CHAPTER SEVEN

7.0 CONCLUSION

7.1 GENERAL CONCLUSION

The advances in biotechnology will undoubtedly have profound impacts on the lives of every citizen. Malaysia is aggressively pushing the biotechnology agenda to become a global player with agriculture, medical and industrial biotechnology given much prominence under the National Biotechnology Policy (2005), National Biomass Strategy (Agensi Inovasi Malaysia, 2011) and BioEconomy Initiative Malaysia (MOSTI, 2012). Nevertheless, there is no synergism among all the biotechnology players in communicating biotechnology and engaging the public. An integrated and comprehensive approach in this area is severely lacking. This is a critical shortcoming and has to be urgently addressed for public to form opinion about policies (Hartz and Chappell, 1997), evaluate science policies issues (Nelkin, 1995), help generate excitement among young people who might otherwise not consider scientific careers (Hartz and Chappell, 1997), aid people to better discriminate the activities of scientists from those of "pseudo" scientists (Shortland and Gregory, 1991), and create favourable attitudes towards science and science funding among policymakers (Hartz and Chappell, 1997). All of these have been discussed under the Literature Review and are important reasons to ensure the success of all the national biotechnology-related policies.

Although Malaysia has a more robust biotechnology communication strategies compared to countries like Singapore and the USA, especially lacking is an approach that links together the main players and stakeholders in communication of biotechnology. Brossard and Shanahan (2007) listed the components of public

communication about biotechnology as i) knowledge/awareness; ii) trust; iii) mediated discourse; and iv) risk communication. Incorporating the above components into biotechnology communication strategies require a synergistic approach among the different government agencies involved in biotechnology to ensure a single message is conveyed to the public. For a country like Malaysia, where there is huge investment in biotechnology and various policies to support the biotechnology industry, getting the public on the same wavelength is crucial. It is no doubt that NGOs would have their own agenda, but a national framework on biotechnology communication would form the strong link between the government sectors that aligns with the policies and government aspiration to develop the biotechnology sector. This may also counter any negative impact of anti-biotechnology NGOs' communication initiatives to the public. A good lesson is from the UK, where anti-biotechnology NGOs has strong influence among the public and play an important role in shaping public opinion on biotechnology (Poortinga and Pidgeon, 2007), which leads to public rejection of modern biotechnology, especially in the field of agriculture.

The objectives of this research were achieved as this research managed to identify existing biotechnology communication activities in Malaysia in terms of players involved, their objectives, strategies, challenges and shortcomings, which were then compared to the public attitudes and interests toward biotechnology from the public survey for the development of a communication framework and strategy for Malaysia. International comparison of countries such as the USA, UK, Australia, Singapore and the Philippines was also carried out as planned and further enriched the proposed communication framework and strategy. On the whole, the results from this research are in agreement of the hypothesis that was formulated earlier. This research showed that there is neither national policy nor champions to spearhead biotechnology

communication in Malaysia. However, it cannot be entirely concluded that biotechnology communication is not a priority among scientists and policymakers, while it is true for the media. In spite of the lack of a coordinated approach at the national level, scientists, and policymakers at NROs are involved in communicating biotechnology and in engaging with the public. The media support to bring biotechnology closer to the society is indeed lacking. From the interviews carried out with the scientists and NROs, there is a lack of understanding of the public attitude and interest as mentioned in the hypothesis.

Lévy-Leblond (1992) argued that "scientific understanding of publics" is just as important as "public understanding of science". Ireland et. al. (2007) said successful policies/responses will first have to aim at understanding what the community believes. An alignment of publics' trust, information preference and topics of interest is a necessary first step for developing an effective biotechnology communication strategy for Malaysia. Neglecting to identify the needs, interests and concerns of the primary stakeholders of publics in the biotechnology arena has been a major factor in the emergence of controversies (Kalaitzandonakes and Bijman, 2003; Sagar et. al., 2000). But it needs to go beyond that to increasing interest, awareness and engagement on biotechnology topics by maximising the impact of all media and communicators, framing topics to better align with public interests, and actively seeking to create more biotechnology-literate citizens through use of multiple channels and topics for multiple audience.

In conclusion, the results from this research convey that there is a breadth of activities on biotechnology communication taking place in the Malaysian biotechnology sphere but these are mostly carried out in an ad-hoc manner with no synergism among the

communicators. Moreover, these activities are carried out without the understanding of public attitudes and their influences that motivate them to take interest in biotechnology. None of the institutes in this research has carried out evaluation to measure the impact of their activities for further improvement. Malaysian biotechnology communicators still operate in the top-down model or the deficit model, in spite of the general agreement among science communicators that this model is inappropriate. The current communication flow is shown in Figure 7.0. Communication strategies employed by scientists and NROs heavily leans towards "teaching people biotech", instead of engaging them in a dialogue where public is considered as a partner of scientific enterprise. This is evident from the objectives of their communication programmes which are promotion of stakeholders' understanding on research at their institutes, encouraging youths to take up entrepreneurship related to the institutes' research area, informing students the career opportunities in the biotechnology sector, empowering general public with knowledge on biotechnology, and dispelling misinformation on biotechnology. Scientists and NROs need to find a common ground with mutual understanding which can synergistically build a powerful culture of biotechnology communication and public engagement.

Nevertheless, the efforts of these communicators and institutes are commendable in reaching out to almost all sectors of the publics, in spite of the lack of institutional direction (in the case of scientists), and many other limitations (lack of trained communicators, funding, and a national agenda). Moreover, when benchmarked with the USA and Singapore, Malaysia is ahead in terms of its efforts and strategies, and is on par with the UK and the Philippines.

