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Review

Public attitude towards modern biotechnology

Latifah Amin[1,2]*, Hasrizul Hashim[1,2], Nik Marzuki Sidik[1,3], Zinatul A. Zainol[1,4] and Nurina Anuar[1,5]

[1]Social Impact of Biotechnology Development in Malaysia Research Group (SIMBIO). Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.
[2]Centre for General Studies, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.
[3]Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.
[4]Faculty of Law, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.
[5]Faculty of Engineering and Architecture, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.

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This article reviews the literature related to the main idea of the study, rooting from the definition of biotechnology, global status of commercialized biotechnology products, and global and local public attitudes towards modern biotechnology and past models for attitude towards modern biotechnology. The first section of the review will be the in-depth-discussion regarding the definition of modern biotechnology according to several established international organizations, followed by global status of commercialized biotechnology products which will emphasize on how modern biotechnology is classified and which area are being focused more by the stakeholders, and global and local public attitudes towards modern biotechnology based on previous studies. Last but not least, the final section is credited to past studies related to attitudes and past models of public attitudes towards biotechnology, both globally and locally. A developing country like Malaysia was chosen in this article as an example of the case study related to local situation of modern biotechnology.

Key words: Modern biotechnology, genetically modified (GM), public attitude, Malaysia

INTRODUCTION

United Nations on biological diversity defines biotechnology as any technological application that incorporates biological system, living organisms, or derivatives thereof, to produce or to refine products or processes for specific use (United Nations, 1992). It is acknowledged that biotechnology has formed the fundamental of knowledge about people and diseases, and that includes supporting various developments of treatments (Biotechnology Online). Even though the term biotechnology started to bloom up when a Hungarian agricultural engineer, Karl Ereky firstly introduced the term in 1919 (Fari et al., 2006), ancient and classical biotechnology techniques have been documented to exist over centuries ago. For examples, the use of moldy soybean curds by the Chinese as an antibiotic in order to treat boils exist since 500 B.C, the manipulation of plant traits through selective breeding in order to improve the crops yield, and the use of microorganisms in fermentation to make bread and wine (Biotechnology Institute).

According to Department of Primary Industries of Victoria state (Australia), modern biotechnology is another stage that comes after ancient and classical biotechnology, which describes a range of processes and techniques particularly involved at the molecular level, and that includes genomics, genetic modification (gene technology, genetic engineering), molecular marker-assisted breeding, cloning, bioprocessing and cell culture. However, it is always noted that the terms modern biotechnology and genetic engineering can be used in the current context interchangeably since most establish-

*Corresponding author. E-mail: nilam@ukm.my. Tel: +603-89216907. Fax: +603-89252976.

Abbreviations: **GMO**, Genetically modified organism; **NRC**, National Research Council; **CIHR**, Canadian Institute for Health Research; **GM**, genetically modified.

ed regulations agree that both fields do not involve traditional breeding and mutagenesis (Latifah et al., 2007). The product resulted from modern biotechnology or genetic engineering processes is called genetically modified organism (GMO). Study has shown that GMO can increase the crops' yield while reducing the number of applications of insecticides (Qaim et al., 2003).

GLOBAL STATUS OF COMMERCIALIZED BIOTECHNOLOGY PRODUCTS

Nowadays, Biotechnology has been classified into few categories based on their applications.

1. Bioinformatics: Interdisciplinary field that involves solving biological puzzles using computer applications, organizing and analyzing biological data (Luscombe et al., 2001).
2. Red biotechnology: Biotechnology used in medical processes, to produce antibiotics, or to provide genetic cures through genomic manipulation (Lorenz et al., 2005).
3. Green biotechnology: Biotechnology used in agricultural processes, such as to grow food crops with enhanced nutritional content, or to increase their yields (Lorenz et al., 2005).
4. Blue biotechnology: Biotechnology used in marine and aquatic organisms, as to increase seafood supply and safety, controlling the proliferation of deadly water-borne organisms, bioremediation, and developing new drugs (Biology Online).
5. White biotechnology: Biotechnology used in industrial processes, to produce chemicals, materials and energy source (Lorenz et al., 2005).

