).

Meanwhile, we also find that perceived ease of use was positively and significantly associated with perceived usefulness. It means that the easier the product to use, the more useful it is perceived to be. In fact, PEU was found as a significant antecedent of PU, rather than a parallel, direct determinant of acceptance, and thus it can affect indirectly the acceptance through PU (Davis et al., 1992). According to a study of Lee et al. (2003), 69 studies showed a significant relationship between PEU and PU in TAM model from 1986 to 2003.

With regard to the mediating hypotheses, the bootstrapping results reveal that the relationship between perceived ease of use and attitude toward is mediated by perceived usefulness. Similarly, the relationships between perceived ease of use and behavioral intention as well as perceived usefulness and behavioral intention are intervened by attitude toward. In both cases of PU and AT as mediating variables, the total effects of exogenous variables on endogenous variables are increase in magnitude as compared to direct effects. The results substantiate the importance of the mediating variables in the model that further strengthen the well acceptance of the collagen products sourced from recombinant collagen-like protein. Nonetheless, the model developed in the study could be highly trusted based on high performance of each predecessor in predicting the behavioral intention.

Conclusion

The most important task in food producing industries is to produce the healthy and desirable products in which the techniques of production and food sources are well accepted by consumers. Our study focuses on collagen products which currently doubted on the sources used. The growing concerns on the transfer of diseases from animal sources and halal issue on the sources and manufacturing processes as well as the limited sources from marine animals, is a reason to call this study that aims to provide an alternative source to the available collagen market and to analyze the acceptance level of consumers on this new product of collagen. In detail, the technology acceptance level is evaluated among consumers on the new product introduced using recombinant collagen-like protein as its source. Using cross sectional data of 1446 consumers through survey, the objective of study is achieved by adopting TAM in which data are analyzed using PLS – SEM. Results clearly show a direct positive and significant relations between perceived usefulness and attitude toward, perceive ease of use and attitude toward, and attitude toward and behavioral intention of using the product sourced from recombinant collagen-like protein. Further, the study investigates the mediating role of perceived usefulness between perceive ease of use and attitude towards and mediating role of attitude toward between perceived ease of use and behavioral intention as well as perceived usefulness and behavioral intention. The findings of this research confirm that both PU and AT play important roles in increasing intention to use the collagen product sourced from recombinant collagen-like protein.

Thus, the results imply the high potential end collagen product to be marketed using this alternative source of collagen. Food industry, particularly in the country, should hence pay more attention to the aforementioned technique of extracting collagen for final food production to increase their future returns. It could also enhance consumer loyalty on the product used, which would help any business to survive in the current competitive scenario. Implications of our study offer some useful suggestion to firms in food and health industries to opt for the alternative method of extracting collagen using recombinant collagen-like protein that would further enhance consumer loyalty in collagen-based products and help in successful sustainability of the environment, biodiversity and most importantly the halalness. By effectively understanding the level of consumers' acceptance, producers can have a proper plan to adopt the new technique of extracting collagen for their products and to well equip the process with necessary tools. It is imperative to generate positive perception and confidence among consumers about the new source of product. By doing so, it helps firms to increase overall productivity in the competitive market. This study not only extends the literature on food security and health areas of research but also provides insights for environmental concern of food production for sustainable development.

As for study limitations, the findings of the present study are based on the data collected from consumers in Malaysia only. As such, the generalization of the findings to other countries should be done with caution. Representativeness of our model is limited for two reasons. Firstly, the factors identified in determining the behavioral intention are not exhaustive. A more exhaustive list of such factors could lead to further interesting insights. Secondly, this is a cross-sectional study and hence does not take into consideration temporal effects. However, replicating the study using longitudinal data could further validate the relations we have proposed and tested. Moreover, the present research has mainly focused on the role of mediators in enhancing the impact of factors or constructs on the intention. Future investigations should test moderating effects in the model to elucidate the relationship between these constructs. Demographic variables (e.g., gender, age, educational background) can be some of the potential moderators that can strengthen or weaken the relationship between PU, PEU and intention.