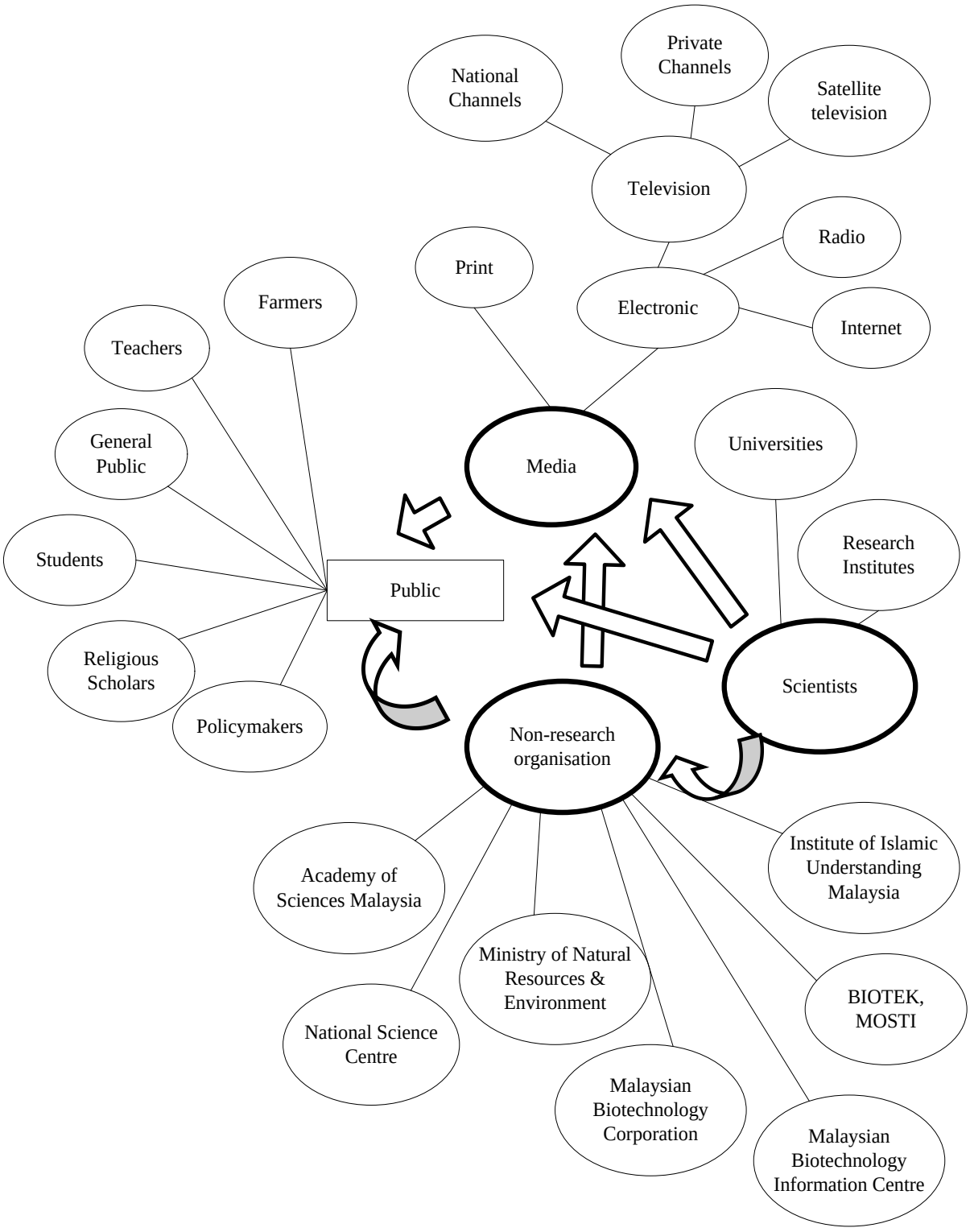

Figure 7.0: Current biotechnology communication flow in Malaysia

The constraints in engaging the public which were raised by scientists in this study were also addressed by Kyvik (2005). Kyvik acknowledged that scientists are expected to perform many tasks and roles to fulfil their obligations to their institutions. They undertake research and publish their results, teach and supervise students at various levels, participate in university administration and policy making, evaluate their researchers' work, and apply for external funding for research projects. Scientists' obligations towards the society is not compensated nor appreciated by the management of their institutes. All scientists in this study conduct public understanding of biotechnology activities on a voluntary basis. Thus, Malaysian scientists do play the role of "civic scientists" (see Clark and Illman, 2001; Greenwood and Riordan, 2001). However, biotechnology communication in Malaysia involves transmission of science from scientists to the public without taking into account the public voices. Communication is constructed as one-way transfer of information. This has been described by Gregory and Miller (1998) and Davies (2008) where one-way transfer of information is carried out with the assumption that this transfer of information will "educate" the audience.

NROs, undoubtedly play an important role in communicating biotechnology in spite of the lack of resources at their end. The target audience reached by scientists and NROs, basically covers a good spectrum of the publics. One common challenge among NROs and scientists is the obstacle they face in engaging with the media and getting media support. However, findings in this study showed that PAOs at research institutes understand the media culture and approaches to get media involved. Nevertheless, the disengagement of PAOs with biotechnology communication activities prevents them from providing their support to scientists in engaging the media. This area requires change in institutional policies.