Red Biotechnology is currently leading the modern biotechnology industry, followed by green biotechnology, each of which are focusing on biopharmaceuticals and GM crops, respectively (Latifah et al., 2007). Since, the approval of the first biopharmaceuticals product in 1982, which was the recombinant human insulin, the pharmaceutical industry has grown rapidly, producing some 140 biopharmaceuticals by the year 2003 (Walsh, 2004). The first generation of biopharmaceuticals were targeted towards a variety of widespread diseases such as diabetes, growth disorders, genetic disorders, infertility, infectious diseases, blood disorders, cancer, autoimmune disorders, heart diseases, AIDs, skin disorders, non-malignant tumor, and hypoglycemia (Walsh, 2004). Since then, Red biotechnology continues to promote innovation in order to create novel biopharmaceuticals, to reduce current product's production cost and to improve current product’s therapeutic value. For example, National Research Council (NRC) of Canada coordinates policies, budgets, and strategies for innovation in biotechnology as part of the government aim to drive Canada as one of the top five R&D countries by 2010 (Rosenberg-Yunger et al., 2008). Canadian government’s main health research funding agency, The Canadian Institute for Health Research (CIHR), had allocated $699 million as their budget between 2005 and 2006 (Rosenberg-Yunger et al., 2008).

Transgenic tobacco was among the first genetically modified (GM) crops to be commercialized as an outcome of the emergence of green biotechnology (Jan-Peter et al., 2003). This began unofficially in China in 1992, it was then followed by commercial planting of GM FLAVR SAVR™ tomato by the USA in 1994 (Jan-Peter et al., 2003). Since then, commercial large scale plantings of GM crops started to increase steadily, with a growth of more than 10% per year, beginning at 1.7 hectares in 1996 to 58.7 million hectares in 2002 (James, 2002). Following the commercial approval of the GM tomato, few transgenic crops were being approved and entered the global market one by one. Currently, GM rice (Bt rice) and GM maize (biotech phytase maize) had been approved by China on 27 November 2009 (James, 2009). These approvals are momentous and have enormous implications for biotech crop adoption not only for China and Asia, but for the whole world since rice is the most important food crop in the world and maize is the major animal feed crop in the world (James, 2009). Prior to the approval, in October 2009, a landmark decision was made by India’s Genetic Engineering Approval Committee (GEAC) to recommend the commercial release of GM Brinjal (Bt brinjal/eggplant) in India. However, the final decision regarding the matter is still pending and subject to the final clearance by the government of India (James, 2009). Besides, other transgenic crops which have been commercialized until 2010 are GM soybean, maize, cotton, canola, squash, papaya, alfalfa, sugarbeet, tomato, poplar, and sweet pepper (James, 2010).

Yet, the global GM area had increased to a total of 67.7 million hectares in 2003 (James, 2003) before reaching more than a twofold increase – 148 million hectares in 2010 (Table 1, James, 2010). The number of countries growing transgenic crops has increased steadily from 6 in 1996 to 18 in 2003 and 29 in 2010 (James, 2010). The principal crops in 2010 remained the same as in 2003, with GM soybean continued to be the leading principal GM crop occupying 73.3 million hectares or 50% of global biotech area, followed by GM maize which occupies 46.8 million hectares (31%), GM cotton which occupies 21 million hectares (14%) and GM canola occupying 7.0 million hectares (5%) (James 2003, 2010). Consistently, the dominant trait during the fifteen-year period 1996 to 2010 was herbicide tolerance (James, 2010).

“Gene stacking” or “gene pyramiding” is a term to describe a breeding approach to attain higher crop yield while controlling the pest at the same time (Taverniers et al., 2008). It is a prominent way for researchers to transfer multiple traits to a crop, usually involving insect resistance and herbicide resistance. Until 2010, 11 countries have already planted the crops containing stacked genes, occupying up to 22% of global biotech crop area

Table 1. Global area of transgenic crops in 2010 by country.