Appendix

Distribution of Respondents by States in Malaysia

State	Frequency	Percent
Johor	133	9.2
Kedah	184	12.7
Kuala Lumpur	199	13.8
Kelantan	102	7.1
Melaka	15	1.0
Pahang	106	7.3
Pulau Pinang	341	23.6
Perak	99	6.8
Perlis	51	3.5
Selangor	135	9.3
Terengganu	81	5.6
Total	**1446**	**100.0**

Acknowledgement

This study is funded by the Trans-disciplinary Research Grant Scheme (TRGS), TRGS/1/2018/UIAM/01/1/2, Ministry of Higher Education, Malaysia. The authors would like to thank the Ministry for generously funding the research.

References

Abbasi, M. S., Chandio, F. H., Soomro, A. F., & Shah, F. (2011). Social Influence, Voluntariness, Experience and the Internet Acceptance: An Extension of Technology Acceptance Model with a South-Asian Country Context. *Journal of Enterprise Information Management*, 24(1), 30-52.

Abedin, M. Z., Karim, A. A., Latif, A. A., Gan, C.-Y., Che Ghazali, F., Zzaman, W., Hossain, M., Ahmed, F., Absar, N., & Sarker, M. Z. I. (2013). Physicochemical and Biochemical Properties of Pepsin-Solubilized Collagen Isolated from the Integument Of Sea Cucumber (Stichopus Vastus). *Journal of Food Processing and Preservation*, 38(4), 2027-2036.

Aberoumand, A. (2012). Comparative Study Between Different Methods of Collagen Extraction from Fish and Its Properties. *World Applied Sciences Journal*, 16(3), 316-319.

Agarwal, R., & Prasad, J. (2007). Are Individual Differences Germane to the Acceptance of New Information Technologies? *Decision Sciences*, 30(2), 361-91.

Ajzen, I., & Fishbein, M. (1980). Understanding attitudes and predicting social behavior. Englewood Cliffs, New Jersey: Prentice-Hall, 1980.

Alhajyaseen, W. K. M., Asano, M., & Nakamura, H. (2013). Left-Turn Gap Acceptance Models Considering Pedestrian Movement Characteristics. *Accident Analysis & Prevention*, 50.

Alhashmi, S. F., Salloum, S. A., & Mhamdi, C. (2019). Implementing Artificial Intelligence in the United Arab Emirates Healthcare Sector: An Extended Technology Acceptance Model. *International Journal of Information Technology and Language Studies*, 3(3), 27-42.

Althumairi, A., Hariri, B., Aljabri, D., & Aljaffary, A. (2022). Patient Acceptance and Intention to Use e-Consultations During the COVID-19 Pandemic in the Eastern Province of Saudi Arabia. *Frontiers in Public Health*, 10.

Al-Gahtani, S. S., Hubona, G. S., & Wang, J. (2007). Information Technology (IT) in Saudi Arabia: Culture and the Acceptance and Use of IT. *Information & Management*, 44(8), 681-691.

Brunner, G. C., & Kumar, A. (2005). Explaining Consumer Acceptance of Handheld Internet Devices. *Journal of Business Research*, 58(5), 553-558.

Cai, R., Cain, L. N., & Jeon, H. (2022). Customers' perceptions of hotel AI-enabled voice assistants: does brand matter? *International Journal of Contemporary Hospitality Management*, 34(8), 2807-2831.

Capasa, L., Zulauf, K., & Wagner, R. (2022). Virtual Reality Experience of Mega Sports Events: A Technology Acceptance Study. *Journal of Theoretical and Applied Electronic Commerce Research*, 17(2), 686-703.

Carrión, G. C., Nitzl, C., & Roldán, J. L. (2017). Mediation Analyses in Partial Least Squares Structural Equation Modeling: Guidelines and Empirical Examples. In Latan, H. and Noonan, R. (eds.) Partial Least Squares Path Modeling: Basic Concepts, Methodological Issues and Applications. Cham: Springer International Publishing AG, 2017.

