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Research Article

The Effect of Trust Benefit and Risk Perception of GM Foods on Behavior Intention: A Study on University Students

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ABSTRACT

The aim of this study is to examine the attitudes and behaviors of university students towards "foods containing Genetically Modified Organisms" (GMO). For this purpose, firstly, a research model was proposed to describe the relationships between attitudes and behaviors towards GMO by making use of the literature review, and then various hypotheses were formed to test the relationships between the factors in the model. The factors in the proposed research model are "Attitude (ATT),""Attitude towards Knowledge and Technology (KNOW)," "Trust (TRUST)," "Perceived Benefit (BEN)," "Perceived Risk (RISK)" and "Behavior (BEH)". In the study, the proposed research model was analyzed using Structural Equation Modeling (SEM), and the suitability of the proposed model was evaluated according to various fit criteria. As a result of the analysis, it was determined that a one-unit increase in the perceived benefit and perceived risk for GMO will cause an increase of 0.89 units and a decrease of 0.19 units, respectively, in the attitude towards GMO. In addition, it was determined that as trust in scientific research results, media, labeling system and inspection systems increase, the perception that GMO can be beneficial will also increase.

Keywords: GMO (Genetically Modified Organisms), Attitude, Trust, Perceived Benefit, Perceived Risk, Structural Equation Modelling

1. Introduction

Human beings have sought ways to improve their living standards throughout history and managed to achieve some of them with the new advances in biotechnological fields. Changes in the genetic structure of living things that could not be obtained by natural reproduction processes have been developed using modern techniques since the early 1970s (Kaya et al., 2012). Gene technology is defined as the process of isolating genes with molecular biology methods and transferring them to the isolated organism or to a different organism by making the desired changes on these genes (Bayraç et al., 2014; Tahmaz, & Özkaya, 2017). The organisms whose existing characteristics are changed or which gain new characteristics through modification of their genetic characteristics using these methods are called "genetically modified organisms - GMO" (Kaynar, 2009).

Gene technology (GT) has developed rapidly and consistently worldwide over the past twenty years (Rodŕguez-Entrena, & Salazar- Ordóñez, 2013; Zhang et al., 2018). Almost all of the agricultural production based on GMOs in the world is realized primarily in the USA, Argentina, Canada, Brazil, and China. In general, GMOs are used in a wide range of agricultural products that are resistant to pesticides and various agricultural pests, such as soy, corn, cotton, rapeseed, potato, tobacco, paddy and tomato along with their byproducts in the world (Zhang et al., 2018; James, 2016; Li et al., 2014).

Food security has been a growing concern in recent years as a major consumer anxiety. In particular, the research on purchasing behaviors for genetically modified foods has attracted great interest (Bawa, & Anilakumar, 2013). Pesticide composition, pollution, food spoilage, and health concerns have a major impact on purchasing behaviors of consumers. Attitudes of consumers towards GMO vary in terms of countries and individuals (Rodŕguez Entrena, & Salazar-Ordóñez, 2013). In particular, the public acceptance of GMO is low in Japan and the European Union (EU). As a result of a survey, it was determined that the public awareness level for GM crops was "bad" (16%) in 2003, "medium" (57%) in 2006, and "high" (90%) in 2009 (Lv, & Ma, 2012).

Studies have been conducted on evaluating the perspectives of different parts of public opinion towards GMOs in Turkey. For instance, in the study carried out by Özdemir (2009) across Turkey on 2,626 people between 2007-2009, it was concluded that the consumers did not have sufficient information on GMOs, that they believed that GMO were widely used in Turkey, and that they found these products quite risky in terms of human and environmental health and socioeconomic aspects. In the public opinion survey conducted by Greenpeace in 2012, 81% of the participants were concerned about GMOs, and the question of *"What would you do if you knew that a packaged product contained GMO" was* responded as *"I would not purchase it"* by 83% (Greenpeace Mediterranean, 2012). In the study called "GMO Awareness in Three Regions of Turkey" and carried out in three regions of Turkey (Southeast and East Anatolia, Aegean and Black Sea) in 2012, 73% of the participants indicated that they had heard about the concept of GMO while 27% stated that they had never heard about it. Among those who had heard about the concept of GMO, 93% associated GMOs with agricultural products/crops accurately (Baykan, & Ertunç, 2012). In the study carried out by Erbaş (2008) in the urban and rural areas of Ankara and Isparta provinces in Turkey, it was determined that the percentage of those who believed that GMO could be harmful was 86.1% in urban consumers while it was 75% in the participants from rural areas.

As concluded from the previous studies, it could be argued that the public is aware of GMO, and they are highly concerned about it in Turkey (Yilmaz, 2014). In addition, it could be argued that a reliable and effective biosafety mechanism is required to address public concerns about GMO.

Today, there is an intensive discussion about the potential negative effects of GMO on human health and the environment. In this study, the perspectives and attitudes of university students towards GMO and the factors affecting their purchasing behaviors were investigated through a Structural Equation Model (SEM), which was suggested based on the benefit-risk analysis (BRA). No study has been carried out about the perspectives of students towards GMO in Eskişehir where intensive agricultural fields of Turkey are located. The contribution of this study to the literature is important in two respects. These are the proposed research model and the measurement tool developed for attitudes and behaviors towards GMO products.

