Public Understand. Sci. **1?** (2010) 1–16

Factors influencing Malaysian public attitudes to agro-biotechnology

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Despite considerable research in advanced countries on public perceptions of and attitudes to modern biotechnology, limited effort has been geared towards developing a structural model of public attitudes to modern biotechnology. The purpose of this paper is to identify the relevant factors influencing public attitudes towards genetically modified (GM) soybean, and to analyze the relationship between all the attitudinal factors. A survey was carried out on 1,017 respondents from various stakeholder groups in the Klang Valley region. Results of the survey have confirmed that attitudes towards complex issues such as biotechnology should be seen as a multifaceted process. The most important factors predicting support for GM soybean are the specific application-linked perceptions about the benefits, acceptance of risk and moral concern while risk and familiarity are significant predictors of benefit and risk acceptance. Attitudes towards GM soybean are also predicted by several general classes of attitude.

Keywords: agro-biotechnology, factors influencing attitude, Malaysian, moral concerns, perceived benefit, structural equation modeling

1. Introduction

Modern biotechnology has been viewed by many as the frontier of the 21st century revolution. It is a powerful tool that presents a range of potential environmental, social and economic benefits that demands rigorous oversight (Kamaldeen and Powell, 2000). However, because the advancement in biotechnology has been so rapid in the past ten years, it has been the object of an intense and divisive debate in developed countries. Sagar et al. (2000) suggest that a major factor in the emergence of controversies surrounding biotechnology has been the neglect of the needs, interests and concerns of the primary stakeholders – the public. Public perceptions, understanding and acceptance of genetically modified organisms (GMOs) can both promote and hamper commercial introduction and adoption of new technologies (Kamaldeen and Powell, 2000).

Modern biotechnology has been classified as a complex emerging issue that exhibits high salience combined with limited knowledge on the part of the public. Various studies have

 ISSN 0963-6625 DOI: 10.1177/0963662510369622

shown that consumer acceptance of modern biotechnology tends to be conditional and dependent on many factors. It has also been suggested by social scientists that any complex object may be located in a variety of general classes where its evaluation may also be strongly affected by extraneous concerns (Pardo et al., 2002).

Although there have been many studies on public attitudes to modern biotechnology and some researchers have tried to identify factors predicting attitudes using either regression or correlation analyses, there have been limited studies which try to construct a structural or path model predicting attitudes towards modern biotechnology. The first documented model was developed by Kelley (1995) who constructed a model for the approval of genetic engineering by Australians based on regression analyses. Kelley found that approval of genetic engineering was mainly predicted by agricultural and health goals (beneficial aspects) as well as a scientific worldview. Scientific and genetic engineering knowledge did not predict approval. Demographic variables also did not directly affect approval of genetic engineering (their effects were not statistically significant) but some variables did affect the intermediate variables.

Bredahl et al. (1998) proposed an attitude model towards the application of genetic engineering to food production which Bredahl modified later following empirical research (Bredahl, 2001). Initially, he suggested a distinction between attitudes towards product and process but later showed empirically that European consumers do not distinguish between risks and benefits pertaining to the technology itself and risks and benefits related to resulting products, but rather their perceptions of risks and benefits derive from the same underlying dimensions (Bredahl, 2001). His attitude model, based on pooled Danish, German and British data, showed that attitudes to genetic modification in food production were based on perceived risks and benefits. Perceived welfare benefits had the highest direct impact on overall attitude while perceived risks were a crucial determinant of how the benefits were perceived. The more risks consumers associated with the use of genetic modification in food production, the fewer benefits they perceived. Bredahl's model also showed that perceived risks and benefits related to genetic modification in food production were influenced by a number of more general attitudes, notably attitudes to nature and technology, alienation from the marketplace, food neo-phobia and to a lesser extent, perceived own knowledge about the use of genetic modification in food production. More risks were perceived when the consumers believed that humans have no right to rule over nature, had less trust in those in charge of the food markets, were less keen on trying out new food products and had less knowledge about the use of genetic modification in food production.

However, Bredahl (2001) found that his other model, constructed using the Italian data was slightly different. Although the overall attitude was well explained by perceived benefits and risks, perceived benefits were not influenced by perceived risks and only some of the risk items (control-related risks) apparently influenced overall attitude to genetic modification in food production. Moreover, among the five general attitude determinants studied, alienation from the marketplace was not related to perceived benefits or risks. Attitude to technology was found to correlate only with some of the perceived benefit items (perceived family and health benefits) and did not have any relationship with perceived risk. On the other hand, attitude to nature seemed to influence perceived family and health benefits rather than perceived risks while food neo-phobia was also related to perceived family and health benefits besides perceived control-related risks.

