



Adaptability of the mental models approach to the development of risk communication messages on climate change for rice farmers in Pangasinan Province, Philippines

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Abstract

The mental models approach has been put forward as a method for investigating laypeople's knowledge, beliefs, and perception as precursor to the development of risk communication messages and strategies. Using means-ends analysis, the paper assessed the adaptability of the mental models approach to the development of risk communication messages on climate change for rice farmers in a village in the province of Pangasinan. Overall, the mental models approach was adaptable as it made possible the systematic and in-depth elicitation of relevant knowledge and beliefs on climate change of both the experts and rice farmers, as argued by its proponents. Likewise, the mental models interviews provided an opportunity for a candid discussion with rice farmer-respondents. It also facilitated the identification of knowledge gaps and misconceptions, paving the way for a focused climate change risk communications. Insights on how the adaptability of the approach may be enhanced were discussed. Among these are the need to ensure that the richness and complexity of interviews with experts and laypeople would still guide climate change communication; the importance of an interdisciplinary team in crafting climate change risk communications; and the possibilities opened up by *Sikolohiyang Pilipino* (Filipino Psychology) or SP methods for more culturally appropriate and sensitive elicitation methods in the mental models approach.

Keywords: Mental models approach · *Sikolohiyang Pilipino* (Filipino Psychology) · climate change · rice farmers

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Introduction

Rice or *palay* is an important major crop in the Philippines, known as the 8th biggest producer and 8th largest consumer of rice in the world (Department of Agriculture [DA], 2012). As a staple food, rice provides 30-50% of Filipinos' total calorie intake (Dawane et al., 2010). Accordingly, rice is grown on 44.60% of agricultural farms in the Philippines in 2002 (Philippine Statistics Authority [PSA], 2014). Over two million households in the Philippines depend on rice farming as a source of livelihood (DA, 2012).

Rice production is facing a grave threat from the impacts of a changing climate. The United Nations Development Program (2006) identified agriculture, where rice production is an important sub-sector, as one of the sectors that will bear the brunt of dangerous climate change risks. Particularly, rice is sensitive to high temperature, floods, drought spells, and salinity—conditions that are aggravated under climate change (Mohanty et al., 2013). Climate change is expected to increase temperature and frequency of droughts and flooding, which will have negative impacts on yields (Mohanty et al., 2013).

Moreover, the Water for Food, Water for Life Issue Brief No. 5 recognized that the “challenge for rice cultivation in the next 50 years is to feed more people, while keeping prices low to benefit poor rice consumers and reducing production costs to benefit poor growers”. It was furthered that this move is vital for poverty reduction in areas where rice is the staple food such as in the Philippines. To meet this challenge, rice cultivation will have to adapt to water scarcity, drought, flooding, salinity and climate change (Carriger, 2007).

The effectiveness of government policies and programs to climate change adaptation and risk management depends in part on stakeholders' values, beliefs, and perceptions on climate change issues. Public perception on climate change largely influences their support or opposition to government policy and/or action (Leiserowitz, 2005; McCright et al., 2013; Sterman, 2011). Further, Lorenzoni & Pidgeon (2006) underscored the importance of taking into consideration the public's views and beliefs, as they are the ones who will be affected by climate policies and programs. As such, the public's risk perception plays a crucial role to climate change adaptation and risk management.

As part of risk management, one method of analyzing risk perception as a precursor to the development of risk communication messages and strategies is the mental models approach. Rooted in cognitive science and cognitive psychology, mental models are “psychological representations of real or hypothetical situations” (Zaksek, 2004, p.1504). Various mental models approaches have been put forward (Bostrom et al., 1992; Lazo et al., 2000; Morgan et al., 2002; Sterman & Sweeney, 2007). Essentially, these approaches involve the elicitation of both expert and layperson mental models; comparison of these models; integration of findings about these models in the planning and development of communication interventions; and evaluation of interventions.