Country	Hectare (million)	Hectare (%)	Biotech Crop
USA	66.8	45.1	Soybean, maize, cotton, canola, squash, papaya, alfalfa, sugarbeet
Brazil	25.4	17.2	Soybean, maize, cotton
Argentina	22.9	15.5	Soybean, maize, cotton
India	9.4	6.4	Cotton
Canada	8.8	6.0	Canola, maize, soybean, sugarbeet
China	3.5	2.4	Cotton, tomato, poplar, papaya, sweet pepper
Paraguay	2.6	1.8	Soybean
Pakistan	2.4	1.6	Cotton
South Africa	2.2	1.5	Maize, soybean, cotton
Uruguay	1.1	<1	Soybean, maize
Bolivia	0.9	<1	Soybean
Australia	0.7	<1	Cotton, canola
Philippines	0.5	<1	Maize
Myanmar	0.3	<1	Cotton
Burkina Faso	0.3	<1	Cotton
Spain	0.1	<1	Maize
Mexico	0.1	<1	Cotton, soybean
Colombia	<0.1	<1	Cotton
Chile	<0.1	<1	Maize, soybean, canola
Honduras	<0.1	<1	Maize
Portugal	<0.1	<1	Maize
Czech Republic	<0.1	<1	Maize, potato
Poland	<0.1	<1	Maize
Egypt	<0.1	<1	Maize
Slovakia	<0.1	<1	Maize
Costa Rica	<0.1	<1	Cotton, soybean
Romania	<0.1	<1	Maize
Sweden	<0.1	<1	Potato
Germany	<0.1	<1	Potato
TOTAL	148	100	

Source: James, 2010.

(Table 2). More of the two-third of maize planted in the USA contain stacked genes. One of the stacked maize variant, known as “SmartstaxTM” which has eight genes in it coding for several pest resistant and herbicide tolerant traits was released in the USA and Canada in the same year (James, 2010).

Among nations, blue biotechnology is mostly at various developmental stages. Taken Norway as an example, several new initiatives promise to discover novel enzymes, drugs, and other helpful compounds, along with the exploration of the marine ecosystem's genetic diversity. For example, various species of sponge have been collected which filter million liters of water every day; they are claimed to cove bacteria and work as anti-infective (anti-bacterial) (Aldridge, 2005). Ellingsen, who is a research director at SINTEF (Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology), added that they have already found the production organisms for all the products and it is the time now to screen those for industrial potential (Aldridge, 2005). In addition, the latest finding of soluble beta glucan (SBG), an immunostimulant derived from used in fish feed to decrease mortality (Aldridge, 2005) could potentially contribute significant impact on blue biotechnology industry.

White biotechnology has been valued as the most reliable solution in order to produce alternative energy sources for the future. Most stakeholders agreed that sooner or latter white biotechnology will lead the industry through their biomass based product which will eventually assist the petroleum-dependent economies (Lorenz et al., 2005). This renewable energy approach has been proposed as a new transportation fuel due to an increment of conventional energy cost and global warming concerns (Yarris, 2010). Furthermore, recent study has shown that *Escherichia coli* bacteria is capable to produce biodiesel fuel and other important chemicals derived from energy-rich molecules such as fatty acids. Department of

Table 2. Global area of GM crops in 2010.

Trait	Crop	Area (million hectares)	Area (%)
Herbicide tolerance	Soybean, maize, canola, cotton, sugarbeet and alfalfa	89.3	61
Stacked double and triple traits	Maize, cotton	32.3	22
Insect resistance	Maize, cotton	26.3	17
Total		148	100

Source: James, 2010,

Energy's Joint BioEnergy Institute (JBEI) has been looking into the possibility of converting biomass directly to biodiesel using the *E. coli* strain that has been engineered (Yarris, 2010).

MODERN BIOTECHNOLOGY STATUS IN MALAYSIA

Malaysia aims to use biotechnology as an economic growth vehicle by the year 2020 (Firdaus-Raih et al., 2005; BIOTEK, 2010) by introducing the Malaysian Biotechnology Policy which is divided into three phases - Phase I (2005-2010), Phase II (2010-2015), and Phase III (2016-2020) (MABIC, 2010). The first phase, accomplished in 2010, consists of research and development (R and D), technology development, and promotion of biotechnology programs (BIOTEK, 2010). During this period, the government had taken a promotion step by actively introducing biotechnology into the classrooms of high schools throughout the nation (Firdaus-Raih et al., 2005), established BiotechCorp (Malaysian Biotechnology Corporation) as the primary center for biotechnology industry development in this country, provided various fiscal and tax incentives to biotechnology companies granted the BioNexus status (BIOTEK, 2010), and introduced several grants which are ScienceFund, Technofund, Innofund, e-Content and DAGS Roll Out in order to support the studies and local projects financially, from R and D to commercialization stage (MOSTI, 2010).