Pardo et al. (2002) developed a path model using the 1996 Eurobarometer data on public attitudes to modern biotechnology applications. The strongest predictor of perceived benefits of biotechnology applications (GM benefit) was a schema about the promise of biotechnology (BT promise), followed by technology optimism and informed public. General BT promise showed a negative association with the risk of biotechnology applications (GM risk), while

general biotechnology reservation (BT reserve) was positively correlated with GM risk. Well informed members of the public were negatively correlated with both BT promise and BT reserve but the path to BT reserve was more negative, indicating that members of the informed public tended to be less concerned than less informed citizens. Technology optimism was found to have a strong correlation with BT promise. The level of formal education was positively correlated with perception of GM benefit. Other demographic variables had a very modest role in accounting for variability in the perceptions of GM benefits. European women held slightly less positive perceptions of GM benefits than men, and younger Europeans were slightly more likely to hold positive assessments of GM benefits than older subjects.

Although earlier studies in developed countries identified the majority of the factors related to public acceptance of modern biotechnology, the findings were not based on the same respondents or research. Therefore there is a need to carry out a more comprehensive study to assess all the relevant factors in a single study or using the same respondents in order to be able to determine their importance in predicting the acceptance of modern biotechnology. Although there have been some initiatives by a few researchers such as Kelley (1995), Bredahl (2001) and Pardo et al. (2002) to construct models for public attitudes towards modern biotechnology, many important factors were not included in their models. There is a need to construct structural models which include all important factors including both attitudinal and general classes of attitudinal factors in order to fully understand the multifaceted process related to modern biotechnology acceptance. It is the purpose of this paper to identify the relevant factors or variables that influence public attitudes to genetically modified (GM) soybean (soybean containing bacterial genes to make it resistant to herbicide) as an example of an agro-biotechnology product that is already available in the Malaysian market and to construct a structural equation model to analyze the relationship between all the factors.

2. Methodology

Survey data collection

A survey was carried out between June 2004 and February 2005**.** This is one of the first in-depth studies on attitudes to modern biotechnology in Malaysia. The people in the Klang Valley region were chosen as the targeted population as it is the center of the country's economic and social development (with numerous universities, research and development institutions and biotechnology-related industries). Also, the respondents in this region meet the requirement of diverse backgrounds stated in the model. In Malaysia, information on modern biotechnology was available to the public through the Internet as well as through periodic coverage of modern biotechnology issues in the Malaysian general media. The Malaysian Biotechnology Information Centre (MABIC) has also made an effort to provide online information on modern biotechnology issues and development in Malaysia and to provide links to several international websites on modern biotechnology education as well as organizing public seminars in Malaysia.

Most of the biotechnology activities in Malaysia are still under research except for delayed ripening papaya which has been approved by the Genetic Modification Advisory Committee (GMAC) for contained field trials. Although modern biotechnology products developed by Malaysian researchers are not being commercialized yet, biotechnology products from other countries are slowly coming into the country. The only agricultural product/food officially available in the Malaysian market at the time of the survey was Glyphosate resistant soybean for human consumption but labeling of GM products was not yet mandatory in Malaysia.

In this study, a wide range of interest groups including producers, scientists, policy makers, non-governmental organizations, media, politicians, religious scholars, university students and the general public were surveyed. Since the respective populations for the stakeholders involved were mostly unknown, the respondents were chosen using the stratified purposive sampling technique as recommended by McGrew and Monroe (1993). This technique would enable the inclusion of respondents from different stakeholders groups that might otherwise be under-represented if random sampling were used.

For structural equation modeling (SEM), Hair et al. (1992) considered a ratio of 10 respondents per measured parameter as the most appropriate but should be increased when model complexity increases. Since there are 72 measured variables in this study, the minimum sample size required would be 720 but because of the structural equation model's complexity and the possibility of incomplete questionnaires, the allocated sample size was increased. The respondents (n = 1017) were adult representatives (age 18 years and above) from the various interest or stakeholder groups mentioned above. Each group had a minimum target sample of 22 respondents except for the general public. Since the majority of the Klang Valley residents comprised the general public, this group was allocated 550 respondents as for any population size beyond 5,000 a sample size of at least 400 would be adequate and representative of the population in the Klang Valley area (Krejcie and Morgan, 1970). The total population of residents in the Klang Valley area in the year 2000 was about 4 million people. The general public were further stratified according to their occupations as classified by the Malaysian Standard Classification of Occupations (MASCO) in 1998. The ratios for different gender, race and religion of the residents in the Klang Valley were also taken into account.