The mental models approach to risk communication has been applied in drugs, vaccines, breast implants, sexually transmitted diseases, human immunodeficiency virus /acquired immunodeficiency syndrome (HIV/AIDS), injury prevention, hazardous chemicals,

radon in homes, power-frequency electric and magnetic fields, nuclear energy sources on spacecraft, wildfires, flashfloods, landslides, and climate change, among others, with more studies on health risks in the context of the environment (Austin & Fischhoff, 2012; Vogt & Shaefer, 2012; Wagner, 2007).

Past studies point to the usefulness of the mental models approach to risk communication; however, studies also point to areas that need further consideration (Bostrom et al., 1992; Cox et al., 2003; Fischhoff, 1995; Morgan et al., 2002; Niewöhner et al., 2004; Skarlatidou et al., 2012; Vogt & Shaefer, 2012; Zaksek & Arvai, 2004). For instance, according to Cox et al. (2003), the method used in developing the expert influence diagrams unavoidably leads to the loss of the complexity of expert accounts. Niewöhner et al. (2004) stated the importance of validating the expert models through logical soundness and inter-subjective (expert) agreement. Bostrom et al. (1992) also raised the labor intensiveness of open-ended interviews but noted that they were effective in identifying misconceptions. There are also differing perspectives as to which mental models, that of the experts or laypeople, would be used as basis for analysis (Cox et al., 2003; Morgan et al., 2002).

Likewise, most studies dealt with eliciting and creating expert and laypeople's mental models; developing risk communications; and evaluating these communication interventions (Skarlatidou et al., 2012; Wood et al., 2011).

As the mental models approach offers a systematic and evidence-based method for determining what people know and need to know about risks, there is a need to explore its adaptability, especially since few studies solely focus on an assessment of the approach and studies on the mental models approach have been predominantly oriented in the context of Western countries.

As such, this paper aims to assess the adaptability of the mental models approach to the development of risk communication messages on climate change for rice farmers in a village in Pangasinan Province, Philippines. Specifically, the paper explores the prospects and constraints of the mental models approach and recommends ways on how the mental models approach to risk communication may be taken forward.

Theoretical Considerations

Through the years, risk communication practice has developed from pre-risk communication stage wherein the public is largely ignored to a stage wherein the public is treated as partners. According to Strydom (2002), “from restricted and exclusive expert ethos of risk calculation and assessment, risk discourse shifted to a more open ethos of wide-ranging participation in the discursive construction of risk through public communication” (p.34). A corollary of these developments is intensified efforts to communicate to the public about risks as a part of risk management.

Understanding how people perceive risks is a necessary step towards the public becoming partners in risk communication, and ultimately, in risk management. Efforts to understand the dynamics of risk perception are vital to effective risk communication about hazards (Löfstedt & Frewer, 1998) as results of risk perception studies are fed into risk communication programs. However, failure

of various risk communication initiatives has prompted the need to take a closer look at the nature and dynamics of risk perception, with stakeholders' mental models as one of the conceptual angles identified (Löfstedt & Frewer, 1998).

Mental models are cognitive representations that people use as a basis for making decisions. Similarly, Stermann and Sweeney (2007) stated that mental models have been defined as "domain knowledge, typologies for categorizing experience, and heuristics for judgment and decision-making, among others" (p.215). Proponents of the theory of mental models argue that people understand a phenomenon using a 'working model' of that phenomenon in their minds (Johnson-Laird, 1983, 2004, 2006). People use these "working models" or mental models as frameworks for decision-making and action.

Bostrom et al. (1992) developed a mental models approach composed of the following steps: a) creation of an expert influence diagram; b) elicitation of laypeople's relevant beliefs; c) mapping of these beliefs into the diagram; and d) identification of gaps and misconceptions. Meanwhile, Morgan et al. (2002) went further by developing a five-step method for creating and testing risk messages based on the mental models approach: a) creation of the expert model using an influence diagram; b) elicitation of laypeople's mental models; c) creation of confirmatory questionnaire; d) development of communication intervention; and e) evaluation of communication intervention. Essentially, the mental models approach to risk communication entails eliciting expert's models and laypeople's mental models; comparing these models to identify gaps and misconceptions; determining the prevalence of these to the population; and developing and evaluating communication interventions (Austin & Fischhoff, 2012).