2. Theoretical framework

BRA has been widely used to examine the intentions of consumers to purchase GMO (Zhang et al., 2018; Costa-Font, & Gil, 2009; Chen, & Li, 2007). The literature on purchase intentions for GMO is vast. However, there are very limited studies that examine and evaluate factors affecting purchasing intention for GMO systematically. Most studies usually include empirical evidence independently (Zhang et al., 2018).

Zhang et al. (2018) examined the intentions of Chinese consumers to purchase GMO. In light of the results analyzed , it was concluded that it was important to reduce the perceived risks in order to increase the purchasing intentions of Chinese consumers. Costa-Font, & Gil (2009) contributed to the literature by analyzing the behavioral process that guided the perceptions of individuals about GMO. Decision-making processes for food products were investigated through SEM in three Mediterranean countries which were Spain, Italy and Greece. The first finding of the study indicated that the attitudes towards GMO were affected by the trust in science as well as the attitudes and behaviors of public authorities. Secondly, it was determined that there were significant differences among three countries in terms of the final mechanism that led to the acceptance of GMO.

2.1. Research hypotheses

The purpose of this study was to investigate the attitudes and behaviors of university students towards GMO. For this purpose, first of all, a research model was designed by reviewing the literature and various hypotheses were developed to test the relationships in the model. Next, the data collection tool was developed to test these hypotheses. The factors of the research model were "Attitude (ATT)," "Attitude towards Knowledge and Technology (KNOW)," "Trust (TRUST)," "Perceived Benefit (BEN)," "Perceived Risk (RISK)" and "Behavior (BEH)" regarding GMO.

Knowledge

Knowledge factor: General knowledge about gene technology and specific knowledge about GMO plays a role in determining the benefit and risk perceptions of consumers, and accordingly, the attitudes of the consumers towards GMO (Chen, & Li, 2007; Klerck, & Sweeney, 2007). Some research results demonstrated that although the public gained knowledge on biotechnology, they didn't know much about GMO. Gaskell et al. (1999) concluded that limited information about GMO increased the perceptions of risk and decreased the acceptance of GMO. Klerck, & Sweeney (2007) found that objective knowledge about GMO significantly reduced psychological risks. In this study, the following hypotheses were proposed to test the effect of knowledge level on perceived benefit and risk.

H1: There is a positive relationship between the knowledge level about GMO and the perceived benefit.

H2: There is a negative relationship between the knowledge level about GMO and the perceived risk.

Trust

One of the factors that affects product preferences of people is "Trust". According to the literature, it was stated that trust did not affect the intention of consumers towards GMO directly (Zhang et al., 2018; Hakim et al., 2020). In everyday life, people sometimes make their own decisions on recent products based on expert reviews. However, the majority of the public do not have sufficient information (Hu et al., 2009; Lonji et al., 2020). Therefore, they do not rely on their own ability to resolve uncertainty and to understand, inspect and control technological risks. Gaskell et al. (1999) demonstrated that trust in public administration could compensate consumer concerns about GMO based on lack of knowledge.

According to a survey conducted on the people of China by Lv, & Ma (2012), social media are important sources of information that could be trusted. Studies revealed have shown that the acceptance of GMO is indirectly influenced by trust in institutions through perceived benefits and risks (Chen, & Li 2007, Prati et al. 2012, Rodriguez-Entrena et al., 2013). The following hypotheses were proposed to measure the effect of trust factor on perceived benefits and risks regarding GMO.

H3: There is a positive relationship between the level of trust in GMO and the perceived benefit.

H4: There is a negative relationship between the level of trust in GMO and the perceived risk.

Perceived Benefit and Perceived Risk

One of the factors that affects product preferences of people is "Perceived Benefit". When the studies in the literature were examined, it was concluded that while perceived benefit affected the attitudes towards GMO and purchasing intention positively, it affected the perceived risks negatively (Bredahl.et.al., 1998; Zhang et.al., 2018). The perceived benefits associated with GMO are often associated with reducing energy and chemical inputs. This consists of perceptions such as lower food prices, healthy food, high yields and product variety. Perceived risks arise from the side effects of GMO on human health as well as the environmental and social problems that they pose (Amin et al., 2014; Knight, 2007, 2009).

Many studies on attitudes and purchasing intentions regarding GMO concluded that perceived benefit was more effective than perceived risk (Bredahl.et.al., 1998; Phillips, & Hallman, 2013; Zhang.et.al., 2018). However, some studies confirmed that consumers perceived risks more than they perceived benefits (Amin, et al., 2013; Gaskell et al., 2004; Hall, & Moran, 2006). In light of this information, the following hypotheses have been proposed:

H5: There is a positive relationship between perceived benefit and attitude regarding GMO.

H6: There is a negative relationship between perceived risk and attitude regarding GMO.