7.2 PROPOSED BIOTECHNOLOGY COMMUNICATION FRAMEWORK FOR MALAYSIA

Taking into consideration all the constraints discussed above that are currently plaguing biotechnology communication initiatives in Malaysia, a robust and effective biotechnology communication framework should provide accurate, up-to-date, unbiased and substantive information and at the same time engage the public and make them part of the biotechnology ecosystem. Furthermore, it would utilise all media channels and avenues for a maximised impact, and ensure objectives of both communicators and audiences are met. This would eventually ensure the realisation of the country's aspiration to develop human capital for the biotechnology sector, a thriving biobusiness, public acceptance and appreciation of biotechnology. Based on the results from this research, it is recommended that Malaysia has a National Science Communication Policy. An overarching National Science Communication Policy where biotechnology communication could be a subset along with other disciplines of sciences and engineering, is best placed under Ministry of Science, Technology and Innovation (MOSTI). A national-level committee for biotechnology communication should be formed under the National Science Communication Policy which would implement the proposed framework in this thesis. The development and implementation of a National Science Communication Policy will see more scientists engaging with the public and in a more coherent manner. This has been the case in the UK where since the Wolfendale Committee (1995) concluded that scientists receiving public funding for their research have a duty to communicate their research to the public, there has been an impetus to increase the number of scientists engaging with the lay public (Poliakoff and Webb, 2007). Cormick (2011) reported that the underlying success factors of biotechnology communication initiatives in Australia are its coordinated and strategic approach.

In countries where public trust on government agencies is high, such as in Singapore and the USA, the need for public understanding of biotechnology and a framework at the national level might be lower. This is not the case for UK and other European countries. Hence, UK has a number of national strategies for communicating science. Another factor that determines the need for national initiatives is the presence of active anti-biotechnology NGOs. This is the case of the UK. Malaysia has a moderate level of activism, with the major opposition coming from consumer organisations and Third World Network, which is an international anti-biotechnology organisation based in Penang. The public survey conducted in this study showed that NGOs and government agencies have the same level of public trust (16.1%). Thus, a national level framework is important for Malaysia to build public trust on government agencies, which is key for public support towards biotechnology and government policies.

Furthermore, survey by the National Science Foundation (2006) showed science knowledge in the USA is not improving and has remained essentially unchanged since the 1990s. However, Eurobarometer (European Commission, 2005) showed that in most European countries, including the UK, there is a double-digit increase in science knowledge among the public between 1992 and 2005. This could be due to the various national science communication strategies, such as the Bodmer and Wolfendale reports in the UK. The two initiatives of European Commission (European Commission 2001a and 2001b): "Science and Society Action Plan" and "The European Governance", together with the Lisbon Agenda adopted in Europe in March 2000 (Wagner, 2007) also encouraged European countries to take up public participation programmes in science and government policies. These findings further support the justification of developing a national framework for biotechnology/science communication in Malaysia and the hypothesis that a national framework would increase public knowledge and acceptance towards biotechnology. Thus, combining the factors that drives public

knowledge and acceptance from the USA and the UK would be ideal for Malaysia – the trust factor from the USA and the national strategy from the UK. The Australian example is another model that justifies a national strategy in communicating biotechnology (Inspiring Australia, 2010; and Craig, 2011), where a coordinated effort is seen to be more impactful.