In a developing country like Malaysia, where biotechnology is still new, it is expected that the majority of the public might not know much about biotechnology. The conventional multiple indicator survey research approach as proposed by Kelley (1995) was adopted in this study, which results in comprehensive item coverage. So the questionnaires were developed to be of the fixed response type to make it easier for the respondents to answer. The questionnaires were handed out personally to respondents by trained biotechnology graduate enumerators. Before answering, the respondents were given an introduction to basic concepts, examples and several possible benefits and risks related to several applications of modern biotechnology and they were also given the chance to enquire further. This approach was suggested by Kelley (1995) to assess unsophisticated public attitudes on complex issues like modern biotechnology. This style works perfectly well for sophisticated respondents as well as unsophisticated respondents and allows the researchers to use sophisticated statistical multivariate procedures to discover whether the attitude responses are empirically sensible. By using a multiplicity of questions, measurement errors are reduced.

Instrument

The multidimensional instrument measuring specific attitudes to modern biotechnology applications used in this study was constructed based on the work of earlier research (Gaskell et al., 2000; Kirk et al., 2002; Macer, 2000; Rohrmann, 1994) and validated in an earlier study (Amin et al., 2004). The instrument measuring specific attitudes towards GM soybean incorporated six dimensions or factors: perceived benefits, perceived risks, encouragement, familiarity, moral concerns and risk acceptance. Each dimension or factor comprised several items or measured variables. The perceived benefit scale (α = 0.87) comprised five items. Each item was measured on a 7-point scale, ranging from 1 (not useful at all for item 1, strongly disagree for the other items) to 7 (very useful for item 1, strongly agree for the other items).

The measure for perceived risk ($\alpha = 0.88$) was obtained by using five items and each item was measured on a 7-point scale, ranging from 1 (not worried at all for the first four items, no harm at all for the last item) to 7 (very worried for the first four items, very harmful for the last item). Encouragement ($\alpha = 0.88$) was measured by four items with each item measured on a 7-point scale, ranging from 1 (strongly disagree) to 7 (strongly agree). Familiarity ($\alpha = 0.72$) comprised four items: easy to know, easy judgment, effect known and controllability. Each item was measured on a 7-point scale, ranging from 1 (not easy at all for the first two items, strongly disagree for the remaining two items) to 7 (very easy for the first two items, strongly agree for the other items). Moral concern ($\alpha = 0.81$) was assessed by asking the respondent three questions. Each item was measured on a 7-point scale, ranging from 1 (strongly disagree) to 7 (strongly agree). The measure for risk acceptance ($\alpha = 0.80$) comprised three items. Each item was measured on a 7-point scale, ranging from 1 (not willing at all for the first item, not acceptable for the second and strongly disagree for the last item) to 7 (very willing for the first item, very acceptable for the second item and strongly agree for the last item).

General classes of attitude surveyed in this study included general promises of and general concerns about modern biotechnology, societal value, impact of technology, engagement with modern biotechnology, religious attachment and confidence in key actors. Each general attitude factor again comprised several items or measured variables. The measurement scales for two general attitude factors – general promise of and concerns about modern biotechnology – were developed based on the concepts suggested by Pardo et al. (2002) while the other general attitude factors were validated in existing, established scales with some modification. General promise of modern biotechnology ($\alpha = 0.87$) was measured by five items while general concern about modern biotechnology comprised six items, based on the concepts suggested by Pardo et al. (2002). Each item was measured on a 7-point scale, ranging from 1 (strongly disagree) to 7 (strongly agree). Societal value ($\alpha = 0.78$) was assessed by asking the respondents to state their preferences on five bipolar statements, four concerning nature and material values (Rohrmann, 1994) and another statement with the views that nature can withstand human action versus nature is fragile (Gaskell et al., 2000). Each item was measured on a 7-point scale, ranging from 1 (strongly preferred nature value) to 7 (strongly preferred material value). Impact of technology ($\alpha = 82$) was measured by four statements describing the impact of science and technology on humanity and nature (Rohrmann, 1994) and whether modern technology has upset the balance of nature (Gaskell et al., 2000). Each item was measured on a 7-point scale, ranging from 1 (strongly disagree) to 7 (strongly agree).

In this study, the "engagement" of the public with biotechnology ($\alpha = 0.69$) is defined as recommended by Gaskell et al. (2000), using a combination of knowledge, awareness of modern biotechnology and reported and intended behaviors related to modern biotechnology. Respondents were asked whether nine statements regarding concepts and facts about biotechnology were true or false (Gaskell et al., 2000) with the omission of item one, "it is impossible to transfer animal genes into plants." Item one was replaced with "there are useful bacteria which live in our body," while item six was slightly modified where the term "beer" from the original question "yeast for brewing beer consists of living organisms" was changed to "bread" to suit the local culture where most of the respondents are Muslim and therefore do not drink beer. As for awareness, the concept used by Gaskell et al. (2000) was followed where the respondents were asked whether they had heard of seven applications of modern biotechnology and two related developments in Malaysia. Three items which refer to reported and intended habits and behaviors related to information seeking were from Gaskell et al. (2000) but each item was measured on a 7-point scale, ranging from 1 (strongly disagree) to 7

(strongly agree). Religiosity ($\alpha = 0.93$) comprised four items involving the importance of religion (Brazelton et al., 1999) and religious rites (Ansari and Ansari, 2003) in the respondents' life. Confidence in key actors ($\alpha = 0.82$) was assessed by asking the respondents three items on the extent to which scientists, biotechnology-related industries and government departments involved in food and biotechnology regulation are perceived to have done a good job for society (Gaskell et al., 2000). Each item was measured on a 7-point scale, ranging from 1 (strongly disagree) to 7 (strongly agree).