Attitude towards GMO

In his multi-featured model in 1963, Fishbein, who has a basic theory of knowledge about consumer attitude, suggests that "attitude" is a function of the beliefs that each individual maintains on the qualities of a product (Costa-Font, & Gil, 2009). The present study assumes that the attitude towards GMO has a positive effect on the purchasing intentions of consumers. This assumption supports the results obtained by Mountari et al. (2012), & Zhang et al. (2018) in their studies. In this study, the following hypothesis was established to test the relationship between the attitudes towards GMO and purchasing intention.

H7: There is a relationship between attitude towards GMO and purchasing intention.

2.2. Data Collection and Sample

The sample of the study consisted of 239 students randomly selected from the students enrolled in the Department of Statistics, Field Crops and Agricultural Biotechnology at Eskişehir Osmangazi University in Turkey. The data collected in the study were compiled using the convenience sampling method.

"The method based on acceptable error level" is used to determine the sample size.

$$n = \frac{z^2 pq}{d^2} \tag{1}$$

Symbols in Equation 8; Z indicates the value obtained from the Standard Normal Distribution in the sense of α, p: the rate of occurrence of the investigated event, q: the rate of absence of the investigated event (p + q = 1) and d: the level of error (margin of error), which is also called the acceptable margin of error. For the highest sample size, p = q = 0.50. For d = 6.3% and α = 5%, the sample size for z = 1.96 is calculated as 240. Face-to-face application was conducted with 239 students who voluntarily accepted.

In the study, the measurement tool called "Attitude and Behavior Intention Towards GMO" was developed based on studies by Chen , & Li (2007), Costa- Font , & Gill (2009), Prati et al. (2012), Rodriguez-Entrena et al. (2013), and Zhang et.al.(2018) in the literature. Before starting the present study, the measurement tool was administered to 50 randomly selected students enrolled in the Department of Statistics at Eskişehir Osmangazi University in March 2019. The measurement tool was finalized as a result of the pilot study. The measurement tool used in the research consists of three parts. In the first part of the questionnaire, there are 6 questions about demographic characteristics, in the second part 26 items of attitude statements, and in the third part 4 statements that measure behaviors. The measurement tool used in the study consisted of 6 factors: (ATT: Attitude towards GMO; KNOW: Knowledge; TRUST: Trust; BEN: Perceived benefit; RISK: Perceived Risk, BEH: Behavior-Purchasing Intention). ATT, KNOW, TRUST, BEN and RISK factors were measured with 5-point Likert type (1-Strongly disagree; 5- Strongly agree). The behavior intention factor consisted of 4 items and was prepared in 5-point Likert type. (1-Never; 5- Always). The internal consistency coefficient of the data collection tool was calculated as Cronbach Alpha (α) 0.89. This value indicated that internal consistency of the data collection tool was sufficient.

2.3. The Proposed research model

In this study, the attitudes and behaviors of university students towards GMO were investigated with a proposed structural model. The proposed research model was inspired by the BRA benefit-risk based models (Gaskel et al., 2006; Chen, & Li, 2007; Costa-Font et al., 2008; Prati et al., 2012; Rodriguez-Entrena et al., 2013; Zhang et al., 2018). Structural relationships in the proposed model were estimated using SEM analysis. The research model is presented in Figure 1.

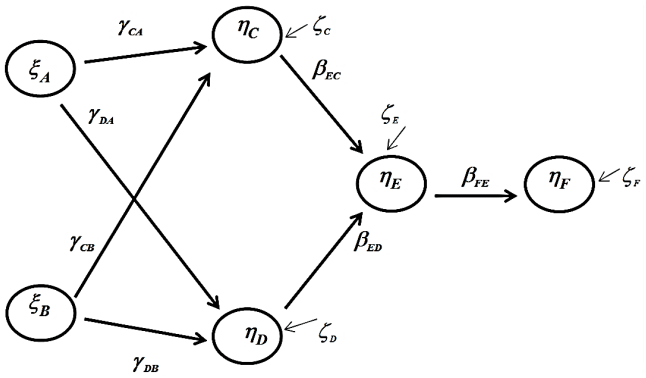

Figure 1: Proposed research model

About research model, ξ_A: Know, ξ_B: Trust, η_C : Perceived Benefits, η_D: Perceived Risks, η_E: Attitude, and η_F: Behavior, ζ_C, ζ_D, ζ_E and ζ_F: Error terms for Perceived Benefits, Perceived Risk, Attitude, Behavior. γ_{CA}: The direct effect on Perceived Benefits of Know, γ_{DA}: The direct effect on Perceived Risks of Know, γ_{CB}: The direct effect on Perceived Benefits of Trust, γ_{DB}: The direct effect on Perceived Benefits of Trust, β_{CB}: The direct effect on Perceived Risks of Trust, β_{EC}: The direct effect on Attitude of Perceived Benefits, β_{ED}: The direct effect on Attitude of Perceived Risks, β_{FE}: The direct effect on Behavior Intention of Attitude.

The matrix notation of the measurement part of the research model in Figure 1 is given in Equations 2–8. There were four endogenous variables (m= 4) and two exogenous variables (n= 2).

