INTERPRETIVE SYNERGIES BETWEEN SCIENCE AND INTANGIBLE CULTURAL HERITAGE: A CASE STUDY OF COMMUNICATING KNOWLEDGE ABOUT THAI RICE FARMING IN A SCIENCE MUSEUM

Thesis submitted for the degree
of Doctor of Philosophy
at the University of Leicester

by

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2019

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Abstract

This research presents an approach to interpreting Intangible Cultural Heritage (ICH) for communicating science in the context of Thai science museums. Using rice farming as a case study, the research brings together literatures on worldviews, ICH and science communication, to conceptualise a framework that enables the exploration of connections between ICH and modern science through a design workshop. The *ScienceICH* design workshop was trialed in Thailand with eight participants from one ethnographic and one science museum. The participants had various disciplinary backgrounds and experiences in museum programming and exhibition development. The workshop facilitated knowledge exchange and sharing between participants in the course of producing design representations. The analysis of workshop activity showed that cross-disciplinary work played an important role in creating design representations such as exhibit prototypes that combine ICH concepts with mainstream science. These design representations have the characteristics of boundary objects that facilitate cross-disciplinary communication and embody the processes of negotiation and consent (over meanings, objectives and priorities) that are inherent in cross-disciplinary design teams. The workshop participants were thus able to bring together Thai rice farming ICH and science into an exhibition plan for Thailand's National Science Museum. The findings suggest that the design workshop and its underlying theoretical framework can indeed be utilised by museum professionals to interpret ICH for the purposes of science communication in Thai science museums. This synergy can strengthen the links between the traditional knowledge that is embedded in ICH and modern science, and can in turn be one of the key factors that contributes to a sustainable future for museums and their communities.

Acknowledgements

Foremost, I would like to express my sincere gratitude to my supervisor Dr Giasemi Vavoula for very kind and continuous support my research and study. I appreciate her patience, motivation, and immense knowledge. Her guidance drove me throughout the time of research, fieldwork, and writing of this thesis. She was always available whenever I needed her to supervise. During my research she supported me develop the ideas and methodology that have resulted in this thesis.

Besides my supervisor, the list of people to whom I feel grateful for their support and assistance in this thesis is endless. I begin with my ex-boss and colleagues at the National Science Museum, Thailand, Prof. Dr Pichai Sonchaeng, ex-president of the NSM, who has given me a good opportunity and encouraged me to conduct this research; my direct boss Dr Aphiya Hathayatham, and Dr Ganigar Chen, who have taken care of my work and provided useful suggestions and connections. My gratitude also goes to Mr.Supachai Sittilert, Mr.Thanakorn Palachai for suggestions and encouraging me in this research; and also to colleagues at the Science Communication Division and many staff of NSM who have well supported me very well during my fieldwork. I also thank the Ministry of Science and Technology, who granted me my scholarship. I am sincerely grateful to all of them.

All the staff at the School of Museum Studies are in the next group to whom I say thank you, for their professional expertise and kindly support and suggestions through this project. I also would like to thank Christine and Bob, for the brilliant administrative support.

Special thanks to all competent participants in ScienceICH design workshop in Thailand who contributed their time and professionals skills and experiences, including useful feedback and suggestions for my research without which this thesis would not have been possible.

Words cannot express the feelings I have for my parents and my parent in-laws for their constant unconditional love and support - both emotionally and financially particularly my Dad who is the most want to see my success, but he cannot. Without understanding and immense support from them, it would have been much more difficult to complete this study in a foreign country. Much appreciation also goes to my brother and nephews who have helped take care of mom and dad during the time of my absence.

Finally, I wish to acknowledge the most important person in my life – my wife, Dr Wijitra who provides a constant source of strength and unending inspiration and always raises me up anytime I fall down.

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CHAPTER 1 INTRODUCTION

1.1 Introduction

This research presents an approach to interpreting Intangible Cultural Heritage (ICH) for communicating science in the context of Thai science museums. This introductory chapter begins with an overview of the researcher's background to provide a historical account of how my interest in communicating science through ICH developed. The importance of worldviews, ICH, Western science, museums, and science communication are discussed first. The current state of science museums in Thailand is then summarised. The introduction concludes with the outline of research questions and the structure of this thesis.