Methodology

The mental models approach to risk communication was evaluated using the means-ends analysis. Dale (2004) espouses the means-ends analysis in evaluation under the context of development work and identified the following components of the means-ends structure: 1) inputs or the planned resource allocation; 2) implementation tasks or the planned work tasks; 3) outputs or the direct outcome of the work; and 4) benefits.

This paper focused the assessment on the inputs and implementation tasks of the means-ends structure of the mental models approach as applied in the development of risk messages on climate change for rice farmers in a village in Pangasinan Province, Philippines (Figure 1). The inputs included experts' and rice farmers' knowledge and beliefs on climate change and logistics such as orientation of interviewers in mental models interviews. The implementation tasks included: 1) creation of the experts' model of climate change; 2) elicitation of rice farmers' mental models of climate change; 3) comparison of the rice farmers' mental models and experts' model of climate change; and 4) identification of points of convergence and divergence between the rice farmers' mental models and experts' model.

Adaptability was explored by analyzing the prospects and constraints in the inputs and implementation tasks, excluding the outputs, of the means-ends structure of the mental models approach. Prospects and constraints referred to potentials and limitations, respectively,

of the mental models approach used in generating risk messages on climate change for rice farmers.

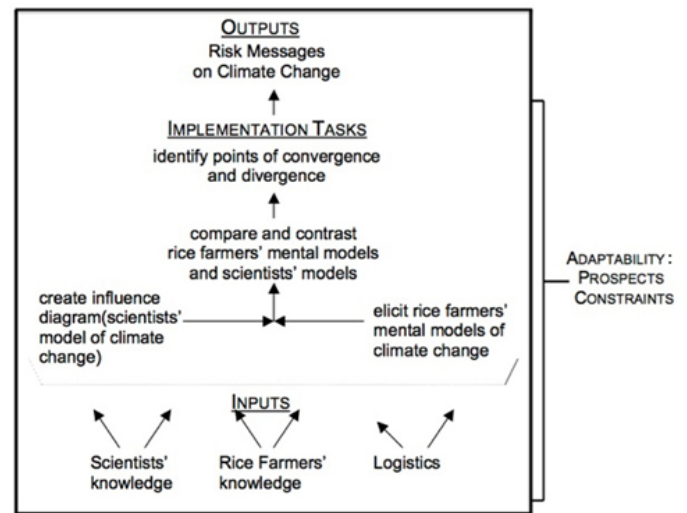


Figure 1. Means-ends structure of the mental models approach to risk communication

Moreover, the case study research design was employed, focusing on the evaluation of the mental models approach as it was applied in the development of climate change risk messages for farmers in a village in Pangasinan Province, Philippines. Corollary to this, in terms of scope, this paper did not dwell on a discussion of the experts' model, laypeople's mental models, and risk messages on climate change, although a general description was provided (See Francisco & Tirol, 2010 for a more detailed discussion of these models and the risk messages).

Results and Discussion

Communicating about risks is unique in the sense that one should be mindful that risk has two components, namely, hazard and outrage, as conceptualized by Sandman (2003). The mental models approach to development of risk communication messages and strategies has incorporated both of these components, with the creation of the experts' model to represent the hazard component; and elicitation of laypeople's mental models of a particular risk to represent the outrage component.

Creating the Experts' Model of Climate Change

As it was applied to the development of risk messages on climate change for rice farmers in a village in Pangasinan Province, the mental models approach generated experts' model of climate change that was composed of concepts such as human-induced activities that contribute to greenhouse gas emissions (GHG); various impacts of climate change (e.g., higher temperature, more intense rainfall and flooding, more intense typhoon, and intensified drought); impacts of these on rice crop growth; and various adaptation strategies that rice farmers could employ (Francisco & Tirol, 2010). The experts' model of climate change captured general and specific concepts that

rice farmers need to know to make informed decisions concerning climate change and rainfed lowland rice production system. Through the creation of the experts' model of climate change, "a composite of expert knowledge and beliefs" (Austin & Fischhoff, 2012, p.126), the mental models approach took into consideration the technical component of climate change risks. Sandman (2003) explained that hazard, the technical component of risk, is the "product of probability and magnitude" and more commonly based on experts' point of view.