Statistical analysis

Structural equation modeling (SEM) was carried out using AMOS version 5.0 with maximum likelihood estimation. As recommended by Anderson and Gerbing (1988), a two-stage approach was adopted. First, a confirmatory factor analysis (CFA) was performed to assess the measurement model followed by the testing of the overall relationships among the constructs.

3. Results and discussion

Correlational analyses

From Table 1, it can be seen that general promise and concern of modern biotechnology and the six dimensions of attitude were interrelated. General promise was positively related to familiarity, perceived benefit, risk acceptance and encouragement of GM soybean but negatively related to moral concern and perceived risk. The respondents who were more familiar with GM soybean tended to perceive more general promise of modern biotechnology, more benefit, higher risk acceptance level and more encouragement of GM soybean besides perceiving lower moral concerns. On the other hand, those who rated modern biotechnology as having high general concerns also perceived GM soybean to be of high moral concern, high risk and low in benefit, risk acceptance and encouragement level. Perceived risk has an inverse relationship with risk acceptance and encouragement. While perceived benefit and risk acceptance were found to be positively correlated with each other and with encouragement but negatively correlated with perceived risk.

From Table 2, it can be seen that some of the general attitudinal variables were correlated to general promise of and concerns about modern biotechnology and several dimensions of attitude towards GM soybean. The respondents with high confidence in key actors (scientists, industry and government) and who were more engaged tended to be more familiar with GM soybean and saw higher general promise of modern biotechnology, higher benefit, risk acceptance and encouragement of GM soybean. They also perceived lower moral concerns related to GM soybean while those more engaged with modern biotechnology also perceived lower risk. Although the respondents with a negative view of the impact of technology seemed to be more familiar with GM soybean, they tended to have higher general concerns about modern biotechnology, higher moral concerns and higher perceived risk related to GM soybean which was followed by lower encouragement. On the other hand, materialist values were positively correlated with risk acceptance and encouragement of GM soybean. It is interesting to note that the respondents who were more attached to their religion seemed to be more critical where they perceived both high general promise of modern biotechnology as well as high risk of GM soybean.

Table 1. Intercorrelations between general promise and concerns and six dimensions of attitude towards GM soybean

Attitude dimension	1. General promise	2. General concern	3. Familiarity	4. Moral concern	5. Perceived benefit	6. Perceived risk	7. Risk acceptance	8. Encouragement
1. General promise	–							
2. General concern	−0.005 (ns)	–						
3. Familiarity	+0.083**	+0.006 (ns)	–					
4. Moral concern	−0.210***	+0.209***	−0.068*	–				
5. Perceived benefit	+0.360***	−0.068*	+0.147***	+0.228***	–			
6. Perceived risk	−0.099**	+0.277***	+0.034 (ns)	+0.309***	+0.409***	–		
7. Risk acceptance	+0.286***	−0.147***	+0.176***	+0.261***	+0.538***	+0.421***	–	
8. Encouragement	+0.320***	−0.106**	+0.181***	+0.285***	+0.571***	+0.341***	+0.490***	–

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ns, not significant at $p < 0.05$.

Table 2. Correlation coefficients between general attitudinal variables and general promise and concerns and six dimensions of attitude towards GM soybean

General attitude variable	General promise	General concern	Familiarity	Moral concern	Perceived benefit	Perceived risk	Risk acceptance	Encouragement
Confidence in scientists, industry and government	+0.178***	−0.036 (ns)	+0.226***	−0.093**	+0.223***	+0.051 (ns)	+0.192***	+0.271***
Engagement	+0.187***	−0.016 (ns)	+0.152***	−0.083**	+0.148***	−0.126***	+0.094**	+0.091**
Impact of technology	+0.051 (ns)	+0.221***	+0.098**	+0.109***	−0.052 (ns)	+0.171***	−0.059 (ns)	−0.105**
Societal value	+0.008 (ns)	+0.016 (ns)	+0.036 (ns)	−0.034 (ns)	+0.050 (ns)	+0.016 (ns)	+0.065*	+0.078*
Religious attachment	+0.182***	+0.033 (ns)	+0.036 (ns)	−0.036 (ns)	+0.031 (ns)	+0.108**	−0.025 (ns)	+0.053 (ns)

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ns, not significant at $p < 0.05$.