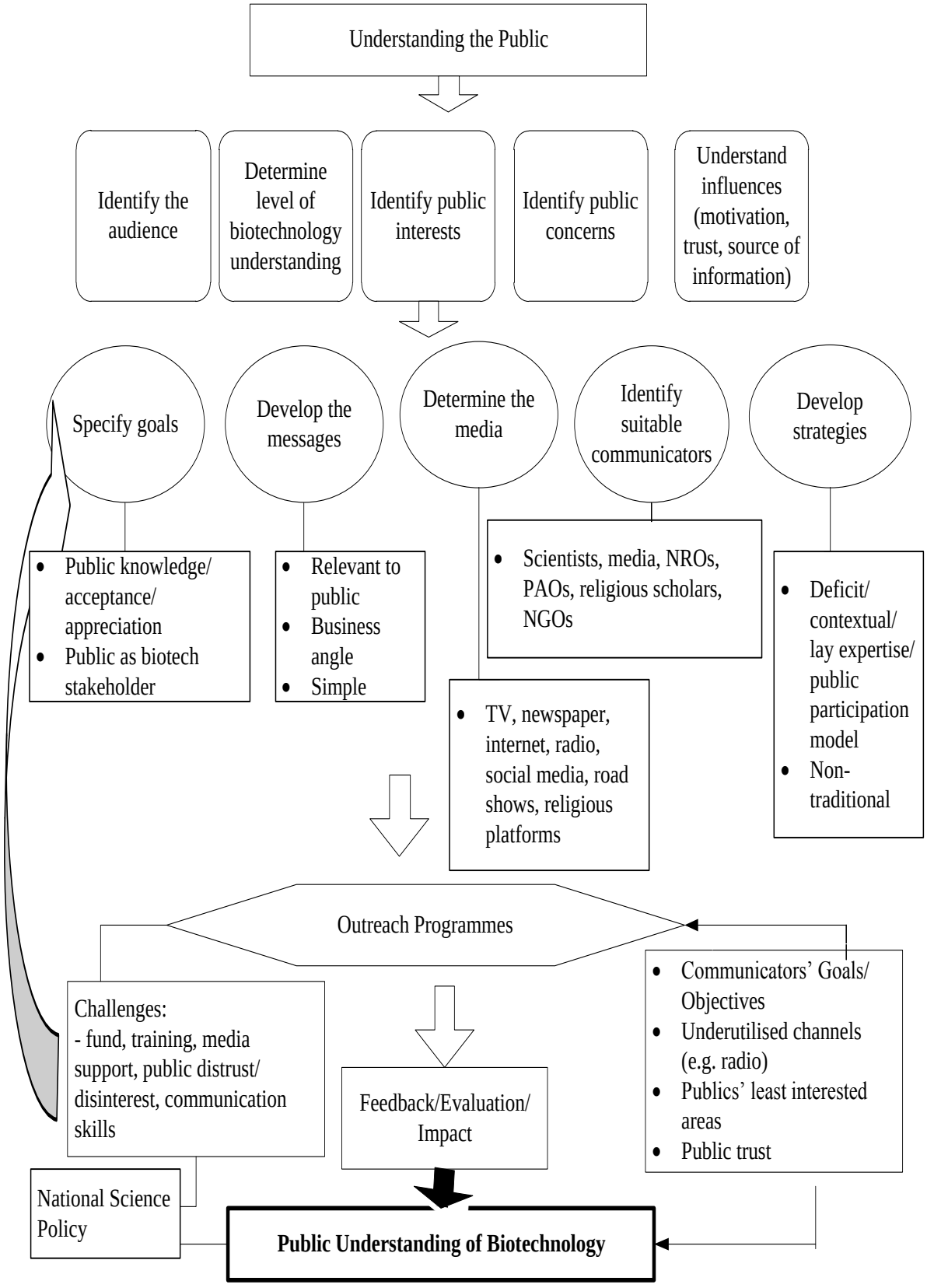

Figure 7.1: Proposed Biotechnology Communication Framework for Malaysia

The proposed biotechnology communication framework (Figure 7.1) is supplemented with the analysis of the issues and challenges, and strategies to overcome the challenges based on the outcome of this research in Table 7.0 and Table 7.0a. Coupled with the recommendations given in this section, the proposed framework will most likely create a dynamic biotechnology communication matrix for Malaysia. All these could be implemented under the National Science Communication Policy. Figure 7.1 is a schematic diagram of science communication framework based on the results and data obtained in this research.

Figure 7.1 illustrates that "Public Understanding of Biotechnology" starts with "Understanding the Public". A number of previous studies stressed the need to understand the public and answer the questions of why, under which conditions, and in which form the general public assimilates scientific background information (Falk et. al., 2007; Wagner, Miller, 2004; 2007). Identifying an appropriate communication model is important for Malaysian context based on the government policies, aspiration and also public attitudes. Bodmer Report (1985) stated that the public is suffering from a deficit of science knowledge, but it must be acknowledged that scientists are also suffering from a deficit of societal empathy (Ireland, et. al. 2007). Nevertheless, as stressed by Sturgis and Allum (2004), the deficit model cannot be completely scrapped from biotechnology communication strategies. Matterson (2006) in Wellcome Trust's report on "Engaging Science: Thoughts, Deeds, Analysis and Action" said in rejecting the deficit model forcefully, a narrow view of public engagement ignores the clear public appetite for science, the thrill of scientific discovery, as well as the way it can aid people in their lives, where individuals can benefit significantly from an awareness of emerging medical opportunities, and of risk and safety. A combination of models will work best for a heterogeneous society with different needs.

Thus, the proposed framework starts with the tasks of identifying the key audiences or stakeholders, their level of understanding of biotechnology, areas of interests, their concerns, and the factors that influences their behavior and attitude towards biotechnology and understanding this subject (sources of information, motivation to understand biotechnology, and trusted sources of information). The key information about the public/audiences/stakeholders would then be the deciding or the influencing factors for biotechnology communicators to decide on their media or channels of communication, the objectives of their outreach programmes, messages and strategies to be developed, and identifying suitable spokesperson or communicators. These would then lead to the outreach programme that would be more relevant, attractive and beneficial for the public that would meet audiences' preferences. Falk et. al. (2007) argued that the key to success in public science education depends upon achieving a more accurate understanding of the where, when, how, why, and with whom public learn science, across their lifespan and the myriad settings in which they learn science. By more deeply understanding where, how, when, why and with whom the public comes to learn science, science educators should be able to become more strategic, and able to leverage limited resources and access by actively building upon the public's existing science and technology learning needs and interest. This argument supports the proposed framework.

The results in this study showed only 30.7 per cent of the general public polled understood biotechnology enough to explain it to a friend, whereas 50 per cent has little understanding, and 19.2 per cent with no understanding. The heterogeneity of this population merits the deficit model, but with a combination of contextual model, and where appropriate the lay expertise and public participation models. However, the latter two models have to be employed with cautious as they can be used by anti-science communicators (Lewenstein, 2003). Nevertheless, there are instances where the public

participation model might be appropriate, for example in the case of the Ministry of Natural Resources and Environment which has the obligation to promote and facilitate public awareness and public participation regarding activities related to the protocol and products of modern biotechnology (Secretariat of the Convention on Biological Diversity, 2000). The appropriate model can only be identified after identifying the audience, determining their level of biotechnology understanding, identifying their interests and concerns, and influences that motivate them to understand biotechnology. There is no one-size-fit-all approach in communicating biotechnology, as each target audience has their own needs and concerns. The complementarity of the various models should be examined based on the audiences, and how these models could combine to create an innovative form of communication.