1.2 Research background

Worldwide, science and, by extension, technology have become fundamental knowledge for the public. Science helps us to understand the functioning of our bodies and minds and our places in the world. Science is the primary tool that people use to make decisions in their lives (Yuthavong, 2017). Science plays an essential role in many contexts, such as food, health, transportation, household activities, and communication; indeed, science plays such an important role in daily human activities that people cannot avoid using it. In today's age of intense international economic competition, an understanding of science and technology is a necessary foundation for developing the professional workforce and hence a strong technologically-based economy (Bowater and Yeoman, 2013; Brown, 1986; Chalmers, 1999; Hathayatham, 2005; Miller et al., 2002; Wilsdon et al., 2005a; Yuthavong, 2017). Many modern conveniences also rely on technology. The design and function of facilities and equipment are facilitated by technological advancement. Technology is founded on the progress of science. Science is a significant way to explain natural phenomena and confirm

theories (Brown, 1986; Chalmers, 1999; Gribbin, 2009). Inventors adopt and adapt the knowledge from science to design useful technological systems and products. The body of knowledge in science has become an essential basis for creating technology.

With extensive use and application of science in everyday lives, come questions about how the public accesses and relates with this body of knowledge. General public attitudes towards science and technology are positive (Bauer, 2009; Castell et al., 2014; Lewenstein, 2010; Wilsdon et al., 2005). Despite this, levels of scientific literacy and public understanding of science are more limited (Gregory and Miller, 1998, Bauer, 2009). Science museums are among the main players in increasing public understanding of, and engagement with science. In this study, the term *science* refers to scientific knowledge as it is known to the Western world. The purpose of Western science is to explain natural phenomena through data, hypotheses, and analysis (Brown, 1986; Chalmers, 1999; Crofton and Black, 2016; Gribbin, 2009). Western science has been a part of Western culture since the 16th century and has spread throughout the world (Bowater and Yeoman, 2013; Cobern, 1991; Gribbin, 2009; Yuthavong, 2017). In fact, Western science modernised the world. When the world entered the industrial age, all societies adopted mass production. The expansion of European influence brought Western knowledge and culture to other lands and, as a result, to people who had their own cultures and knowledge. These different cultures and knowledge systems derived from different ways of perceiving the world and this can lead to difficulties in cross-cultural learning and communication, including in relation to science. One theoretical concept that can shed more light on these difficulties is that of the 'worldview'.

The term 'worldview' refers to a view or perspective of the world and the universe and explanations of how they work (Koltko-Rivera, 2004). Worldviews capture how people understand nature, the world around them, and reality. Modern Western worldviews are dominated by scientific thinking while non-Western worldviews tend to be based on religion, beliefs, and systems of explaining natural contexts holistically (Cobern, 1991; Harrison and Rose, 2010). Western culture has been transferred to the non-Western world as Western people have travelled to find and/or conquer other lands. Scientific and technological progress and the perceived prosperity they bring have led to acceptance of Western science by many other cultures. As a result, Western science has become an essential part of

education in non-Western cultures (Cobern, 1991). At the same time, the spread of Western science to non-Western cultures is affecting local worldviews (Cobern, 1991; George, 1999; Harrison and Rose, 2010). The traditional practices and beliefs of indigenous people are affected when learning something new, such as Western science and technology, especially in schools (George, 1999). This influence presents an important challenge as on one hand, public understanding of science is necessary for maximising societal benefits from scientific progress (Royal Society, 1985); and on the other hand, the traditional practices and beliefs that are based on native worldviews are too culturally (and, arguably, ecologically) important to be forgotten. The main argument of this thesis is the potential role of the science museum in addressing this challenge, owing to its nature as an institution that facilitates both science learning (by engaging students visiting with school groups) and public understanding of science (by engaging adult visitors).

Science learning refers to the building of conceptual knowledge and the development of skills necessary for practicing the scientific method, including observing (noticing things in the physical / social / built environment), making predictions (asking questions and proposing possible answers), planning (determining possible strategies to answer the questions), experimenting (gathering evidence), and generating conclusions based on evidence (producing reliable answers) (Fenichel et al. 2010). Formal science learning refers to learning scientific information in classrooms and is controlled by curricula. In contrast, informal science learning refers to the activities that take place outside the school environment. Those activities are not designed for learning in classrooms or to be a part of a school curriculum. Informal learning can happen at home; in after school clubs, libraries, and theatres; on the job; by watching science documentary programs on television; in science centres and museums; in zoos and aquaria; and even during discussions of science topics at the dinner table (Crane, 1994; Sawyer, 2006; Vavoula, 2004).