The experts' model of climate change was created using the assembly method wherein the key concepts on climate change vis-à-vis rainfed lowland rice production system were listed, and relationships between and among them were determined. These key general and specific concepts and their relationships were determined by reviewing relevant primary and secondary sources at IRRI Library, one of the world's most comprehensive repositories of rice literature. The review of literature phase took two weeks to complete and involved examining highly technical literature. This seems to indicate that creating the experts' model could become a time-consuming process. As such, this entails that a risk communicator, tasked to develop risk communication messages on climate change, must have a good background in this technical field as it is applied in a specific context, in this case, rice production. The researcher who developed the initial experts' model of climate change had a technical background in environmental science, thereby facilitating the review and analysis of related literature.

After the review of related literature phase, the initial experts' model of climate change was presented for discussion to four scientists who had specialized knowledge in rice production and/or climate change. Using semi-structured interviews, the scientists were asked to comment on, improve on, and assess its accuracy and relevance to the risk decisions of farmers concerning climate change and rainfed rice production systems. Lasting for an average of one hour, the semi-structured interviews allowed for in-depth probing of the initial experts' model and paved the way for two-way communication between the experts and the risk communicator such that "those being interviewed can ask questions to the interviewer" and "confirm what is already known but also provides the opportunity for learning" (Case, 1990), especially needed if a risk communicator lacks the relevant technical knowledge. In addition, this step in the mental models approach ensured that the experts' model systematically captured all information deemed relevant by experts on climate change to the risk decision-making of the rice farmers as an audience of climate change risk communications, as suggested by Morgan et al. (2002). Flick (2002, p.89) noted that the expert "is integrated into the study not as a single case but as representing a group (of specific experts...)".

Alternatively, the experts' model of climate change could be created through a focus group discussion (FGD), especially if experts are readily and easily accessible to the risk communicator. Further, the experts' model could be developed based on review of literature alone and supplemented only by experts when possible (Cox et al., 2003).

Meanwhile, the experts' model of climate change was visually represented using an influence diagram (Francisco & Tirol, 2010),

"a form of directed network in which each node represents a factor and each connecting arrow represents a predictive (possibly causal) relationship between factors" (Austin & Fischhoff, 2012, p.125).

As part of a method in designing risk communications, representing the experts' model of climate change using an influence diagram ensures that the technical component of risk was carefully taken into consideration. According to the scientist-respondents, the influence diagram prompted them to examine what they knew about climate change and rice production. They also found the influence diagram easy to understand and captured the important factors about climate change in relation to rice production. They realized that other risk communicators could use the final influence diagram on climate change concerning rainfed lowland rice production to inform similar domains/contexts. As one scientist-respondent pointed out, the influence diagram could be used in other ecosystems aside from rainfed, for instance irrigated lowland.

However, similar to findings in other studies, in an attempt to capture all concepts in one influence diagram, the richness of the interviews with scientists was lost in the final consolidated experts' model of climate change, affirming the findings of Cox et al. (2003).

Meanwhile, with the scientist-respondents oriented towards the hard sciences, the experts' model of climate change as represented in the influence diagram did not include adequate concepts and issues from the social sciences vis-à-vis climate change and rice production. The specializations of the scientists were on hydrology, applied meteorology, crop physiology, and agricultural sciences.

Eliciting the Rice Farmers' Mental Models of Climate Change

The rice farmers' mental models of climate change was composed of their knowledge and beliefs about climate change in relation to a rainfed lowland rice production system, specifically, on the causes of climate change, effects of climate change on the rice plant, and adaptation strategies. Compared to the experts' model of climate change, their mental models were incomplete and not well defined (Francisco & Tirol, 2010). Most of the rice farmers observed changes in rainfall patterns; however, most were unaware of any causes of observed changes in climate. In general, the rice farmers related their observed climate changes to decreases in grain yield. On the average, each rice farmer mentioned two adaptation strategies, with use of fertilizers, use of machines for watering crops, and construction of small dikes as the three most common cited adaptation strategies.