In Malaysia, the exact boundary between conventional and modern biotechnology has not been established. As long as the study involved any biotechnology techniques or tools, they are included under biotechnology (Latifah et al., 2007). Among research organizations in Malaysia which engage with the first R and D stage are:

1. Malaysian Agricultural Research and Development Institute (MARDI).
2. Malaysian Palm Oil Board (MPOB).
3. Rubber Research Institute, Malaysia (RRIM).
4. Institute of Medical Research (IMR).
5. Universiti Kebangsaan Malaysia (UKM).
6. Universiti Malaysia Sarawak (UNIMAS).
7. Universiti Putra Malaysia (UPM).
8. Universiti Sains Malaysia (USM).
9. Universiti Malaya (UM).
10. Univeristi Teknologi Malaysia (UTM).
11. Standard Institution for Industry Malaysia (SIRIM).
12. Malaysian Institution for Nuclear Technology (MINT).
13. Forest Research Institute of Malaysia (FRIM).
14. Veterinary Research Institution (VRI).

Being an agriculture-based nation, the strength of Biotechnology in Malaysia is in agricultural biotechnology (green biotechnology) which is foreseen as a potential powerful tool to ensure food security and to boost the country's economy (Latifah et al., 2007). Even though modern biotechnology products developed by Malaysian researchers were not being planted and commercialized yet, but the action is almost there. One of the researches focused on the development of delayed ripening papaya, which has already been approved by the Genetic Modification Advisory Committee (GMAC) for contained field trials (Latifah et al., 2010). In fact other GM products from other countries are slowly coming into the country. In 2004, the only agricultural product available in the Malaysian market is Glyphosate resistant soybean (Latifah et al., 2007). However, it is no doubt that GM maize has already entered the market since YieldGard™ maize, RoundupReady™ maize and YieldGard™ maize (all released by Monsanto) has already been approved for imports into the country (Hoh, 2010).

Espicom (2008) estimates that the Malaysian biopharmaceutical market would be at US$75 million in 2008 and believes it will rise to US$132 million by year 2013. At least twenty six biopharmaceuticals products of modern biotechnology techniques were already registered with the Ministry of Health of Malaysia for use in this country (Latifah et al., 2007). The therapeutic values of the biopharmaceutical products range from different types of insulin for the treatment of diabetes, growth hormones, drug for the treatment of various kinds of cancers, hepatitis, infertility, autoimmune disorders, organ transplant and infectious diseases (Latifah et al., 2007). The first biopharmaceutical plant was opened in Nilai, Negri Sembilan in June 2006. Fully owned by a local biotechnology firm Inno Biologics Sdn Bhd, which encompasses gene cloning and expression in CHO cells and novel cell expression systems, bioprocess development, and cGMP biopharmaceutical manufacturing (Potera, 2010), the plant will help the country to save up to 30% on biogenerics-based drugs in addition to capitalize the fact that global industry players are now looking to Asia to cut operating costs (Pharma Asia, 2006).

The phase II of the National Biotechnology Policy has been initialized since 2010, and the plan emphasizes on the business aspects, such as developing expertise in drug discovery and the development based on natural resources, new product development, and technology acquisition and licensing. Following the Phase II, the Phase III will be based on the results achieved in the first two phases, and together bringing the local biotechnology companies to international status (MABIC, 2010).

On the contrary, the policy makers themselves, who are the backbone of the Malaysian Biotechnology Policy as they are responsible in setting the policy framework for the government, are quite positive towards the development of modern biotechnology in Malaysia. A study by communication researchers from ISAAA and the University of Illinois at Urbana-Champaign (2003) showed that Malaysia's policy makers have some willingness to focus on an array of different applications of biotechnology ranging from medical, agricultural and environmental modern biotechnology applications. In addition, majority of the policy makers along with one-third of the customers involved in the closed ended questionnaire showed some level of disagreement in contributing time and money to ban GM foods (ISAAA-UIUC, 2003). The comparison of attitudes towards modern biotechnology across Malaysian stakeholders based on the previous study will be discussed again in "Malaysian Public Attitude towards Modern Biotechnology" subtopic.