Structural equation:

$$\eta = B\eta + \Gamma\xi + \zeta \tag{2}$$

$$\begin{bmatrix} \eta_C \\ \eta_D \\ \eta_E \\ \eta_F \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ \beta_{EC} & \beta_{ED} & 0 & 0 \\ 0 & 0 & \beta_{FE} & 0 \end{bmatrix} \begin{bmatrix} \eta_C \\ \eta_D \\ \eta_E \\ \eta_F \end{bmatrix} + \begin{bmatrix} \gamma_{CA} & \gamma_{CB} \\ \gamma_{DA} & \gamma_{DB} \\ 0 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} \xi_A \\ \xi_B \end{bmatrix} + \begin{bmatrix} \zeta_C \\ \zeta_D \\ \zeta_E \\ \zeta_F \end{bmatrix} \tag{3}$$

$$\begin{aligned} \eta_C &= \gamma_{CA}\xi_A + \gamma_{CB}\xi_B + \zeta_C \\ \eta_D &= \gamma_{DA}\xi_A + \gamma_{DB}\xi_B + \zeta_D \\ \eta_E &= \beta_{EC}\eta_D + \beta_{ED}\eta_D + \zeta_E \\ \eta_F &= \beta_{FE}\eta_E + \zeta_F \end{aligned} \tag{4}$$

Where η (eta) is a (*4×1*) vector of *m* endogenous variables, ξ (xi) is an (*2×1*) column vector of two exogenous variables, β (beta) is a matrix *(4×4)* of the coefficients related to the direct effects of the endogenous variable on another endogenous variable, Γ (gamma) is a matrix (*4×2*) of coefficients and ζ is a column vector of error terms.

Measurement equations:

p=12, measured endogenous variables, and q=7, measured exogenous variables

$$\mathbf{y}=\boldsymbol{\Lambda}_y\,\boldsymbol{\eta}+\boldsymbol{\varepsilon} \tag{5}$$

$$\begin{bmatrix} s_{16}\\ s_{17}\\ s_{22}\\ s_{24}\\ s_{25}\\ s_{21}\\ s_{19}\\ s_{20}\\ s_{33}\\ s_{34}\\ s_{35}\\ s_{36} \end{bmatrix} = \begin{bmatrix} \lambda^{y}_{16,C} & 0 & 0 & 0\\ \lambda^{y}_{17,C} & 0 & 0 & 0\\ 0 & \lambda^{y}_{22,D} & 0 & 0\\ 0 & \lambda^{y}_{24,D} & 0 & 0\\ 0 & \lambda^{y}_{25,D} & 0 & 0\\ 0 & \lambda^{y}_{21,D} & 0 & 0\\ 0 & 0 & \lambda^{y}_{19,E} & 0\\ 0 & 0 & \lambda^{y}_{20,E} & 0\\ 0 & 0 & 0 & \lambda^{y}_{33,F}\\ 0 & 0 & 0 & \lambda^{y}_{34,F}\\ 0 & 0 & 0 & \lambda^{y}_{35,F}\\ 0 & 0 & 0 & \lambda^{y}_{36,F} \end{bmatrix} \begin{bmatrix} \eta_C\\ \eta_D\\ \eta_E\\ \eta_F \end{bmatrix} + \begin{bmatrix} \varepsilon_{16}\\ \varepsilon_{17}\\ \varepsilon_{22}\\ \varepsilon_{24}\\ \varepsilon_{25}\\ \varepsilon_{21}\\ \varepsilon_{19}\\ \varepsilon_{20}\\ \varepsilon_{33}\\ \varepsilon_{34}\\ \varepsilon_{35}\\ \varepsilon_{36} \end{bmatrix} \tag{6}$$

$$\mathbf{x}=\boldsymbol{\Lambda}_x\,\boldsymbol{\xi}+\boldsymbol{\delta} \tag{7}$$

$$\begin{bmatrix} A_7\\ A_8\\ A_9\\ B_{10}\\ B_{11}\\ B_{12}\\ B_{13} \end{bmatrix} = \begin{bmatrix} \lambda^{x}_{7,A} & 0\\ \lambda^{x}_{8,A} & 0\\ \lambda^{x}_{9,A} & 0\\ 0 & \lambda^{x}_{10,B}\\ 0 & \lambda^{x}_{11,B}\\ 0 & \lambda^{x}_{12,B}\\ 0 & \lambda^{x}_{13,B} \end{bmatrix} \begin{bmatrix} \xi_A\\ \xi_B \end{bmatrix} + \begin{bmatrix} \delta_7\\ \delta_8\\ \delta_9\\ \delta_{10}\\ \delta_{11}\\ \delta_{12}\\ \delta_{13} \end{bmatrix} \tag{8}$$

In which $y_{(12\times1)}$ and $x_{(7\times1)}$ are the column vectors of the 12 measured endogenous variables, and the 7 measured exogenous variables, respectively; in which x and δ (delta) are column q-vectors associated with the observed exogenous variables and errors, in order of; *Λx* (lambda) is a (7×1) structural coefficient matrix for the influences of the latent exogenous variables on the observed variables; y and ε (epsilon) are column vectors associated with the observed endogenous variables and errors, in order of; and *Λ*y is a (12×4) structural coefficient matrix for the influences of the latent endogenous variables on those observed.