Jolly (2005) distinguishes between the following types of public participation:

1. Informing: providing information to various publics (pamphlets, websites)
2. Consulting: taking feedback from the publics and decision makers
3. Involving: supporting articulation of views from the public, giving influence to the public or giving power to the public

The above types of public participation would suit the Malaysian context, given that a large sector of the general public (50%) has low understanding of biotechnology. Providing information would suit this sector of the public. The ability to participate in government policies and provide input to the government was the second least motivation for Malaysian public to understand biotechnology based on the results from this study. The consulting and involving component of Joly's proposal may encourage more citizens to be involved in this area, as this is of paramount importance for a country like Malaysia with the myriad policies related to biotechnology. All the components as proposed by Joly require a combination of deficit, contextual, public

participation and lay expertise model. Thus, this study concurs with Sturgis and Allum (2004) and Matterson (2006) that the deficit model cannot be completely scrapped, but should be complementary to the other newer models.

Once a suitable communication model, combining all models is developed after scrutinising and understanding the target audiences, communication goals need to be specified. The motivation for most Malaysian publics (with a mean of 7.7343) to understand biotechnology is to be able to make well-informed decisions on nutrition, medical needs, and environmental care. Inculcating interest on biotechnology among the children (a mean of 6.7139) and to develop the ability to participate in government policies and direction (a mean of 6.5456) came second and third. These motivation is, however, very instrumental to support the country's agenda towards developing biotechnology. The relationship between science and policy has become a topic of public debate and social conflict (Lujan and Todt, (2007), where most of the controversy has centred on the role of scientific knowledge in regulatory decision making (Jasanoff, 1990; Raffensperger and Tickner, 1999; and Tesh, 2000). Therefore, these goals should be built in communication strategies and initiatives, in fact, giving more prominence in getting the public to participate in government policies and direction, as it requires more efforts to influence the public in areas that are of least interest to them. Another key area that cannot be neglected is instilling interest among the public to venture into biobusiness (a mean of 1.2382). Involvement in public policies and biobusiness requires knowledge-based society and this draws similarity to the Lisbon Agenda in March 2000, where the European Union strived to develop a knowledge-based populace (Wagner, 2007). This strategic goal which was set for Europe in 2010 intended to create a knowledge-based society that could integrate all instruments available for knowledge acquisition in a scheme that is accessible to all members of society to easily locate scientific evidence to inform their political, business

and other decisions. The similarity between Malaysian policies and government aspirations to the European Union further strengthens the need for a framework to coordinate biotechnology communication initiatives.

For Malaysia, a good comparison could be drawn from Falk et. al. (2007)'s observation – science literacy is considered an essential component of a democratic society, supporting a modern, technology-based economy and promoting the cultural values of the society. These authors believed that a scientifically literate public is more apt to understand public policy discussions based on science, and consequently will support the most rational policies that emerge from public discourse on the issue. A science-literate public is also believed to create a culture of science and technology learning that leads to students choosing careers in science and technology for the benefit of businesses and the economy in general. The two initiatives of European Commission (European Commission 2001a and 2001b): Science and Society Action Plan and The European Governance that encourages public participation in government policies are good examples for Malaysia. It is important to note that among scientists and NROs who are involved in biotechnology communication, who were interviewed in this study, relatively little explicit attention is given to enable citizen participation in government policies. This objective was not mentioned by the scientists and NROs in this study. Looking at the UK situation where an eroded public trust could hamper the development of modern biotechnology, there is a strong need for Malaysia to strengthen its biotechnology communication strategy. The implementation of the proposed framework in this thesis is expected to yield these desirable goals and important outcomes, which are complementary to Malaysian biotechnology-related policies. Public participation is of utmost importance as the public is on one of the key stakeholders in the biotechnology ecosystem.

To support the above goals, appropriate messages should be developed. Messages would highly be dependent on communication goals and to develop the messages the distinct public behaviour in terms of areas of interest, sources of information and motivation to understand biotechnology should be understood. These elements could be used as "hooks" to get public attention, and the least preferred choices should not be neglected. For example, agricultural and industrial biotechnology were least preferred areas by Malaysian publics, however, communication strategies need to go beyond this as not to neglect any sector of the public and also to ensure all areas of biotechnology gets public support and attention. Falk et. al. (2007) suggested that rather than framing efforts in communicating science, offering the public opportunities for engaging with, appreciating and better understanding the science of interest and need to them would be more effective. This approach leans more towards contextual model, which would be appropriate to understand why public has disinterest towards certain areas of biotechnology. A two-way interaction is more likely to provide insight for communicators on ways to engage the public in areas such as agricultural and industrial biotechnology, as learning is driven by each individual's need to know.

Identifying the suitable media is another crucial step in any communication strategies. Public acquire information on biotechnology from a wide range of information sources: newspapers, television, internet, family and friends (Besley and Shanahan, 2005), science centres and museums (Ten Eyck, 2005), and leisure and non-formal activities (Anderson et. al., 2000; Falk, 2002; and Falk and Dierking, 1992). This provides a number of options for communicators, however, the media would depend on the target audiences. Findings from this study showed that television, internet and newspapers are the popular media among Malaysian publics. Nevertheless, both NROs and scientists face obstacles in working with the media. There is clearly a lack of ability among

scientists and the NROs in this area. This has to be addressed as media is one of the most trusted biotechnology information sources as revealed by the public survey in this research. One way to advance a solution for this could be working with PAOs who have good understand about media framing and aligning research news to suit media needs and also public interest. Training scientists in the area of scientific journalism and in handling the media would addressed this problem as scientists who are have confident with the media are more likely to be involved with public understanding of science activities (Wellcome Trust, 2000 and Weigold, 2001). Pearson (2001) also reported similar observation based on initiatives taken by CoPUS on media workshops for scientists. This is an important area for Malaysia and could be supported by PAOs at universities and research institutes.