GLOBAL PUBLIC ACCEPTANCE TOWARDS MODERN BIOTECHNOLOGY

During the first commercial introduction of GM foods (crops) in the United States of America (USA), only few number of farmers were willing to take the risk that GM crops would be marketable (Oeschger and Silva, 2007). However, since then, the US farmers began to realize the potential of the GM crops in exploiting the global agricultural economy. The commercial large scale plantings of GM crops started to increase steadily, with a growth of more than 10% per year, beginning at 1.7 hectares in 1996 to 58.7 million hectares in 2002 (James, 2002).

Asians were found to be less concerned about medical products of genetic engineering compared to genetically modified food (Macer et al., 2000). In contrast to the European public, the American public is ignorant of GM technology and its level of implementation (Oeschger, 2007). Cynical attitudes to certain applications of gene technology seem to be more common in Europe (Siegrist, 2003) than in the USA, where public is still relatively little concerned about gene technology (Loureiro and Hine, 2004). The uncertainty about possible long-term effects of GM food to the environment and human health seems to influence the European public who question the benefits of the new technology between producers and consumers (Christoph et al., 2008). The highest degree of supports of the Europeans was only restricted to genetic testing followed by the introduction of human genes into bacteria to produce medicines or vaccines (Gaskell et al., 2000). Later, Sjöberg (2008) in his paper defined the GM technology as 'a technology that is not well received by the European public'. It was found that GM technology was rated as the worst of 18 technologies by members of the public and highly replaceable, though the experts might have a very different view but still saw GM technology as replaceable. This clearly demonstrates that GM technology was rated as very risky amongst Europeans (Sjöberg, 2008).

The emergence of modern biotechnology in the developing continent like Africa centers on the development of GM crops (GM foods) to fight food insecurity, poverty and malnutrition (FAO, 2003), nevertheless the acceptance of modern biotechnology there, taking Ghana as an example are still between average to low, which could be reflected by the level of knowledge of the public (Buah, 2011). In fact, public who concerned regarding GM products in Ghana believed GM will only benefit the big multinational companies together with the lack of their trust towards the government (Quaye et al., 2009).

MALAYSIAN PUBLIC ATTITUDE TOWARDS MODERN BIOTECHNOLOGY

Generally, Malaysian stakeholders in the Klang Valley region were cautious on modern biotechnology applications and products (Latifah, 2007). It has been the matter of controversial in both modern and developing countries, including Malaysia, though its development has been rapidly evolved in the past few decades. Organisation for Economic Co-operation and Development (OECD) (1999) headlines that, worries towards GMO fall under three categories: Human health concerns, environmental concerns, and ethical concerns, which do not lie on the characteristics of the product but rather the way it is made.

As mentioned earlier in this paper, the Malaysian policy makers are quite positive towards the development of modern biotechnology in Malaysia. They were also shown to have high support for GM palm oil; however, they were only shown to have moderate encouragement for GM soybean and GM insulin (Latifah, 2007). This might be due to the fact that oil palm is the primary crop production in Malaysia (Shuit et al., 2009) and any of its development which helps to drive Malaysia's economy to another level must be fully supported. ISAAA-UIUC (2003) has also been reporting that ethical together with religious concerns are the main stakeholders' predominance on judgments about biotechnology, whereas political issues are the least influence on their judgments. As a matter of fact there are few "Don't Know" responses to certain statements in the survey conducted, indicating that the public were not aware with its status in the country or do not posses enough knowledge regarding modern biotechnology (ISAAA-UIUC, 2003). Overall, the most frequently used sources of information on biotechnology by Malaysian stakeholders are the mass media (radio, television, and newspapers), followed by the printed media and surrounding people, including family and friends (ISAAA-UIUC, 2003; Latifah et al., 2007). This is contradicting with other public/stakeholders in other developing country like Ghana. The Ghanaian do not use both electronic and printed media solely as sources of information on GM foods, instead friends have been a major source of information of the matter (Buah, 2011).