3. Results

In the following sections, descriptive statistics regarding sampling and results of structural equation modeling are given in detail.

3.1. Descriptive Statistics

Among the students who participated in the study, 53.1% were female (f=127) and 46.9% were male (f=112). Considering the variables of the individuals in terms of the educational backgrounds of their parents, the secondary education category was noted 44.4% of the mothers and 47.7% of the fathers. Among the students who participated in the study, 73.3% were enrolled in the department of statistics, 14.6% in agricultural biotechnology and 12.1% in field crops. It was determined that 39.3% of the students who participated in the study were 3rd tear students, 26.3% were 4th year students, 17.2% were 2nd year students, 14.2% were first year students, and 3.0% were postgraduate students. Demographic statistics are given Table 1.

Table 1: Demographic Information

Gender	**N**	**%**
Female	127	53.1
Male	112	46.9
Mother's Educational Status	**N**	**%**
Primary School Graduate	83	34.7
Secondary School Graduate	106	44.4
Bachelor's Degree	50	20.9
Father's Educational Status	**N**	**%**
Primary School Graduate	52	21.8
Secondary School Graduate	114	47.7
Bachelor's Degree	73	30.5
Department	**N**	**%**
Agricultural and Biotechnology	35	14.6
Field Crops	29	12.1
Statistics	175	73.3
Grade	**N**	**%**
1	34	14.2
2	41	17.2
3	94	39.3
4	63	26.3
Graduate	7	3

3.2. The Results of Structural Equation Modeling

In this study, the data were analyzed using LISREL 8.80 software. First of all, data were tested for their suitability to the multivariate normal distribution in order to select the appropriate parameter estimation technique. As the χ^2=556.648 ($p < 0.01$) was calculated for multivariate normality, the data set did not have multivariate normal distribution. Therefore, robust maximum likelihood (Robust ML) method was used as the parameter estimation method.

In the study, confirmatory factor analysis (CFA) was conducted to investigate the structural validity of the factors constituting the dimensions of attitudes towards GMO. The representativeness of the CFA item and the correlation of the factors with each other can be determined. The data collection tool includes 6 demographic questions and 30 Likert items measuring 6 factors. As

a result of CFA, 11 items with a factor load below 0.50 and statistically insignificant were removed, and the final measurement tool consisted of 19 items. When the CFA results are examined, it can be said that the GMO model consisting of 6 dimensions is appropriate and valid. The factor loads of the items representing each dimension were between 0.60-0.88 for the Know, 0.64-0.74 for Trust; 0.86-0.89 for Ben, 0.52-0.83 for risk, 0.70-0.86 for Att, 0.76-0.80 for Beh. All factor loadings calculated on CFA were found to be greater than 0.50 and statistically significant. The criteria for the fit of the model were $\chi 2$=191.09, $\chi 2$/df= 141.08/137= 1.03< 3, Normed fit index (NFI) =0.97, Non normed Fit Index (NNFI) =1.00 Comparative fit index (CFI)=1.00, Root Mean Square Error of Approximation (RMSEA)=0.011. It was determined that the fit values of the GMO measurement model and the fit criteria used in SEM were within the good fit limit values.

Factors of the research model construct validity (CR) and explained variance values (AVE) of the factors, standard loads, R^2 values and hypothesis test results according to the results of the SEM are presented in Table 2. When the standard loads showing the relationship between the expressions of the factors in Table 2 and the elements are analyzed, it is seen that the loads are between 0.61-0.89. When the CR values in Table 2 are examined, it is seen that all of them are above 0.60. The AVE values for the factors must be above 0.50. (Fornell, & Larcker, 1981). When the AVE content in Table 2 is examined, it is understood that the others except one are above 0.50. As a result of these values, it is understood that the reliability and validity of the model are ensured. The common method bias (CMB) was analyzed using Harman's single factor test (Podsakoff et al., 2003). The previous research also used Harman's single factor test to detect CMB effects. Our results demonstrated that the first factor explained 28.64% of the variance. Our findings prove no threat of CMB in this study.

As a result of the *t* test, the hypotheses of H1, H3 H5, H6, and H7 were supported, while H2 and H4 were not supported. In terms of the suitability of the model, the following calculations were made: Root Mean Square Error of Approximation (RMSEA)=0.037, Goodness of Fit Index (GFI) =0.91, Normed Fit Index (NFI)=0.95, Comparative Fit Index (CFI)=0.97, Relative Fit Index (RFI)=0.95, Expected Cross-Validation Index (EVCI)=1.19 < EVCI for Saturated Model= 1.60, Consistent Akaike Information Criterion (CAIC)= 489.01 < CAIC for Saturated Model=1230.53, $\chi 2$=191.09, χ^2/df= 191.09/144= 1.32< 3. When the results regarding the proposed models were examined, it could be argued that the model was within acceptable limits. *(For details of the goodness-of-fit indices, see: Schermelleh-Engel,* et al., *2003; Ciavolina et al., 2014).*