There are many diverse contexts for informal science learning and everyone can engage in informal science learning in their daily activities. In every country children are required to learn science at school. However, the time they spend learning science at school is less than the time they spend in informal science learning outside the classroom. This indicates that

school is not the only place that provides opportunities for people to learn science (Fenichel et al., 2010).

Learning science outside the school environment promotes understanding of scientific knowledge and is also associated with enjoyment, further inquiry, and a sense that science learning can be personally relevant and rewarding (Fenichel et al., 2010). Informal science learning is purposely pursued by learners and they are free to choose what they want to learn and when they are satisfied, depending on their needs and interests (Dierking et al., 2001).

Museums are one such context for informal science learning. Falk and Dierking (2000) identify three contextual factors that affect learning in the museum. The first is the visitor's personal context, which is shaped by prior experiences (Falk & Dierking, 2000, 2013; Kelly, 2002). The second is the visitor's socio-cultural context, which is shaped by the visitor's cultural background as well as their interactions within the social groups they are part of. The third is the physical context of the visit, including the layout of the space and the design of the exhibits. Of particular interest to this thesis is the second contextual factor, the visitor's socio-cultural background, as this is where worldviews 'reside'. Specifically, the thesis asks, how can science museums in non-Western countries engage their audiences with modern science Learning science is not of concern only to those who will later train to be scientists. As a part of everyday life and, by extension, a part of society, science is important to non-scientists who also must be enabled to understand scientific culture and develop an awareness of science as part of a sustainable society. Bauer (2009) presents a review of the evolution of science communication for public understanding in the UK and how approaches within it have evolved, from a deficit model in the 1960s-1980s that emphasised science literacy to a public understanding of science (PUS) model from the mid-1980s to the 1990s that emphasised positive public attitudes to science, to public engagement with science from the 1990s to the present day (Bastos, Henriques & Wilkinson, 2019; Bultitude, 2011; Lewenstein, 2010) that emphasised public's participation and involvement in science. Of particular relevance to this study is Bauer's (2009) call for further research in science in society that addresses differences in local identity and pays attention to variances in the impacts of activities and events for public understanding and engagement in different social and historical contexts, which he termed 'culture indicator for science'(Bauer, 2009). Like

Falk and Dierking (2000), Bauer (2009) also acknowledges a person's cultural background as a factor that affects how the person engages and relates with science.

Another concept that emphasises the role of the socio-cultural context in how people relate and engage with science is that of 'science capital'. It comprises what you know (science literacy), how you think (attitudes and dispositions), what you do (science related activities and behaviours), and who you know (social contacts and networks) (DeWitt & Archer, 2017; DeWitt, Archer & Mau, 2016). Embodying cultural and social capital in science (DeWitt & Archer, 2017; DeWitt, Archer & Mau, 2016), science capital captures an individual's science-related assets such as the science knowledge, attitudes, experiences and resources that an individual builds up throughout their life (Archer et al. 2015). It paints a vivid picture of how social class and surrounding community affect people's participation and aspiration in science (Archer et al., 2015; House of Commons Science and Technology Committee, 2017). While public engagement with science does not always correlate with enhanced public attitudes toward science, however, Archer et. al (2015) suggest that young persons who possess higher levels of science capital tend to pursue science-related careers or view science as important in their lives. The science capital approach argues for three pillars to supporting science education for all; personalising and localising; eliciting, valuing and linking students' experiences, identities, and what matters to them, with science; and building on the science capital dimensions (Godec, S., King, H. & Archer, L., 2017). Of particular interest to this research are the multiple ways in which science capital theory reveals people to connect science to their lives. Within these, worldviews become contexts that have the ability to positively influence learning science in both formal and informal settings. Collins and Evans (2002) highlight the role of experts in driving the science-based society. They suggested that while experts are important for inspiring trust in the public, experts however are not only scientists who work in laboratories but also those who practice science in local communities. These 'local experts' have the ability to understand the complex bodies of tacit knowledge within the social groups in which they reside (Collins & Evans, 2002, 2007) and can leverage them to enhance the communication of scientific knowledge to the public (Collins & Evans, 2002, 2007; Epstein, 1995; Leach, M., Scoones, I. & Wynne, B., 2004).