Through the elicitation of the rice farmers' mental models of climate change, the mental models approach integrated the public or laypeople's perception of risk. Sandman (2003) explains that the public's perception of a risk gives rise to the non-technical component of risk, that is, outrage, defined as an "amalgam of voluntariness, control, responsiveness, trust, dread, among others". Unraveling outrage as a component of risk is important as it is the "principal determinant of perceived hazard" (Sandman, 2003).

The rice farmers' mental models of climate change were elicited through open-ended interviews, also called mental model interviews, with 18 rice farmers.

Lasting for about 20-30 minutes, the open-ended interviews were divided into non-directive and directive stages. Based on a think-a-loud strategy, the non-directive part asked the rice farmers to share everything they knew about climate change. The general prompt question was “Tell me about climate change” and translated in Pangalatoc, the local dialect in the area. The respondents’ knowledge and beliefs about climate change and rice production were elicited with minimum input from the researcher and other interviewers. The open-ended interviews proved to be suitable for a candid discussion of the issue at hand.

The main points brought up by the rice farmers during the non-directive part of the mental models interviews were probed further using neutral prompts (e.g., What can you say about...? Could you elaborate what you mean by....?) The open-ended interviews proceeded with the directive stage when the rice farmer-respondent had no more to say. In the directive stage, rice farmers’ knowledge and beliefs on climate change and rice production not mentioned in the non-directive stage were probed.

Morgan et al. (2002) justified their choice of open-ended interviews over the questionnaire. They explained that the use of questionnaire presumes that one knows beforehand the whole gamut of relevant lay beliefs and misconceptions and “in terms which they are intuitively phrased” (p.23). In relation to this, the proponents of the mental models approach recognized that experts and laypeople perceive a risk differently. According to Morgan et al. (2002) technical and laypeople bound a system differently. Hence, although the structure of the open-ended interviews was based on the experts’ model of climate change, the rice farmers were encouraged to talk freely. In this way, how laypeople intuitively think about an issue, in this case rice farmers vis-à-vis their knowledge and beliefs on climate change, was considered and which aspects of the scientific literature actually matter to them were determined, as explained by Morgan et al., 2002. The various gaps elicited in this study could not have emerged in the unique way by which the respondents phrased them if structured tests were used. In relation to this, according to Wagner (2007), “The danger that messages will be dismissed, misinterpreted, or allowed to coexist with misconceptions is remarkably smaller with this approach” [mental models approach] (p.671).

In light of the above-mentioned premises of the mental models interview, the interviewer must possess certain skills. As part of the logistics involved in following the mental models approach, an orientation on conducting a mental models interview was done. Despite this, review of transcriptions revealed that there were a few instances when the interviewers gave more information to the rice farmer-respondents than what was necessary. These instances were encountered especially when rice farmer-respondents had difficulty answering. The danger here lies in leading the laypeople’s answers to conform to that of the experts’ model and as such, could put into question the accuracy of the mental models elicited from laypeople.

On the part of the rice farmer-respondents, it was observed that compared to those who reached secondary level of education, those who reached only up to elementary level took a longer time in answering the questions, had a hard time answering most of the questions, and entailed more probing. This could be because of the nature of open-ended questions wherein interviewees are more

likely to misunderstand a question and give incomplete or vague answers. This is why probing is very important in mental models interviews.

Meanwhile, all the rice-farmer respondents had a favorable attitude towards participating in the mental models interviews. They saw the interviews as opportunities for learning and expressing themselves, reflecting what the proponents of the mental models approach have envisioned as an outcome—moving towards the public becoming partners in risk communication.

Identifying Points of Convergence and Divergence between the Experts’ Model and the Rice Farmers’ Mental Models of Climate Change

In this step of the mental models approach, the rice farmers’ mental models of climate change were examined with the experts’ model of climate change as a reference point. The extent by which they were similar referred to their points of convergence while gaps between rice farmers’ mental models and the experts’ model referred to points of divergence.