As mentioned in Chapter 4, radio is an underutilised media and has vast potential in communication strategies in Malaysia (Nielsen's Radio Audience Measurement, 2011). Choice of media should not be limited to what is currently being used or what is currently popular among the publics. The potential of alternative media should be explored, such as social media and the internet. The use of multiple channels would have greater effectiveness and it would also reach diverse audiences (Field and Powell, 2001). As mentioned in Chapter 4, Nielsen Mobile Insight Malaysia 2010 report showed internet usage in Malaysia increased from 25 per cent in 2011 to 41 per cent in 2012, making this an effective media to disseminate biotechnology information. However, further studies are needed to see how the attention of these captive users could be turned to news on biotechnology. Social media could be one of the solutions. In the USA, the internet is one of the preferred sources when people are seeking information about scientific issues, where a study by National Science Foundation

(2006) in 2004 found that 52 per cent of survey respondents named internet as the place they would go to learn about biotechnology.

Another avenue for engaging with the public is the use of civil society platforms, such as religious classes. This was discussed in Chapter 4, where the religious scholars interviewed in this study showed interest in participating in biotechnology communication initiatives. A number of NGOs and dharma talks could be engaged and this provides audiences from all walks of life. This avenue would be of particular interest and is worthy for exploration as religions are major part of Malaysians' lifestyle. Furthermore, involving religious scholars in biotechnology communication initiatives would add credibility and public trust as religious scholars are highly trusted among Malaysian population (Sobian and Abdul Rahman, 2003), especially in areas related to bioethics. Establishing public trust is one of the key principles for successful public engagement (Cormick, 2011 and Priest, 2001).

In short, there are unlimited choices of media for biotechnology communicators. These media and avenues could be maximised with good collaboration between scientists, NROs and PAOs. Since television emerged as the most popular source of information for Malaysian public according to this study, efforts should be strengthen to utilise this media. In fact, research by the National Science Foundation (2006) found that in the USA and Canada, adults pick up information on science primarily from watching television, including educational and nonfiction programmes, newscasts and newsmagazines, and even entertainment programmes. Malaysian biotechnology communicators could learn from this experience and forge a strong working relationship with television channels.

Findings from this study also showed that MyBio Carnival was a popular and effective modality to engage with the public. A survey conducted by Falk et. al. (2007) in California among its residents found that nearly half (43%) of the public's self-reported science understanding derives from leisure time and free-choice learning. Growing evidence supports the assertion that science learning occurs through civic organisations and active leisure-pursuits (Anderson et. al., 2000; Falk, 2002; and Falk and Dierking, 1992). Thus, bringing biotechnology to shopping malls and other public space such as science centres, and museums may yield better results in raising biotechnology awareness and appreciation among the public. These approaches should be considered when determining the media and developing the communication strategies. Nevertheless, this can only be done after carefully considering or understanding the audience, their interests, concerns and influences as shown in the schematic diagram.

Identifying key communicators is equally crucial after determining the goals, messages and media. According to Cormick (2011), establishing a strong partner network is one of the key principles in public engagement. Not only this minimises duplication, but also provides a pool of communicators with different strengths, credibility and expertise. Navarro and Hautea (2011) stressed the need to identify and nurture, from different stakeholder groups (policymakers, scientists, academics, regulators and media), champions who are well-informed, have high credibility in the community and are willing to advance the cause of the technology. According to the findings in this study, a majority of Malaysian publics (64%) see media as the most credible source of information, followed by scientists (36.1%), and then NGO and government (16.1%). This makes media the most suitable communicator or mediator, however, it is beyond their duty to be involved in biotechnology communication initiative. Nevertheless, if scientists and NROs are able to forge a good working relationship with the media, it is

highly likely that media would be a partner to this initiative. This was seen in the Philippines when Bt corn was first introduced in 2000s (Panapio and Navarro, 2011). Brossard and Shanahan (2007) suggested that media plays the role of a facilitator in raising and debating conflicting issues which leads to public discussion and (science) democratisation.

All the above parameters (communication goals, media, messages, and communicators) help in developing an appropriate strategy to achieve biotechnology communication objectives. Needless to say, it is a challenging task to change public attitude, but proper media framing, innovative outreach programmes, the right champions as "biotechnology ambassador" could achieve this. The challenge to those charged with public science education is to design and implement effective methods of explaining ongoing research to the layperson that will attract and hold their attention and to find channels of communication that are readily accessible to the lay public (Field and Powell, 2001). The public is a heterogeneous group, each with its own needs, interests, attitudes and level of knowledge (Burns, et. al. 2003). This is also coupled with the heterogeneity of biotechnology communicators as discussed in Chapter 4 who has individual objectives and agenda in engaging the public. Therefore, the challenge in developing communication strategies is that there is no one-size-fit-all model.

Finally, any communication programme has to fulfill the objectives of the communicating parties. These objectives as stated by the scientists and NROs interviewed could be: public acceptance towards their research, human capital development for the bioindustry, creating public awareness on biotechnology, branding their institutes, commercialisation of their research, or dispel misinformation about biotechnology. All these should be incorporated in the outreach programme

appropriately to suit the audiences. It is obvious that one single outreach programme cannot have a combination of all "wish lists", therefore it is important that biotechnology outreach programme is a continuous effort by the communicators.

Finally, the communication programmes have to be evaluated through feedback received from the public and these feedbacks should be used to improve future programmes. The impact of the programmes could be evaluated based on criteria such as: personal fulfillment and satisfaction, opportunity to discuss biotechnology and provide their input, level of understanding after participation, level of technology acceptance, ability to make science-based decisions, ability to differentiate science and pseudo-science, and interest in biobusiness and government policies.