Few years back, the attitude of the Klang Valley public towards modern biotechnology had been assessed using certain key variables for specific attitude, including perceived benefits, perceived risks, encouragement or overall attitude, moral concerns, familiarity and risk acceptance. Generally, the results from the study suggest that knowledge and engagement towards biotechnology differed across religions, races, ages and education levels, but not across gender, while awareness level differed across ages, education levels and gender, but not across religions and races (Latifah, 2007). Overall, the mean scores for encouragement in this study are more or less higher than the ISAAA-UIUC report on general attitude towards agricultural biotechnology. The media were the most critical compared to other stakeholder groups as they perceived the highest risk of all three surveyed applications (Latifah, 2007). Moreover, two issues of modern biotechnology that has intentionally been used by the journalists are “GM crops will be so resistant to pests and diseases but will push native plants into extinction”, and “GM crops will contaminate native plant biodiversity” (ISAAA-UIUC, 2003).

Those with higher levels of education tended to have better biotechnology knowledge. Scientists, including biotechnologists and biologists, policy makers and biology students were in this category. They also scored the highest mean in term of familiarity with the biotechnology applications (Latifah et al., 2007). Religious attachment seemed to influence the Klang Valley public towards modern biotechnology applications, with the Malays were shown to be the most attached to religion followed by the Indian and Chinese. Buddhist experts along with those who posses higher levels of education had higher biotechnology knowledge. Even though the Muslims were found to have least knowledge and less engaged with biotechnology, they were found to be the most positive towards the promise of modern biotechnology. Furthermore, the Muslims and the Hindus showed more confidence on the scientists, industries and government compared to the Buddhists and Christians (Latifah et al., 2007).

The Indians significantly claimed to have the highest familiarity with the biotechnology applications (GM Soybean, Palm Oil, and Insulin); the Chinese seemed to have higher biotechnology knowledge than the Indians and Malays based on the carried Post Hoc tests (Latifah et al., 2007). Chinese community in Klang Valley were also the most positive towards the impact of technology, and they were also more inclined towards nature and professed to have less materialistic values than the Malays and the Indians. Meanwhile, the Malays seemed to be less engaged with modern biotechnology compared to the Chinese and Indians (Latifah et al., 2007). Among the three biotechnology products/applications being surveyed, GM soybean was regarded as the most risky followed by GM insulin and GM palm oil which was perceived as having the highest benefits by the Klang Valley stakeholders compared to the other two. Finally, all biotechnology applications were perceived as having moderate encouragement by the respondents from all races, from all age groups and from all category of education (Latifah et al., 2007).

FACTORS INFLUENCING PUBLIC ATTITUDE AND ACCEPTANCE OF MODERN BIOTECHNOLOGY

There are many ways to assess the public perception towards certain technology. Lim et al. (2009) highlighted six major groups of barriers between the technology and the public (agreement, knowledge, technology, economic, social and political) (Figure 1). These categories which collectively referred to as the ‘AKTESP’ barriers are adopted from 'Trudgill’s Framework for Analysis' which was published in 1990 (Lim et al., 2009). Each stage is constantly being questioned whether it hinder the overall progress towards the solution. Among these categories, only four were almost similar to attitude variables in Latifah's framework (2007), agreement, knowledge, technology, and social, while economic and political point of view were not being stressed in the study.

Moreover, Lim (2009) used the support from the government in terms of providing incentives as well as enforcing the use of renewable energy as the benchmark to assess the political barriers between the technology and the public (Lim et al., 2009). This is parallel with the current global situation, where low-cost and environmentally sustainable supplies of food and biofuels will depend on significant R and D investment in agriculture, nevertheless agricultural research has not been underlined in recent years as a spending priority of governments (Graff et al., 2009). However, Trudgill’s Framework is not suitable in studying the public perception towards modern biotechnology as earlier researches have recommended that public attitude towards a complex emerging issue such as modern biotechnology should be seen as a multi-dimensional construct (Latifah et al., 2007). Dissimilar with Gaskel (2000) who identified four single-directed dimensions, Latifah et al. (2007)