Cheng, T. C. E., Lam, D. Y. C., & Yeung, A. C. L. (2006). Adoption of Internet Banking: An Empirical Study in Hong Kong. *Decision Support Systems*, 42(3), 1558-1572.

Chin, W. W. (1998). The Partial Least Squares Approach to Structural Equation Modelling. In Marcoulides, G. A. (ed.) Modern Methods for Business Research. Mahwah, New Jersey: Lawrence Erlbaum Associates, 1998.

Chin, W. W., Marcolin, B. L., & Newsted, P. R. (2003). A partial least squares latent variable modeling approach for measuring interaction effects: Results from a monte carlo simulation study and an electronic-mail emotion/adoption study. *Information Systems Research*, 14(2), 189-217.

Colson, G. J., Huffman, W. E., & Rousu, M. (2011). Improving the Nutrient Content of Food through Genetic Modification: Evidence from Experimental Auctions on Consumer Acceptance. *Journal of Agricultural and Resource Economics*, 36(2), 343-364.

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 13(3), 319-340.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management Science*, 35(8), 982-1003.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1992). Extrinsic and Intrinsic Motivation to Use Computers in the Workplace. *Journal of Applied Social Psychology*, 22(14), 1111-1132.

Dhir, S., Dutta, T., & Ghosh, P. (2020). Linking Employee Loyalty with Job Satisfaction using PLS–SEM Modelling. *Personnel Review*, 49(8), 1695-1711.

Duc, T. L., Huu, P. N., Be, L. P. T., & Minh, H. P. T. (2021). Toward a model for the acceptance of internet banking in an emerging market. *WSEAS Transactions on Environment and Development*, 17, 332-341.

Engle, C. R., & Kouka, P.-J. (1995). Potential Customer Acceptance of Canned Bighead Carp: A Structural Model Analysis. *Marine Resource Economics*, 10(2), 101-116.

Fadzlillah, N. A., Man, Y. B. C., Jamaludin, M. A., Rahman, S., & Al-Kahtani, H. A. (2011, October 21-23). *Halal Food Issues from Islamic and Modern Science Perspectives* [Paper presentation]. CHHSS 2011 Conference, Cairo, Egypt.

Farooq, M. S., & Radovic-Markovic, M. (2016, October). *Modeling Entrepreneurial Education and Entrepreneurial Skills as Antecedents of Intention towards Entrepreneurial Behaviour in Single Mothers: A PLS-SEM Approach* [Paper presentation]. EEE 2016 Conference, Faculty of Business Economics and Entrepreneurship, University of Belgrade, Belgrade.

Fayad, R., & Paper, D. (2015). The Technology Acceptance Model E-Commerce Extension: A Conceptual Framework. *Procedia Economics and Finance*, 26, 1000-1006.

Fishbein, M., & Ajzen, I. (1975). Belief, attitude, intention and behavior: An introduction to theory and research. Reading, Mass: Addison-Wesley, 1975.

Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research*, 18(3), 382-388.

Gado, S., Kempen, R., Lingelbach, K., & Bipp, T. (2022). Artificial intelligence in psychology: How can we enable psychology students to accept and use artificial intelligence? *Psychology Learning and Teaching*, 21(1), 37-56.

Gefen, D., Karahanna, E., & Straub, D. W. (2003). Trust and TAM in Online Shopping: An Integrated Model. *MIS Quarterly*, 27(1), 51-90.

Gold, A. H., Malhotra, A., & Segars, A. H. (2001). Knowledge Management: An Organizational Capabilities Perspective. *Journal of Management Information Systems*, 18(1), 185–214.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a Silver Bullet. *Journal of Marketing Theory and Practice*, 19(2), 139-152.

Hair, J. F., Hult, G. T. M., Ringle, C., & Sarstedt, M. (2017). A primer on partial least squares structural equation modeling (PLS-SEM) (2nd ed.). Los Angeles: Sage, 2017.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A New Criterion for Assessing Discriminant Validity in Variance-Based Structural Equation Modeling. *Journal of the Academy of Marketing Science*, 43, 115-135.