The framework proposed here is driven by the needs of the audience and communicators, therefore, it is expected to meet the expectation of both parties for their mutual benefits and to meet the nation's goals. It would enable communicators to coordinate and collaborate among themselves so there is synergism in the strategies and messages, and expose public to biotechnology through multiple venues and media.

Table 7.0: Issues, Challenges, Proposed Media and Strategies in Communicating Biotechnology

Issues/Challenges	**Communicators**	**Proposed Media/Avenue**	**Strategies**
Lack of time, fund, incentive	Scientists	Government Institute	• National Science Communication Policy • Institutional priority on Public Understanding of Biotechnology • Portion of research grants is allocated to Public Understanding of Biotechnology
Lack of media support	Scientists	Media/PAOs	• Collaboration with PAOs • Training for scientists on handling media, repackaging research news, identifying the salient point in their research, making research relevant to the public • Media-scientists dialogues and workshops
Inability to translate research into laymen language	Scientists	Institute	• Training scientists (as above) • Hiring of science writers at universities and research institutes • Capacity building to develop a cadre of science communicators • PAOs to support scientists' initiative in public engagement
Public disinterest on biotechnology and low level of understanding	Scientists/ NROs /Media	• Use of media preferred by the public (TV, newspaper, internet) • Non-traditional approach (e.g. carnival)	• Proactive role by mass media in giving more prominence to biotechnology and making it an interesting read or show • Framing topics to suit public interest • Road shows, bringing biotechnology to public places, e.g. malls • Exploit the underutilised media, e.g. radio • Use of multiple channels of communication tools

Table 7.0a: Issues, Challenges, Proposed Media and Strategies in Communicating Biotechnology

Issues/Challenges	**Communicators**	**Proposed Media/Avenue**	**Strategies**
Lack of funding	NROs	• Government	• Allocation of funding for biotechnology outreach programmes under the National Science Communication Policy
Inability of journalists to write biotechnology articles	Media	• Media/Scientists	• Creation of science desk at all newspapers • Hiring of journalists with science background • Media workshops on biotechnology • Science writers and PAOs at universities and research institutes to translate research work into journalistic articles
Lack of biotechnology news in the media	Media	• Media/Scientists	• Creation of science desk at all newspapers • Hiring of journalists with science background • Media workshops on biotechnology • Scientists to be media-savvy and attract media to their research with the appropriate story angle
Ethical and religious concerns	Scientists/NROs	• Religious scholars • Religious affiliations under MCCBCHST and Islamic agencies	• Collaborate with religious scholars to reach to the public • Dialogues between scientists and religious scholars • Work with social scientists
Gaining public trust	Media/ Scientists/ NROs	• Media • Scientists	• Engage the media as it is the most trusted source • Use scientists as champions/spokesperson as they are also trusted by the public
Public's disinterest in certain areas of biotechnology (agri/industrial)	Scientists/NROs	• Media • Scientists	• Explain the relevance/impact of these areas to everyday live
Public's disinterest in policies and business issues	Scientists/NROs	• Media • Scientists	• Explain the benefits to the public • Public's role to ensure taxpayers money is well spend

The following are recommendations to complement the proposed Biotechnology Communication Framework, which would help in its implementation:

1. Biotechnology communication at research institutes could be more effective if there is more support from PAOs. The responses from PAOs and journalists in this research showed there is considerable consensus between journalists and PAOs on how to repackage biotechnology information for public consumption. However, scientists are struggling on their own to get media attention. There is clear divide between PAOs and scientists and this has to be resolved and it is likely only to happen if public understanding of biotechnology is made one of the priorities at institutional level.
2. Treise and Weigold (2002) reported that science writers are at the critical intersection of the practice of science and public understanding of science. And as scientists interviewed in this research have shown interest to be trained, a two-pronged strategy could be adopted at research institutes and universities. Employing science writers and training selected scientists who have interest in communicating biotechnology to the laymen in this field could bring biotechnology closer to the public. Duke (2002) observed that many research universities, private research organisations, government organisations, pharmaceuticals companies, non-profit health associations, and public relations firms hire science communication specialists, trained in both science and journalism, to accomplish the goal of generating public visibility and mass media interest. Navarro and Hautea (2011) in summarising the Asia Pacific experiences in communicating crop biotechnology emphasised the need for a new breed of science communicators be trained and complement existing

personnel to build a critical mass dedicated to sustaining communication activities and programmes.

3. In Europe and USA, popularisation of science gained importance in the twentieth century enhanced by a growing number of science journalists (Kyvik, 2005). However, science journalism is not a popular field in Malaysia. In fact only one university (Universiti Sains Malaysia) offers science journalism and that too in the area of environmental journalism. Degree programmes or post-graduate programmes in science journalism would create trained science writers who in turn could be employed at research institutes, universities and biotechnology companies. Currently, science communication is not part of biotechnology or life science programmes. Only the private universities, namely Taylor's University, Monash University, and Nottingham University offer a module in science communication for their undergraduates. Navarro and Hautea (2011) pointed out that the development of a cadre of science communicators equipped with the theory and skills of biotechnology communication to an array of stakeholders is crucial.
4. Use of multiple media channels to reach to diverse audiences. As human society is growing increasingly dependent on technologies, the number of communication channels binding science and society is also growing (Shults, 2008). Diverse audiences are best reached by a range of different communicators through coordinated efforts. This type of coordinated effort will increase the likelihood that those who only attend to a single venue will be reached. More importantly, it will provide those who attend more than one venue a much deeper understanding of the scope and depth of the subject (Field and Powell, 2001). This could only be done if there is a coordinating movement and is best done under the National Science Communication Policy.