Table 2: Standardized Loads, Hypotheses and R^2 Values

	Loading Factor	***R²***
Knowledge *(Mean=4.03; sd= 0.78; CR=0.76; AVE=0.52)*		
Q7: I am interested in technological devices that have recently been developed.	0.67	0.46
Q8: I feel better when I get new information about science and technology.	0.86	0.75
Q9: I enjoy watching programs related to science and technology on TV.	0.60	0.37
Trust *(Mean= 2.91; sd=0.93; CR=0.78; AVE=0.48)*		
Q10: I trust the studies and reports of scientists on GMO.	0.71	0.50
Q11: I trust the labeling systems for consumers to recognize GMO.	0.75	0.57
Q12: I trust that the government controls the use of genetic modification technology in products rigorously.	0.65	0.42
Q13: I trust the publications of the media (newspaper, magazine, TV, etc.) about GMO.	0.63	0.40
Perceived Benefit *(Mean=2.60; sd=2.20; CR=0.87; AVE=0.77)*		

Q16: I find it appropriate to use GMO to extend the shelf life of the products.	0.86	0.74
Q17: I find it appropriate to use GMO to produce products that are more resistant to agricultural diseases and pests.	0.89	0.79
Perceived Risk *(Mean=3.53; sd= 1.40; CR=0.62; AVE=0.46)*		
Q19: The use of gene technology in food production causes environmental problems.	0.61	0.37
Q20: GMO is risky for all living things in nature.	0.72	0.52
Attitude *(Mean=2.48; sd=1.15; CR=0.83; AVE=0.55)*		
Q21: The use of GMO in food production would increase social welfare today and in the future.	0.68	0.46
Q22: The use of GMO in food production has more advantages for the society than the risks.	0.84	0.71
Q24: I think GMO are of better quality.	0.74	0.55
Q25: I approve of agricultural production with GM seeds in Turkey.	0.70	0.49
Behavior Intention *(Mean=2.53; sd=0.92; CR=0.86; AVE=0.61)*		
Q33: If there were GMO in the department stores, my frequency of purchase would be	0.80	0.64
Q34: If GMO were sold by the farmers, my frequency of purchase would be	0.76	0.57
Q35: If promotional items were offered along with GMO, my frequency of purchase would be	0.77	0.60
Q36: If GMO were sold, my frequency of preference compared to normal foods would be	0.79	0.62

Hypotheses	**Parameter estimation**	**Result**
H1: KNOWLEDGE ⟶ BENEFIT	0.12^{*}	Supported
H2: KNOWLEDGE ⟶ RISK	-0.07^{NS}	Not supported
H3: TRUST ⟶ BENEFIT	0.32^{***}	Supported
H4: TRUST ⟶ RISK	-0.04^{NS}	Not supported
H5: BENEFIT ⟶ ATTITUDE	0.89^{***}	Supported
H6: RISK ⟶ ATTITUDE	-0.19^{***}	Supported
H7: ATTITUDE ⟶ BEHAVIOR INTENTION	0.67^{***}	Supported

*p<0.10; ***p<0.01; NS: Not significant

The path diagram of the SEM is presented in Figure 2.

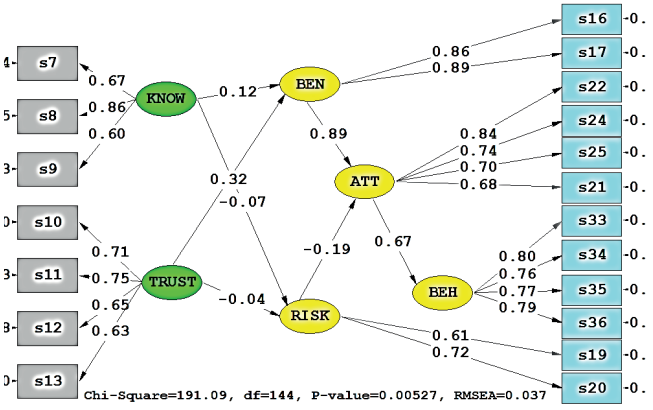

Figure 2: Path Diagram for the Proposed Research Model

About research model, ξA: Know, ξB: Trust, ηC: Perceived Benefits, ηD: Perceived Risks, ηE: Attitude, and ηF: Behavior Intention

Equations related to the structural model found as a result of SEM analysis are presented in Table 3.

Table 3: Structural Equations

$\eta_C = 0.12\xi_A + 0.32\xi_B + \zeta_C$	$:R^2 = 0.14$
$\eta_D = -0.07\xi_A - 0.04\xi_B + \zeta_D$	$:R^2 = 0.01$
$\eta_E = 0.89\eta_C - 0.19\eta_D + \zeta_E$	$:R^2 = 0.84$
$\eta_F = 0.67\eta_E + \zeta_F$	$:R^2 = 0.44$

ξA: Know, ξB: Trust, ηC: Perceived Benefits, ηD: Perceived Risks, ηE: Attitude, and ηF: Behavior Intention

Knowledge level and trust in GMO predicted 14% of Perceived Benefit (BEN); knowledge level and trust predicted 1% of Perceived Risk (RISK); perceived risk and benefit predicted 84% of the attitude towards GMO; attitude predicted 44% of purchasing intention (Behavior).