Ho, L.-H., Hung, C.-L., & Chen, H.-C. (2013). Using Theoretical Models to Examine the Acceptance Behavior of Mobile Phone Messaging to Enhance Parent–Teacher Interactions. *Computers & Education*, 61, 105-114.

Höck, M., & Ringle, C. M. (2006). *Strategic Networks in the Software Industry: An Empirical Analysis of the Value Continuum* [Paper presentation]. IFSAM 2006 VIIIth World Congress, Berlin.

Hong, W., Thong, J. Y. L., Wong, W.-M., & Tam, K.-Y. (2002). Determinants of User Acceptance of Digital Libraries: An Empirical Examination of Individual Differences and System Characteristics. *Journal of Management Information Systems*,18(3), 97-124.

Hossain, F., Onyango, B., Adelaja, A., Schilling, B., & Hallman, W. (2002, June). *Public Perceptions of Biotechnology and Acceptance of Genetically Modified Food* (Food Policy Institute Publication Working Paper No. WP-0602-002).

Huh, H. J., Kim, T., & Law, R. (2009). A Comparison of Competing Theoretical Models for Understanding Acceptance Behavior of Information Systems in Upscale Hotels. *International Journal of Hospitality Management*, 28(1), 121-134.

Huo, J.-X., & Zhao, Z. (2009). Study on Enzymatic Hydrolysis of Gadus Morrhua Skin Collagen and Molecular Weight Distribution of Hydrolysates. *Agricultural Sciences in China*, 8(6), 723-729.

Jackson, C. M., Chow, S., & Leitch, R. A. (1997). Toward an Understanding of the Behavioral Intention to Use an Information System. *Decision Sciences*, 28(2), 357-389.

Jian, W. -S., Wang, J. -Y., Rahmanti, A. R., Chien, S. -C., Hsu, C. -K., Chien, C. -H., Li, Y. -C., Chen, C. -Y., Chin, Y. -P., & Huang, C. -L. (2022). Voice-based control system for smart hospital wards: a pilot study of patient acceptance. *BMC Health Services Research*, 22.

Khan, A., & Woosley, J. M. (2011). Comparison of Contemporary Technology Acceptance Models and Evaluation of the Best Fit for Health Industry Organizations. *International Journal of Computer Science and Engineering Technology*, 1(11), 709-717.

Kline, R. B. (2011). Principles and practice of structural equation modeling. New York: Guilford Press, 2011.

Lee, Y., Kozar, K. A., & Larsen, K. R. T. (2003). The Technology Acceptance Model: Past, Present, and Future. *Communications of the Association for Information Systems*, 12(1), 752-780.

Liang, T.-P., & Huang, J.-S. (1998). An Empirical Study on Consumer Acceptance of Products in Electronic Markets: A Transaction Cost Model. *Decision Support Systems*, 24(1), 29-43.

Liu, D., Liang, L., Regenstein, J. M., & Zhou, P. (2012). Extraction and Characterisation of Pepsin-Solubilised Collagen from Fins, Scales, Skins, Bones and Swim Bladders of Bighead Carp (Hypophthalmichthys Nobilis). *Food Chemistry*, 133(4), 1441–1448.

Liu, H., Li, D., & Guo, S. (2007). Studies on Collagen from the Skin of Channel Catfish (Ictalurus Punctaus). *Food Chemistry*, 101(2), 621-625.

Mahajan, V., & Wind, Y. (1985, January). *Innovation Diffusion Models of New Product Acceptance: A Reexamination* (Cox School of Business Historical Working Papers No. 85-901).

Mankad, A., & Tapsuwan, S. (2011). Review of Socio-Economic Drivers of Community Acceptance and Adoption of Decentralised Water Systems. *Journal of Environmental Management*, 92(3), 380-391.