Based on the comparison of the experts’ model of climate change and the rice farmers’ mental models of climate change, most of the gaps were on the human activities that drive climate changes. The concept of GHG, which is important in relating human activities with climate change, was not in the rice farmers’ mental models. Further, rice farmers’ mental models of climate change lacked concepts on the specific effects of climate change on their rice crop, except for drought. Instead, the rice farmer-respondents knew in general terms that climate change has an effect on the growth of their rice crop. Lastly, the rice farmers’ mental models of climate change lacked other viable options for adaptation to climate change, except for those they had traditionally applied (Francisco & Tirol, 2010).

Once the experts’ model of climate change and the rice farmers’ mental models of climate change had been determined, identifying the gaps between their models of climate change was straightforward. The influence diagrams, which visually represented the scientists’ model of climate change and the rice farmer-respondents’ mental models of climate change, were keys in the identification of these gaps. Indeed, comparison of the experts’ and laypeople’s models to identify risk messages that need to be focused on in risk communications has been regarded as one of the strengths of the mental models approach (Damman & Timmermans, 2012; Zaksek & Arvai, 2004). However, in cases when the knowledge gaps are not well defined between the laypeople’s mental models and the experts’ model, it would be more challenging to identify gaps from which risk messages could be crafted.

Identification of gaps was facilitated as well by the qualitative approach in eliciting experts’ and laypeople’s knowledge and beliefs. The qualitative approach generated detailed and context-specific explanations, which has been recognized as one of the strengths of the mental models approach (Damman & Timmermans, 2012).

Based on the foregoing discussion, the creation of the experts’ model of climate change, which could be taken to represent the hazard component of climate change risk on rice farming, offers

opportunities such as in-depth probing of the experts' model of climate change and systematized inclusion of all information deemed relevant by experts to the risk decision-making of rice farmers with regard to climate change. In addition, the experts found the influence diagram easy to understand and adaptable to other ecosystems aside from rainfed, for instance irrigated lowland. Meanwhile, the creation of the experts' model of climate change could become time-consuming and entails that the risk communicator has a good background in the technical field. The richness of the interviews with scientists was also lost in the final consolidated experts' model of climate change, affirming the findings of Cox et al. (2003). Moreover, the experts' model did not include adequate concepts and issues from the social sciences vis-à-vis climate change and rice production, with the scientist-respondents oriented towards the hard sciences.

In terms of the elicitation of the rice farmers' mental models of climate change, which could be taken to represent the outrage component of climate change risk on rice farming, opportunities included enabling the rice farmers to talk freely given the open-ended nature of the interviews. Relatedly, information gaps emerged in a unique way by which the rice farmers phrased them. All the rice-farmer respondents had a favorable attitude towards participating in the mental models interviews. On the other hand, with the questions being open-ended in nature, misunderstanding questions and giving vague or incomplete answers were more likely. Lastly, findings point towards the need to train interviewees on carrying out mental models interviews.

Given these opportunities and constraints, the mental models approach, therefore, is deemed adaptable to the development of risk communication messages on climate change for rice farmers in Pangasinan Province, Philippines. The following section provides some directions on enhancing the adaptability of the approach.

Ways of Taking the Mental Models Approach to Risk Communication Forward

Logistics. Given that an important aspect of the mental models interviews is to elicit "natural and spontaneous" responses from laypeople (Austin & Fischhoff, 2012), an adequate training on carrying out mental models interviews is necessary. The training could even include role-playing of the interview and should encompass coding the interview transcriptions wherein the coders need to understand and be familiarized with the concepts in the experts' model so as to ensure intercoder reliability.

Creating the experts' model. Conscious effort must be made to represent various disciplines, including aspects on power relations (Mathevet et al., 2011), related to the domain or context when choosing experts to be consulted in drawing up the experts' model. In creating influence diagrams to represent experts' model, FGD with the experts is recommended when possible. An FGD is a practicable way of eliciting the experts' model using influence diagrams as it saves time and facilitates more brainstorming and learning among the experts and the risk communicator.