According to the results in Tables 1-2, and Figure 2;

Knowledge→Benefit: It was determined that the increase by one unit in knowledge level about GMO would lead to an increase by 0.12 units in perceived benefit. Knowledge→Risk: There was no significant relationship between knowledge level about GMO and perceived risk. Trust→Benefit: One unit of increase in the trust in GMO would lead to an increase by 0.32 unit in perceived benefit. Trust→Risk: There was no relationship between trust in GMO and perceived risk. While perceived benefit affects attitude positively (Benefit→Attitude: 0.89), risk affects it negatively (Risk→Attitude: -0.19). Perceived benefit increases and risk perception decreases the positive attitudes towards GMO. Attitude→Behavior: It was concluded that the increase by one unit in attitudes towards GMO would lead to an increase by 0.67 unit in purchasing intention.

4. Conclusion

In this study, some of the factors predicted to affect the perspectives of university students about GMO were investigated using SEM analysis. In the study, factors affecting the attitudes and behaviors of students towards GMO were reviewed as Knowledge, Trust, Perceived benefit, Perceived risk, Attitude and Behavior (Purchasing intention). As a result of this study, while Knowledge and Trust factors were not found to be significant in terms of GMO according to the departments enrolled by the participating students, Perceived benefit, Perceived risk, Attitude and Behavior (Purchasing Intention) factors were found to be significant.

Looking at the structural relationships, the effect of Trust in GMO on Perceived risk was found to be statistically insignificant. According to these results, it could be argued that Trust was more effective on perceived benefits of students about GMO. Finally, it was concluded that the purchasing intentions of students about GMO were affected by the attitudes towards GMO positively by 0.67 units. According to these results, it could be argued that the effect of perceived benefit on the attitude towards GMO was high.

In the study, total indirect effects of Knowledge→Attitude (0.29; $p<0.01$) and Trust→Behavior Intention (0.20; $p<0.01$) were calculated to be significant. The indirect effects of knowledge on attitudes and behaviors were not found to be significant. In addition, the indirect effects of Trust→Behavior→Attitude (0.32; $p<0.01$), Risk→Attitude→Behavior Intention (-0.13; $p<0.01$) and Benefit→Attitude→Behavior Intention (0.60; $p<0.01$) were also found to be statistically sig-

nificant. It was also demonstrated that Attitude played a full mediating role in the relationship between Trust and Behavior.

In the study, Kruskall Wallis analysis was applied to determine whether there was a statistically significant difference in the level of knowledge, trust, perceived benefit, risk, and attitude and purchase intentions of the students according to the department they are studying. Kruskall Wallis analysis is used when data are not normally distributed and is the non-parametric equivalent of parametric one-way analysis of variance (F test). This test examines whether k independent samples come from the same population. The changes in the factor means of students were analyzed according to the department in which they were enrolled. It was determined that there was no significant difference between the means for knowledge level and trust factors according to the departments ($\chi2$=2.007, $\chi2$=4.566; p>0.05). It was observed that there was a significant difference between the factor means of perceived benefit, perceived risk, attitude and purchasing intention according to the departments enrolled ($\chi2$=61,207; $\chi2$=61,207; 31.453; $\chi2$=61.207; $\chi2$=46.192; $\chi2$=26.121; p<0.05). This difference stemmed from the difference between the students of the department of statistics and the other two departments in terms of purchasing intentions. While the means of students enrolled in the department of statistics in the Attitude factor were ($\underline{x}$=2.17; sd=0.96), the means of students enrolled in departments of biotechnology and field crops were ($\underline{x}$=3.48; sd=0.89; $\underline{x}$=2.28; sd=1.10), respectively. Based on this result, it could be argued that the means of students enrolled in the department of statistics were lower than students of the other two departments in terms of attitudes towards GMO. Similarly, while the means of students enrolled at the department of statistics were ($\underline{x}$=2.21; sd=0.88) for the purchasing intention, the attitude means of students enrolled in the departments of biotechnology and field crops were ($\underline{x}$=3.14; sd=0.84; $\underline{x}$=2.41; sd=0.88), respectively. Therefore, it could be argued that students of the statistics department were less likely to purchase GMO than the students of the other two departments.

There were significant differences between the mean of students in the department of statistics and the mean of the students in the department of biotechnology in terms of perceived benefit and perceived risk. While the mean of the students enrolled in the department of statistics was ($\underline{x}$=2.72; sd=0.84) in terms of perceived benefit, the mean of students enrolled in the department of biotechnology department was ($\underline{x}$=3.48; sd=0.89). This result demonstrated that perceived benefit levels of students of the department of biotechnology regarding GMO were higher than the students of the department of statistics. Considering the difference between the perceived risk mean scores, the perceived benefit means of the students of the department of statistics were ($\underline{x}$=3.71; sd=0.85), while the perceived benefit means of the students of the department of biotechnology were ($\underline{x}$=2.81; sd=0.91). The result demonstrated that students enrolled in the department of biotechnology had lower levels of risk perceptions regarding GMO.