Mensah, I. K., Zeng, G., Luo, C., Lu, M., & Xiao, Z. -W. (2022). Exploring the E-Learning Adoption Intentions of College Students Amidst the COVID-19 Epidemic Outbreak in China. *SAGE Open*, 12*(*2).

McKinnon, K., & Igonor, A. (2008). Explaining eLearning Perceptions using the Technology Acceptance Model and the Theory of Planned Behavior. In C. Bonk, M. Lee & T. Reynolds (Eds.), *Proceedings of E-Learn 2008--World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education* (pp. 2994-2999).

Association for the Advancement of Computing in Education (AACE).

Mohd Thas Thaker, M. A. B. (2018). Modelling SMEs' Behavioral Intention to Adopt Islamic Crowdfunding-Small And Medium Enterprises (ICSMEs) Model as a Source of Financing in Malaysia. *Journal of Islamic Monetary Economics and Finance*, 4(2), 293-310.

Mohr, S., & Kühl, R. (2021). Acceptance of artificial intelligence in German agriculture: an application of the technology acceptance model and the theory of planned behavior. *Precision Agriculture*, 22(6), 1816-1844.

Morelli, S., D'avenio, G., Rossi, M., & Grigioni, M. (2022). Investigating Virtual Reality technology acceptance by patients: preliminary results from a TAM-based model. *Annual Review of CyberTherapy and Telemedicine*, 20, 103-107.

Na, S., Heo, S., Han, S., Shin, Y., & Roh, Y. (2022). Acceptance Model of Artificial Intelligence (AI)-Based Technologies in Construction Firms: Applying the Technology Acceptance Model (TAM) in Combination with the Technology–Organisation–Environment (TOE) Framework. *Buildings*, 12(2).

Ndubisi, N. O., Jantan, M., & Richardson, S. (2001). Is the Technology Acceptance Model Valid for Entrepreneurs? Model Testing and Examining Usage Determinants. *Asian Academy of Management Journal*, 6(2), 31-54.

Nitzl, C., Roldan, J. L., & Cepeda, G. (2016). Mediation Analysis in Partial Least Squares Path Modeling: Helping Researchers Discuss More Sophisticated Models. *Industrial Management & Data Systems*, 116(9), 1849-1864.

Parenteau-Bareil, R., Gauvin, R., & Berthod, F. (2010). Collagen-Based Biomaterials for Tissue Engineering Applications. *Materials*, 3, 1863-1887.

Park, N., Roman, R., Lee, S., & Chung, J. E. (2009). User Acceptance of a Digital Library System in Developing Countries: An Application of the Technology Acceptance Model. *International Journal of Information Management*, 29(3), 196-209.

Pavlou, P. A. (2014). Consumer Acceptance of Electronic Commerce: Integrating Trust and Risk with the Technology Acceptance Model. *International Journal of Electronic Commerce*, 7(3), 101-134.

Pearlson, K. E., & Saunders, C. S. (2006). Managing and Using Information Systems: A Strategic Approach (3rd ed.). Hoboken, New Jersey: John Wiley & Sons Inc., 2006.

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS Procedures for Estimating Indirect Effects in Simple Mediation Models. *Behavior Research Methods, Instruments, & Computers*, 36(4), 717-731.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and Resampling Strategies for Assessing and Comparing Indirect Effects in Multiple Mediator Models. *Behavior Research Methods*, 40(3), 879-891.

Ramayah, T., & Aafaqi, B. (2004). Role of Self-Efficacy in E-Library Usage among Students of a Public University in Malaysia. *Malaysian Journal of Library & Information Science*, 9(1), 39-57.

Ramayah, T., Cheah, J., Chuah, F., Ting, H., & Memon, M. A. (2016). Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS 3.0: An Updated and Practical Guide to Statistical Analysis. Kuala Lumpur: Pearson Malaysia Sdn Bhd, 2016.

Ramayah, T., Jantan, M., Noor, M. N. M., Ling, K. P., & Razak, R. C. (2003). Receptiveness of Internet Banking by Malaysian Consumers: The Case of Penang. *Asian Academy of Management Journal*, 8(2), 1-29.