Structural equation modeling

A proposed model was developed based on past research findings and the results of bivariate correlations. The model begins with potential causes that are known to affect attitudes. The variables are arranged according to their assumed influence as proposed by Pardo et al. (2002). The basic idea is that prior variables can influence subsequent variables. The model is divided into two main components: general attitudinal variables and attitude to GM soybean variables. Based on the proposed model, 47 hypotheses were formulated for the relationship between general attitudinal variables and attitude to GM soybean variables. The hypotheses were accepted when the standardized estimates (beta coefficients) were statistically significant at the 0.05 probability level or lower.

Thirty-two of the 47 hypothesized paths retained in the final model were statistically significant in the direction predicted at the 0.05 probability level or lower. A hypothesis which initially predicted a positive relationship between general concern about modern biotechnology and perceived benefit was modified as the SEM result showed the opposite relationship. Two new paths (societal value → familiarity and societal value → perceived benefit) suggested by the modification indexes and which were significant at the 0.05 probability level were added. Fifteen of the 47 hypotheses were eliminated because the hypothesized paths were not statistically significant at the 0.05 probability level.

Confirmatory factor analysis and Cronbach's alpha

Before testing the proposed model with SEM, it is recommended that the unidimensionality of each construct is assessed to ensure that each set of indicators has only one underlying trait or construct in common. In this study, unidimensionality of the overall measuring instrument was assessed using confirmatory factor analysis and Cronbach's alpha. Only items or indicators with factor loadings minimally 0.30 (Hair et al., 1992) or item–total correlation at least 0.30 (Aiken, 1994; Nordin, 1995) were considered acceptable.

Table 3 shows the results of confirmatory factor analysis (CFA) for the measurement scale of attitude towards GM soybean using maximum likelihood estimation. The analysis yielded 13 meaningful item groupings or constructs with strong unambiguous loadings. All of the factor loading values were greater than 0.30 which can be considered as significant as suggested by Hair et al. (1992). From Table 3 also, it can be seen that the corrected item–total correlations for almost all items in each dimension were generally very good (correlation coefficients greater than 0.4) except for item controllability which can still be considered acceptable, with a correlation value of 0.31. The Cronbach's alpha coefficients for the majority of the constructs were considered good (above 0.70) while the alpha value for engagement was still acceptable (0.69).

Interrelationship among the constructs

After confirming the unidimensionality of the measurement scale, SEM was carried out for the proposed model. A single-step SEM analysis as proposed by Hair et al. (1992) was carried out to estimate simultaneously the structural and measurement models using AMOS version 5.0 software with maximum likelihood function. A well fitting model should have CMIN/DF value of 3 or less (Kline, 1998), CFI greater than 0.90 and RMSEA value of 0.06 or lower supported with a narrow confidence interval (Hu and Bentler, 1999).

Figure 1 shows the final structural model of attitude towards GM soybean. The strongest direct predictor for encouragement of GM soybean surveyed is perceived benefit followed by

Table 3. Factor loadings and Cronbach's alpha values for measurement scale of attitude towards GM soybean

Constructs and observed variables	Factor loading	Corrected item–total correlation	Alpha if item deleted	α
Perceived benefit				0.87
Benefit to Malaysian society	0.75	0.72	0.84	
Enhance product quality	0.76	0.75	0.83	
Enhance quality of life	0.79	0.78	0.82	
Enhance Malaysian economy	0.61	0.67	0.85	
Benefits exceed risks	0.47	0.57	0.87	
Perceived risk				0.88
Feelings of anxiety	0.78	0.77	0.84	
Harm to health	0.85	0.82	0.83	
Long-term effect	0.74	0.71	0.86	
Catastrophic potential	0.69	0.69	0.86	
Overall risk magnitude	0.53	0.59	0.88	
Encouragement				0.88
More rigorous R&D	0.65	0.67	0.88	
Should be commercialized	0.69	0.77	0.84	
Should be given monetary support by government	0.78	0.81	0.83	
Overall encouragement	0.68	0.75	0.85	
Familiarity				0.72
Easy to know	0.71	0.59	0.61	
Easy judgment	0.79	0.62	0.59	
Effect known	0.65	0.54	0.64	
Controllability	0.35	0.31	0.77	
Moral concerns				0.81
Threaten natural order of things	0.61	0.57	0.83	
"Play god"	0.81	0.72	0.68	
Commodify life	0.74	0.71	0.70	
Risk acceptance				0.80
Accept if it can boost Malaysian economy	0.68	0.69	0.68	
Societal acceptance	0.58	0.63	0.75	
Comparison with other risks	0.59	0.63	0.74	
General promise				0.87
Contribute to agriculture	0.84	0.71	0.83	
Good for Malaysian economy	0.80	0.77	0.82	
Cure some serious diseases	0.70	0.70	0.84	
Enhance food quality	0.76	0.75	0.82	
Useful to fight Third World hunger	0.53	0.54	0.88	
General concern				0.89
Harmful to health	0.66	0.62	0.88	
Harmful to environment	0.78	0.72	0.87	
Worry to consume	0.85	0.79	0.85	
Harm to future generations	0.88	0.80	0.85	
Worry about sanctity values	0.73	0.70	0.87	
Unnatural	0.60	0.59	0.89	
Confidence in key actors				0.82
Scientists do a good job for society	0.81	0.68	0.73	
Industries do a good job for society	0.68	0.62	0.80	
Government do a good job for society	0.76	0.71	0.71	
Engagement				0.69
Past and intended behavior	0.52	0.42	0.71	
Awareness	0.78	0.60	0.48	
Knowledge	0.66	0.55	0.56	
Impact of technology				0.82
Lead to humanity's extermination	0.76	0.64	0.78	
Impact on urban life	0.77	0.67	0.76	