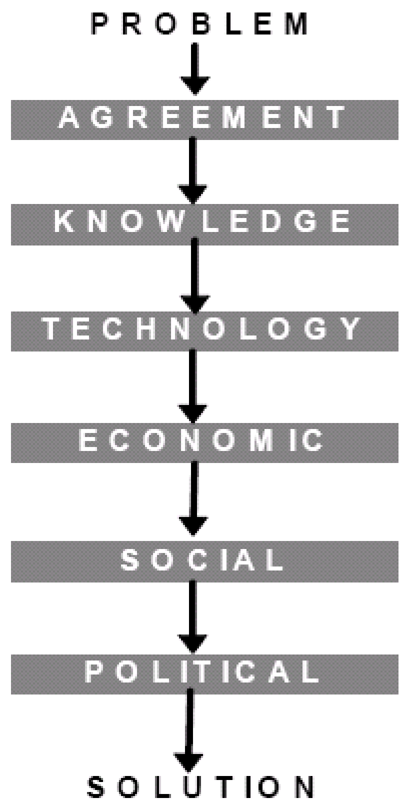

Figure 1: The AKTESP groups of barriers in Trudgill's Framework for Analysis .Source: Lim et al., 2009.

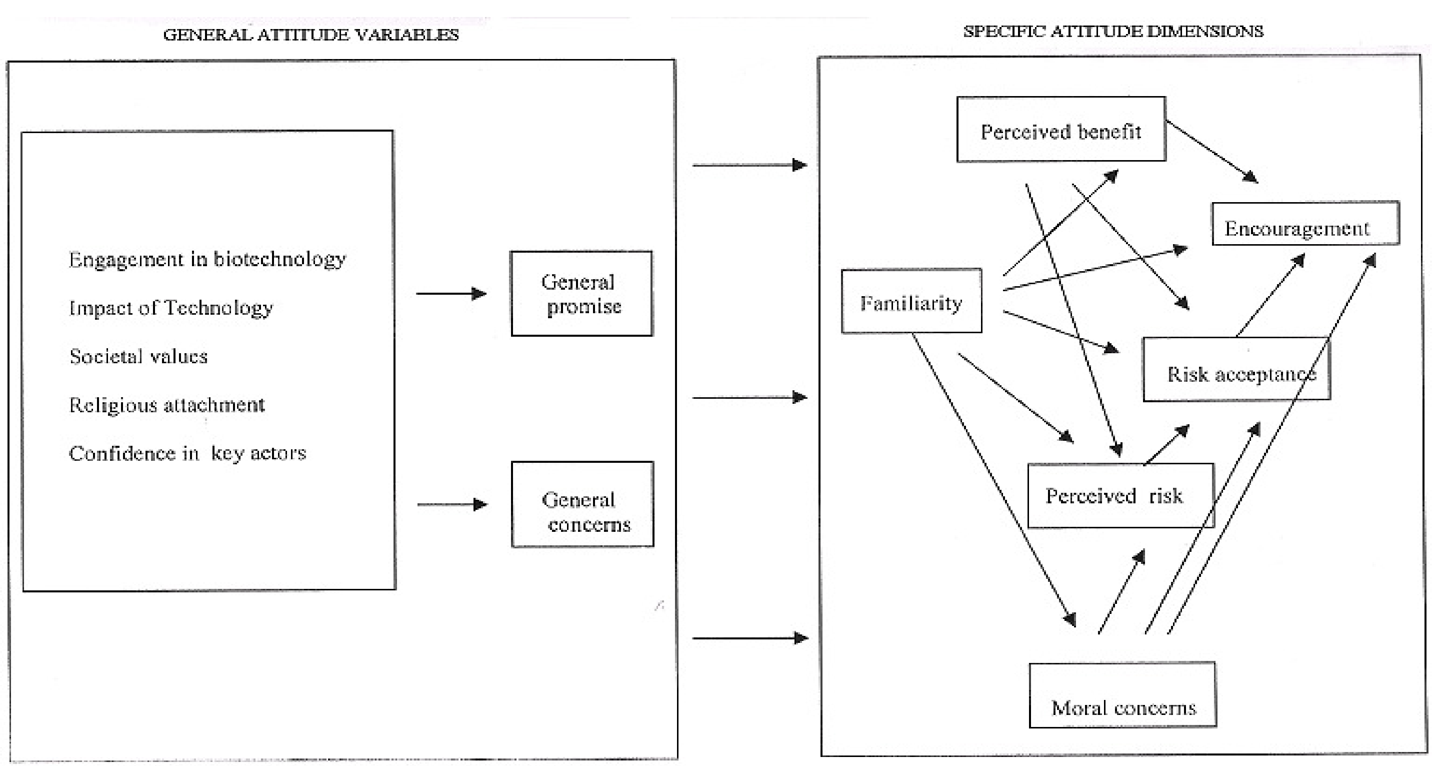

Figure 2. Model for attitude towards modern biotechnology by the Malaysian. Source: Latifah et al., 2007.