Ramayah, T., Ma'ruf, J. J., Jantan, M., & Mohamad, O. (2002, October 14-15). *Technology Acceptance Model: Is It Applicable to Users and Non-Users of Internet Banking* [Paper presentation]. The International Seminar, Indonesia-Malaysia, The Role of Harmonization of Economics and Business Discipline in Global Competitiveness, Banda

Aceh, Indonesia.

Ramírez-Correa, P., Ramírez-Rivas, C., Alfaro-Pérez, J., & Melo-Mariano, A. (2020). Telemedicine acceptance during the COVID-19 pandemic: An empirical example of robust consistent partial least squares path modeling. *Symmetry*, 12(10).

Riaz, M. N., & Chaudry, M. M. (2004). Halal food production. Boca Raton, Florida: CRC Press LLC, 2004.

Ringle, C. M., & Sarstedt, M. (2016). Gain More Insight from Your PLS-SEM Results: The Importance-Performance Map Analysis. *Industrial Management & Data Systems*, 116(9), 1865-1886.

Sagnier, C., Loup-Escande, E., Lourdeaux, D., Thouvenin, I., & Valléry, G. (2020). User Acceptance of Virtual Reality: An Extended Technology Acceptance Model. *International Journal of Human–Computer Interaction*, 36(11).

Sciarelli, M., Prisco, A., Gheith, M. H., & Muto, V. (2022). Factors affecting the adoption of blockchain technology in innovative Italian companies: an extended TAM approach. *Journal of Strategy and Management*, 15(3), 495-507.

Szymkowiak, A., & Jeganathan, K. (2022). Predicting user acceptance of peer-to-peer e-learning: An extension of the technology acceptance model. *British Journal of Educational Technology*.

Tao, D., Shao, F., Wang, H., Yan M., & Qu, X. (2019). Integrating usability and social cognitive theories with the technology acceptance model to understand young users' acceptance of a health information portal. *Health Informatics Journal*, 26(2), 1347-1362.

Venkatesh. V. (2000). Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model. *Information Systems Research*, 11(4), 342–365.

Venkatesh, V., & Brown, S. A. (2001). A Longitudinal Investigation of Personal Computers in Homes: Adoption Determinants and Emerging Challenges. *MIS Quarterly*, 25(1), 71-102.

Venkatesh, V., & Davis, F. D. (2000). A Theoretical Extension of The Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science*, 46(2), 186–204.

Venkatesh, V., & Morris, M. G. (2000). Why Don't Men Ever Stop to Ask for Directions? Gender, Social Influence, and Their Role in Technology Acceptance and Usage Behavior. *MIS Quarterly*, 24(1), 115-139.

Wilson, E. V., & Lankton, N. K. (2004). Modeling Patients' Acceptance of Provider-Delivered E-Health. *Journal of American Medical Informatics Association*, 11(4), 241-248.

Yi, M. Y., & Hwang, Y. (2003). Predicting the Use of Web-Based Information Systems: Self-Efficacy, Enjoyment, Learning Goal Orientation, and the Technology Acceptance Model. *International Journal of Human-Computer Studies*, 59(4), 431-449.

Zhang, M., Shu, L., Luo, X., Yuan, M., & Zheng, X. (2022). Virtual reality technology in construction safety training: Extended technology acceptance model. *Automation in Construction*, 135.

Zhou, T., Wang, N., Xue, Y., Ding, T., Liu, X., Mo, X., & Sun, J. (2015). Development of Biomimetic Tilapia Collagen Nanofibers for Skin Regeneration through Inducing Keratinocytes Differentiation and Collagen Synthesis of Dermal Fibroblasts. *ACS Applied Materials & Interfaces*, 7(5), 3253–3262.

Zhou, L., Xue, S., & Li, R. (2022). Extending the Technology Acceptance Model to Explore Students' Intention to Use an Online Education Platform at a University in China. *SAGE Open*, 12(1).