Table 3. *(Continued)*

Constructs and observed variables	Factor loading	Corrected item–total correlation	Alpha if item deleted	α
Detrimental for humanity	0.75	0.68	0.76	
Upset the balance of nature	0.63	0.60	0.80	
Societal value				0.78
Use of nature for prosperity versus preserving nature	0.70	0.60	0.73	
Rely on market-driven economy versus centrally planned economy	0.57	0.48	0.76	
Accept risks to attain prosperity versus not striving for progress	0.69	0.58	0.73	
Place economic growth above environmental protection versus the opposite	0.80	0.68	0.70	
Nature can withstand human action versus nature is fragile	0.54	0.44	0.78	
Religiosity				0.93
Importance of religion	0.89	0.85	0.91	
Decisions based on religious views	0.86	0.83	0.91	
Importance of praying	0.90	0.86	0.90	
Importance of reading scriptures	0.83	0.82	0.92	

risk acceptance while moral concern is negatively related to encouragement. If the application is perceived as having high and clear benefit to consumers, the risk associated with it is highly acceptable and the moral concern related to it is low, the application would be highly encouraged. The findings in this study are supported by some of the earlier studies on public perception towards modern biotechnology. Data from the fourth Eurobarometer survey suggested that perceived usefulness was found to be a precondition for Europeans' support towards seven applications of biotechnology while the moral aspects of modern biotechnology applications appeared to act as a veto (Gaskell et al., 2000). Although a biotechnology product or application may have clear benefits, if it is seen as having high moral concerns, the level of support will decrease. Kelley (1995) also reported genetic engineering goals to improve health and agriculture as predictors for approval of genetic engineering, while Einsiedel (2000) found perceived usefulness as the second strongest predictor for encouragement of cloning after moral acceptability. Perceived benefit had a strong positive relationship with risk acceptance.

Benefits seem to balance the risk aspects which leads to the acceptance of some risks associated with GM soybean. Rohrmann and Chen (1999) also reported positive correlation between societal benefits and risk acceptance. Moral concern has a strong association with perceived risk. If the moral concern is high, the risk associated with the modern biotechnology application is also perceived as high. Sjoberg (2004) also reported a strong positive correlation between "interfering with nature" (moral concern) and perceived risk of genetic engineering. Gaskell et al. (2000) suggested that the moral aspects of modern biotechnology applications appeared to act as a veto for the support of biotechnology applications. Even though the application may have clear benefits, if it is seen as having high moral concerns, it will not be encouraged.

The pattern of support can be deduced by analyzing the three main factors mentioned earlier but as can be seen from the SEM model, encouragement of GM soybean involved the interplay between other factors as well. Past studies have reported significant relationships