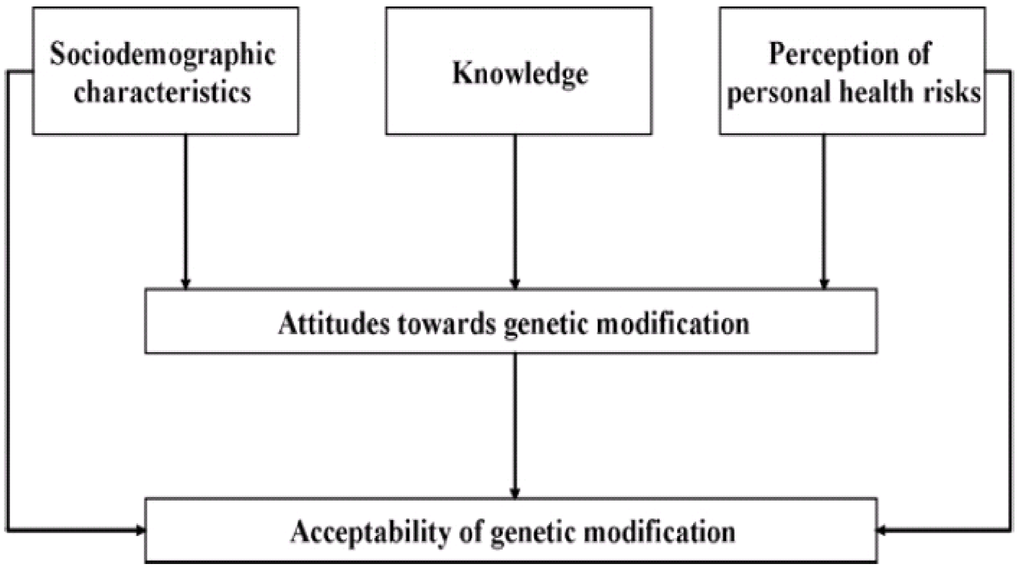

Figure 3. Conceptual model for attitude towards genetic modification by the Germans. Source: Christoph et al., 2008.

developed a multi-dimensions and multi-items instrument, which is more applicable in measuring Malaysian public attitude towards modern biotechnology (Figure 2).

Christoph et al. (2008) almost used a similar model representing a deeper look at attitudes influencing aspects using univariate, bivariate and multivariate methods in assessing the attitudes and the acceptability of the Germans towards genetic modification. The acceptability of genetic modification in different areas of application was thought to be linked from the attitudes, which is influenced by the following factors, such as, socio-demographic variables, knowledge about genetics and biotechnology, and the perception of personal health risks (Figure 3).

CONCLUSION

Malaysia accomplished their first stage of biotechnology policy consisting of research and development (R and D), technology development, and promotion of biotechnology programs. Among those five areas of modern biotechnology, the green biotechnology (Agricultural biotechnology) has been pinpointed by the Malaysia government as the focus subject of modern biotechnology in the country. After all, it has been perceived as risky by certain public and the government has to consider this situation circumspectly before approving or developing any modern biotechnology applications or products.

Earlier studies had shown the acceptability of a GM products or applications is affected by the public or consumer attitudes towards it. It is always important to look at the possible attitudes which influence the public perception in order to fully understand the multi-faceted process related to modern biotechnology acceptance.

Among the key variables used in previous studies for specific attitude are, perceived benefits, perceived risks, encouragement, moral concerns, familiarity, and risk acceptance, while several general attitudinal factors found to be related to specific public attitude included general promise and concerns, confidence in key actors, impact of technology, societal values, attachment to religion, socio demographic factors, knowledge, new age beliefs, suspiciousness, politics, worldviews, the effect of labeling, awareness and engagement with modern biotechnology. The inclusion of these factors would refine the existing conceptual model in assessing the Malaysian public attitude/acceptance towards modern biotechnology.

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