In connection with this, climate change communicators using the mental models approach as one of their tools will benefit

from an organizational set-up that brings together experts from various disciplines. Communicating about climate change entails interdisciplinary teams within an institutional framework to facilitate collaboration (Pidgeon & Fischhoff, 2011).

Eliciting the laypeople's mental models. In the course of the mental models interviews, the laypeople-respondents increasingly open up their minds, feelings, and concerns related to the subject matter at hand. In this regard, orienting the elicitation of mental models to *Sikolohiyang Pilipino* (Filipino Psychology) might prove more fruitful in the context of Filipinos. *Sikolohiyang Pilipino* (Filipino Psychology) is based on perspectives and methods that fit the local history and culture of Filipinos (Clemente, 2011; San Juan, 2006). In this regard, the mental models interviews could explore Filipino laypeople's experienced knowledge (*kamalayan*), awareness of their surroundings (*ulirat*), and information and understanding (*isip*), among others (Enriquez, 1989 as cited in San Juan, 2006). Among the methods that may be employed to explore these are *pakikisalamuha* (level of mixing), *pakikilahok* (level of joining/participating), and *pakikipagpalagayang-loob* (level of mutual trust/rapport) (San Juan, 2006), including data gathering techniques such as *pagtatanung-tanong* (improvised informal unstructured interviews) and *pakikipagkwentuhan* (storytelling or informal conversations) (Clemente, 2011). In this way, the mental models generated are culturally valid (Clemente, 2011). As such SP methods open up opportunities for elicitation methods that are appropriate and sensitive to the Filipino culture.

Furthermore, in line with the values emanating from treating the public as partners in risk communication, the rice farmers' mental models or laypeople's mental models may be presented back to the community for validation and discussion with a larger group.

Comparing the Experts' Model and the Laypeople's Mental Models. Risk communicators should also be conscious of the importance given to the models elicited. Because the approach starts with eliciting the models of experts, the risk communicator might be predisposed to put more importance in the models of experts. Laypeople's mental models should be allowed to emerge on their own. After which, the models can be structurally compared. Ensuring that the laypeople's mental models have a strong contextual element was also raised by Cox et al. (2003), especially in instances when the expert model is used as a structural template from which analysis of data from users will be based (Morgan et al., 2002).

Conclusions

The paper assessed the utility of the mental models approach to risk communication in the development of risk messages on climate change for rice farmers and provided insights on how the approach may be taken forward.

Overall, the mental models approach was adaptable for it made possible the systematic and in-depth elicitation of relevant knowledge and beliefs on climate change of both experts and rice farmers, as argued by its proponents (Morgan et al., 2002).

Likewise, the mental models interviews provided an opportunity for a candid discussion with rice farmer-respondents, affirming Cox et al. (2003); and facilitated the identification of knowledge gaps and misconceptions, paving the way for a focused climate change risk communications. Findings also revealed the constraints of the mental models approach. The creation of the experts' model of climate change could become time-consuming and would entail that the risk communicator has a good background in the concerned technical field. The experts' model of climate change was limited in reflecting the richness of the interviews with scientists and did not include adequate concepts and issues from the social sciences. Further, in the elicitation of the rice farmers' mental models of climate change, the open-ended nature of the questions could likely lead to misunderstanding of questions and giving of vague or incomplete answers. These constraints point to how the adaptability of the approach may be enhanced. A risk communicator should ensure that the richness and complexity of interviews with experts and laypeople, although could not be entirely captured in the influence diagrams, would still guide climate change communication. Likewise, an interdisciplinary team meets the needs of climate change risk communications, particularly in the use of the mental models approach. Further, *Sikolohiyang Pilipino* (Filipino Psychology) or SP methods open up possibilities for more culturally appropriate and sensitive elicitation methods in the mental models approach.

The future of risk communication, as an integral part of risk management, is towards building partnerships with stakeholders. The mental models approach is a step towards this direction. As such, risk communicators should include the mental models approach among their tools.

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