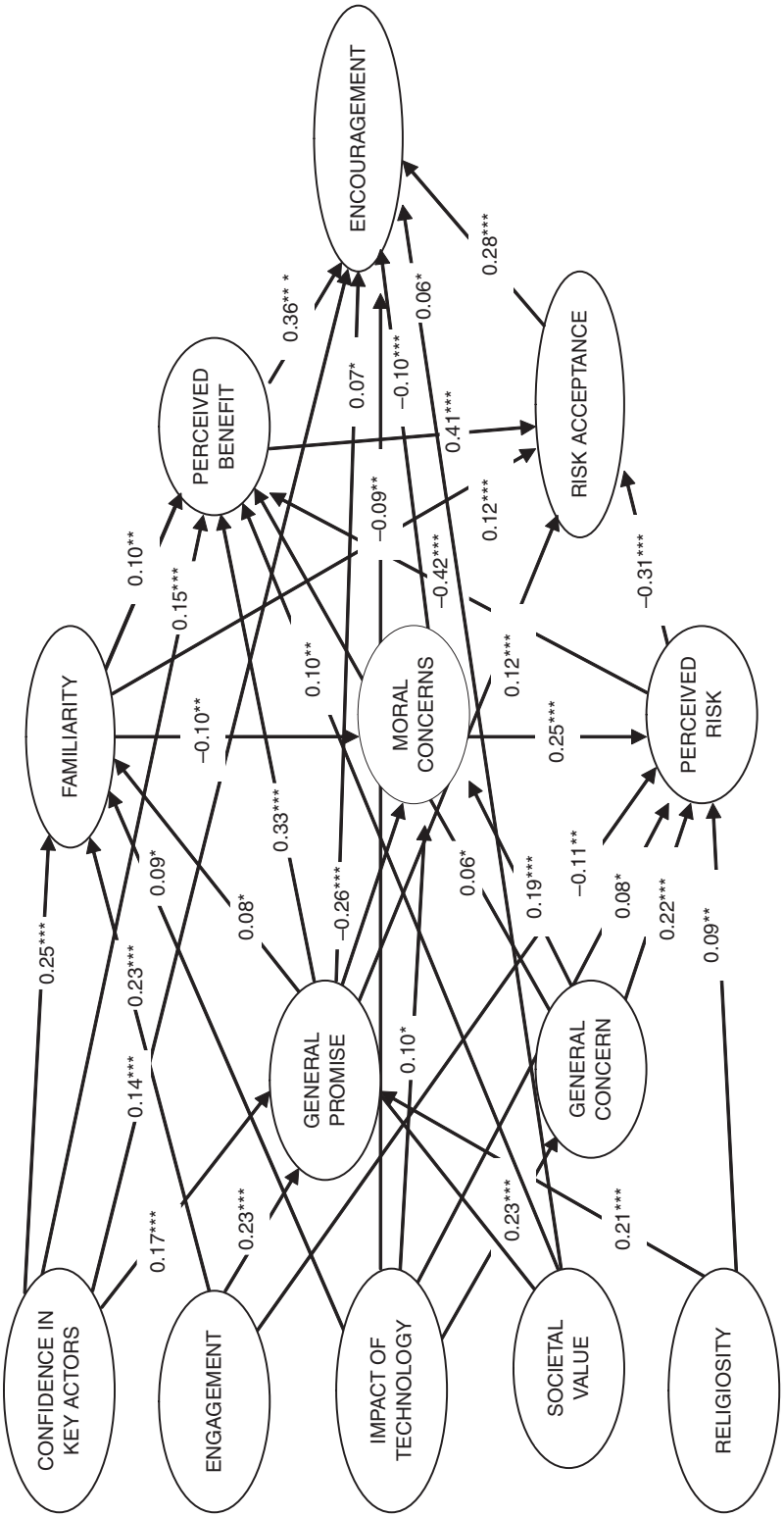

Figure 1. Structural equation model of attitude towards GM soybean showing interrelationships amongst relevant variables. Standardized estimates are presented.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

between perceived risks of and overall attitude/support towards modern biotechnology (Bredahl, 2001; Einsiedel, 2000; Sjoberg, 2004). In this study, it is interesting and surprising to find that encouragement of modern biotechnology applications is not so much a function of perceived risk but rather a function of benefits and the acceptability of the risks. Although the Klang Valley stakeholders acknowledged the presence of perceived risks, the benefits tended to outweigh the risk aspects. There is no direct relationship between perceived risk and encouragement of GM soybean. On the other hand, perceived risk has a strong negative association with risk acceptance. Rohrmann and Chen (1999) also found a negative correlation between risk and risk acceptance. Perceived risk also has a strong negative relationship with perceived benefit. The Klang Valley stakeholders did weigh the risks and benefits of GM soybean but when they made a decision whether to support it or not, they tended to focus more on the beneficial aspects. The presence of substantive benefits tended to compensate for the associated risks. It has been suggested by several researchers that people tend to perceive an inverse relationship between risk and benefit (Alhakami and Slovic, 1994; Gaskell et al., 2004; Hansen et al., 2003; Rowe, 2004). If the application has high risk, its risk acceptance would be low and its benefits would be perceived as low which later translates to low encouragement. Familiarity has a moderate positive relationship with perceived benefit and is negatively associated with moral concern about GM soybean. It is also weakly related to risk acceptance of GM soybean. This finding is in agreement with an earlier study by Bertolini et al. (2003) which reported that Italian consumers who were the most familiar with GM food, were found to have relatively positive attitudes towards GM food. When people have a sense of control over what they eat and they know the effect of eating certain food, they would be more likely to see more benefits.