In the literature, there are many studies that examined consumer attitudes towards GMO. In this study, BRA supported some conclusions from previous studies that supported the development of a strong framework to analyze consumer attitudes and purchasing intentions for GMO (Bredahl et al., 1998; Chen, & Li, 2007; Rodriguez-Entrena et al., 2013). Similar to the result of our study, in their study on the attitudes of consumers in Taiwan towards GMO Chen, & Li (2007) concluded that the most important factor affecting the attitude was perceived benefit. Zhang et al. (2018) stated that attitude, perceived behavioral control and subjective norm had an impact on purchasing intention. Our results showed that perceived benefits had a more significant impact on purchasing intentions for GMO when compared to perceived risks. Similarly, Zhang et al. (2018) and Li et al.

(2014) also found that perceived benefit was found to be more effective on purchasing GMO when compared to perceived risks. In light of this perspective, sufficient attention should be paid to scientific dissemination of knowledge about GM while encouraging the GM technology.

5. Discussion

In the literature, it was confirmed that trust, particularly the trust in the government, was of great importance for the development of GM technology. The findings confirmed that trust in scientists, the government, the labeling system, and media could increase perceived benefits. Trust affects the attitudes towards GMO and the purchasing intentions indirectly. The majority of students cannot understand GM technology; they also lack effective means to understand knowledge about GM. Various studies carried out in Turkey demonstrated that people in Turkey had very little knowledge about GM technology (Adana et al., 2014; Yilmaz, 2014; Özdemir, & Duran, 2010).

Contrary to some previous findings suggesting that the increase in the knowledge levels of consumers about GMO would strengthen their previous negative and skeptic attitudes towards them (Zhang et al., 2018) our study demonstrated that the knowledge levels of consumers were effective significantly in increasing perceived benefits; however, they did not have significant effects on reducing the perceived risks. This means that consumers in Eskisehir see more benefits from gene technology applied to food production as they gain knowledge about it .

The results of the study also confirm that perceived benefits are significant structures that underpin the attitudes towards GMO. In addition, if consumers are offered benefits, their attitudes could change; therefore, their purchasing intentions could change. This finding coincides with the research findings of Frewer et al. (1996), Costa-Font, & Gil (2009), & Zhang et al. (2018).

There are few studies that examine the empirical evidence and theoretical explanations of the purchasing intentions of university students about GMO systematically (Costa-Font et al., 2008; Prati et al., 2012; Zhang et al., 2018). This article attempted to provide a comprehensive understanding of the premises of buying behavior regarding GMO foods within the framework of the BRA. The path model demonstrated in this study can be used by other researchers to examine attitudes and purchase intentions towards GMO Foods systematically.

The study results show that “Known”, which is used to measure the level of interest in new technological developments, and “Trust”, which is used to measure trust in the research and labeling system of GMO, play an important role in shaping people’s attitudes and behaviors towards GMO. However, it is considered that food businesses should focus on the determinants of people’s purchasing behavior, such as perceived risk and perceived benefit. If businesses want to encourage consumers to buy products that are non-GMO, they should take into account that they can do this not only through price promotion, but also by developing new policies to change consumers’ perceptions of risk or benefit. In addition, it may be suggested that consumers develop methods that enable them to access the right information easily in order to help them evaluate the effects of GM products.

NUMBEO, an international research company that focuses on the quality of life in the world’s cities in all aspects, has recently shared the news that Eskişehir is the 10th most reliable city in the world. In Eskişehir, which ranks 2nd in the research by CNBC-E Business and Forbes magazines on “The most livable cities of Turkey”, the proportion of the use of agricultural fields to the population is quite high. It was an important gap that the purchasing behaviors for GMO had never been investigated in a city with high agricultural production. The study addresses this gap with its results, and it presents important information for GM producers, food industry, and decision

makers. In addition, a suitable data collection tool was designed to measure the attitudes and behaviors of students about GMO. The measurement tool presented in the study provides important contributions to the literature in terms of its applicability in researching the attitudes of people living in different cities towards GMO. However, this study still contains limitations in some respects.

In this study, the effects of Knowledge, Trust, Perceived Benefit, Perceived Risk, Attitude and Behavior Intention factors about GMO in students who were enrolled in three departments at Eskişehir Osmangazi University were examined with the proposed model. In order to make more realistic and accurate decisions, it is recommended to administer the study to a wider audience. In addition, other estimating factors that are not included in the model proposed in this study should be added, and the topic should be discussed from different perspectives within more comprehensive models. For instance, certain sources of information such as demographic features and different risk variables were not included in the research model used to study the perception of benefit and risk. Therefore, such issues could be investigated in future studies. It is considered that the research model used in the study qualifies to be suggestive and initial, and that more comprehensive models could be developed by the researchers.

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