5. Underutilised means of communication such as the radio has huge potential to become a popular biotechnology communication tool (see Nielsen's Radio Audience Measurement, 2011; and Brecht 1979/80). Communication strategies should transform this channel into an effective communication media. Effectiveness of the other communication system such as the science centres should also be enhanced.
6. Communication strategies should include all areas of biotechnology, in particular those emphasised by the government such as agriculture and industrial biotechnology. This is crucial to get public support and develop the necessary human capital required for these sectors. New approaches should be employed to communicate areas of least interest to the public. The reason for identifying these areas is not to neglect them but to enhance the strategies used to ensure public interest is raised and retained.
7. It is imperative that biotechnology communication framework involves a wide range of experts, not only from natural sciences, but also from education, social sciences and humanities. This is crucial as biotechnology impinges on socioeconomic, ethics and religious values.
8. Unlike the current communication practice by scientists and NROs which is driven by their institutions' desires about what the public should know, a good communication programme should be driven by a desire to meet audience needs and interests. A panel established in 1998 by the Space Sciences Laboratory of NASA's George C. Marshall Space Flight Centre recommended similar approach (Borchelt, 2001). This would lead to a more transparent and open-dialogue approach.
9. Special funding should be made available for public understanding of biotechnology. The UK model (HMSO, 1993; and Wolfendale, 1995) could be

emulated where a portion of research grants is allocated for engagement with the public, and research proposal should include biotechnology communication plans. This would lead to more scientists involved in biotechnology communication as reported by Pearson (2001).

10. Finally, the communication model used should be able to accomplish a number of objectives: defend and market science and technology (to get public support, acceptance, and promote careers in science); contextual (take into account the diversity of publics and of the way their experiences and perceptions shape their reception of information); consultation (public opinions are sought); engagement (how public express concerns, raise questions and become actively involved); and deliberation (calls on a wider set of understandings about democratic processes, in which the public contributions about the 'why' and 'why not' of science help set the agenda for communication) (Trench, 2008).

The proposed framework, strategy and recommendation could use a combination of science communication models. Although the deficit model is said to be an obsolete approach, Miller (2001) warned that the end of deficit model does not mean there is no knowledge deficit. A combination of models would work best for Malaysia where the public could be "educated" and at the same time be consulted and engaged using the contextual approach. Since religions play an important part in the decision-making process for Malaysians, the lay expertise and public participation model could also be used appropriately. Trench (2008) stated that communications models often perceived to be opposed can, in fact, coexist when choices are made explicit. Thus, a combination of deficit and contextual model at large would be the most appropriate for most audiences.

The framework, strategies and recommendations proposed in this thesis would form a robust, dynamic and public-oriented biotechnology communication matrix for Malaysia. It would address the plurality of the public, their concerns, and utilise a wide variety of communication channels, and establish dialogues between scientists, policymakers, media, the general public, and religious scholars. This would eventually make public an integral part of science and science policies.

7.3 PROPOSED HYPOTHESIS

While it is not possible to provide definitive argument that a national framework would result in biotechnology-literate society, support human capital development, raise public trust and acceptance towards biotechnology, and create citizens who could participate in public policy and discussions, a number of findings (Craig, 2011; Pearson, 2001; Wellcome Trust, 2000; and Wolfendale, 1995) show that a coherent science/biotechnology communication strategy at the national level would play a role towards these goals. This thesis proposes a hypothesis that a national framework would contribute positively towards the above objectives. It is, therefore, recommended that an evaluation is carried out two years after the implementation of the proposed framework to measure its effectiveness and impact in terms of level of public understanding of biotechnology, number of scientists involved, involvement of PAOs, number of trainings on biotechnology communication, and number of institutes involved. This is similar to the evaluations carried out in the UK after Bodmer and Wolfendale reports were implemented. The evaluation would also lead to further improvisation to the framework.

In summary the proposed framework for national biotechnology communication strategy is expected to achieve the following through its implementation:

1. Increased level of biotechnology literacy among the public
2. A more active engagement of scientists with the public
3. A more productive engagement between media and scientists which would translate into more media coverage on biotechnology
4. A more active role played by PAOs in mediating the engagement between scientists and media; and scientists and the public
5. Increased public acceptance towards emerging technologies in life sciences
6. Support human capital development by encouraging more young people to pursue science and consider careers in biotechnology
7. Encourage citizen participation in policy directions of the country

The above parameters could be used to evaluate the impact of the strategy after two years of implementation.

7.4 SUGGESTIONS FOR FUTURE STUDIES

Since this research covered a broad-spectrum of biotechnology communication in Malaysia, and provided the baseline information on biotechnology communicators, their strategies and also on the Malaysian public attitudes and influences, further research could be undertaken in each area to narrow down the issues at the level of individual components for more in-depth research. Some areas that merit further research and that would help elevate the proposal made in this thesis are:

1. Media's role in shaping public attitude, opinion and interest in biotechnology in Malaysia
2. An evaluation to measure the success and impact of current biotechnology communication efforts in enhancing public understanding of biotechnology
3. A large scale survey on scientists' attitude towards biotechnology communication and their understanding of the public
4. Drivers of public concerns, factors that influence public acceptance, interests, and choice of information source.
5. The impact of internet in public understanding of biotechnology and how it could be best utilised