General promise has a strong positive relationship with perceived benefit but a moderate negative association with moral concerns about GM soybean. It is also positively associated with risk acceptance and encouragement. The respondents who saw higher general promise of modern biotechnology also tended to perceive higher benefits and lower moral concerns of GM soybean. They were also more accepting of its risks as well as more encouraging of GM soybean. On the other hand, general concern about modern biotechnology has a moderate positive association with perceived risk and moral concerns. These findings confirmed that people first form attitudes towards the overall usefulness and risk of the technology before inferring from these general attitudes how beneficial or risky a particular application of the technology is (Bredahl, 2001). Pardo et al. (2002) reported a positive correlation between general promise of biotechnology and perceived benefit of a biotechnology application and also a positive correlation between general biotechnology concern and perceived risk of a biotechnology application. Tucker et al. (2006) also reported that respondents from Ohio who expressed negative evaluations of biotechnology were more likely to perceive higher levels of food safety risk.

In their study, Hossain et al. (2002) found that people's confidence and trust in the government and scientific community and the public image of biotechnology industries have significant influence on public approval of food biotechnology. Gaskell et al. (2003) also reported that confidence in key actors was a predictor for encouragement of biotechnology applications but they did not test the association with the other attitude dimensions. In this study, confidence in scientists, industries and government was directly related to encouragement of GM soybean as well as positively associated with familiarity, general promise of modern biotechnology and perceived benefit. According to Hamstra (1992) and Covello (1992), people often judge risk according to their perception of its controlling agents: if these controlling agents have a track record of secrecy, or they dominate supposedly independent regulatory

bodies and the public policy process, then people magnify the perceived risks. It has also been argued that without confidence in key actors – scientists, regulators etc. – people are likely to have exaggerated perceptions of risks, as the assurances provided by the experts that the risks are low or manageable are treated with skepticism (Gaskell et al., 2003).

Engagement has a moderate positive association with familiarity and general promise of modern biotechnology but a negative relationship with perceived risk. According to Gaskell et al. (2003), members of the "issue public" (engaged) are more likely to be better informed and to seek out new information on modern biotechnology so they are more likely to be more familiar with modern biotechnology. Those who are more familiar with modern biotechnology are more likely to have been exposed to the modern biotechnology issues such as its pros and cons so it is expected that some would be supportive while others might have negative views. Gaskell et al. (2003) found that engagement was consistently associated with higher support for six modern biotechnology applications but Einsiedel (2000) also found a weak negative association (although not significant) between attentiveness and genetic understanding (which are components of the engagement factor in this study) with encouragement of cloning. On the other hand, Pardo et al. (2002) found a negative association between the informed public and both general reservation and general promise of modern biotechnology and a positive correlation between the informed public and benefit.

Negative impact of technology has a positive association with general concern about modern biotechnology and moral concerns about GM soybean. It has also a positive association with familiarity and perceived risk but is negatively related to encouragement. General attitudes to science and technology (technology pessimism/optimism) tend to shape specific attitudes to a particular technology (Urban and Hoban, 1997). Those who are more optimistic about one technology tend to be optimistic about others and vice versa (Gaskell et al., 2004). Gaskell et al. (2003) reported that technology optimism is a predictor for encouragement of biotechnology applications while Rohrmann (1994) found a negative correlation between positive impact of technology and risk magnitude. Materialists are found to be critical. Materialist values also have a positive association with familiarity, perceived benefit and encouragement of GM soybean. Materialists are less concerned about the environment, so it is expected that they would perceive more benefits and be more supportive of modern biotechnology applications. Gaskell et al. (2003) reported materialist values as a predictor for encouragement of biotechnology applications but did not mention any association with other attitude dimensions.

Although religiosity has a significantly positive association with perceived risk, it has a stronger positive relationship with general promise of modern biotechnology. This is an interesting finding and may explain why earlier research trying to relate religious values and environmental concerns was inconclusive (Gardner and Stern, 1996). Some earlier studies have shown that being religious has a negative effect on attitude towards science (Sturgis and Allum, 2004), judgment of genetically modified crops (Biel and Nilsson, 2005) and support for genetic engineering (Kelley, 1995), while others have made the opposite claim and state that religious tradition is a cause of pro-environmental behavior (Naess, 1989; Whitney, 1993). The findings of this study showed that although the religious people were more cautious, they were also practical. Although they saw the risks related to modern biotechnology products, they were also able to appreciate their benefits. The majority of the respondents in this study were Muslim, and Islam encourages the mastery of science and technology and the enhancement of skills and expertise as long as these do not contradict the Syariah (sharia) principles.

4. Conclusion

As can be seen from the SEM models, attitudes to agro-biotechnology is a complex issue which involves the interplay between many factors. This study has confirmed that attitudes to complex issues such as biotechnology should be seen as a multifaceted/multidimensional process. The most important factors predicting encouragement of GM soybean are the specific application-linked perceptions about the benefits, acceptance of risk and moral concern, while risk and familiarity are significant predictors of benefit and risk acceptance. Attitudes to agro-biotechnology are also predicted by several general classes of attitude such as general promise of and concern about biotechnology, engagement with modern biotechnology, confidence in key actors, societal value, impact of technology and religiosity.

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