Science museums, and science centres are some of the most critical resources for accomplishing the mission to communicate science and technology to enhance public awareness and build positive attitudes toward science. In addition, science museums and science centres are also places that cultivate, educate, and develop a curiosity that encourages life-long learning (Massey, 1999). Museums, with their diverse exhibitions, media, and programs, provide people with choices to engage with science in whatever forms they prefer.

Science museums, science centres, and natural history museums are considered popular places for informal science learning. Many studies point out that these informal educational institutions create various positive impacts such as memorable learning experiences that can change people's attitudes and behaviour, increase knowledge and understanding about science and technology, generate personal and social inspiration that enhances intergenerational learning, and help bridge the gap between the scientific community and the public (ECSITE, 2008). Modern museums not only function as places for the display of artefacts but are also environments for learning, relaxing, entertainment, and education. As the agendas of museums cater to a variety of visitors, museums need to use as many tools as possible to enhance their visitors' learning (Falk and Dierking, 2000).

Scientific knowledge can be taught in schools, but informal science learning can support and enhance the understanding of science and provide enjoyment. Science museums and science centres provide many immersive engaging and exciting experiences for their visitors through various kinds of exhibits and media such as hands-on interactive activities, graphic and text panel displays, and artefacts displayed with information or infographics (Boyle, 2009; Falk & Dierking, 2013; Rennie & McClafferty, 1999). Science communication is an essential tool for bringing science knowledge to the general public that will enable them to efficiently and appropriately use science and technology (Hathyatham, 2005). Science museums and science centres communicate scientific content through channels such as science exhibitions (both static and interactive forms), science educational activities (e.g., science camps, science shows, or laboratories), and science media (e.g., websites, documentaries, or books). Rennie (2013) suggested that to promote effective communication in science museums, exhibitions must be designed to provide motivation for learning and also attract visitors to engage thoughtfully. She also suggested that storytelling can adjust the level of science and give

people the ability to engage with science. Hilgartner (1990) proposed that the degree of communication ranged from upstream for specialised audiences, such as the specialists, researchers, and lecturers in scientific disciplines, to downstream including students and non-technical audiences. This model suggests that it is imperative for science communicators to design their communication tools and context to suit their audiences. This means that when science communicators deliver the same story and topic, the medium, message, and technique should be varied to suit the listener's level of knowledge.

Like modern science museums, the concept of the science centre and the science museum in Thailand were 'imported' from Western science to the Thai context. The National Science Museum in Thailand (NSM) is similar to most science museums all over the world in that it is communicating Western science concepts through its exhibitions and programs. The NSM was established in the 1990s following the establishment of Thailand's first planetarium in the 1960s and its first science centre in the 1970s. The NSM has been open to the public since 1999 and was founded to serve as the organisation responsible for enhancing public awareness and appreciation of science, technology, and the environment by developing a range of science museums, both in the museum complex (Science Museum, Natural History Museum, Information Technology Museum, RAMA IX Museum, and NSM Science Square) and in other regions of Thailand. The scientific content covers science, technology, natural history, biodiversity, ecology, and information technology. Most of the content in the museums is related to Western science. However, at the Science Museum, the fifth floor is devoted to Traditional Thai Technology. The exhibition on this floor focuses on presenting traditional Thai technology within the context of modern science and technology. Visitors can explore and enjoy learning, playing, and engaging with the traditional technologies that were used by ancient Thai people centuries ago, some of which are still in use, such as wood carving, pottery, metallurgy, wickerwork, and textile technology (Kanhadilok, 2013; Suriyakul Na Ayudhya, 2017). NSM is concerned with the use and development of science communication practices to serve the museum's purposes. The mission of the NSM is to promote learning, create inspiration, reinforce creative thinking, and raise awareness of science, technology, and innovation (National Science Museum, Thailand, 2019).

Since its opening in 1999 until 2017, the NSM had reached approximately 17 million visitors in total (National Science Museum, Thailand, 2018). This is still a small proportion of Thailand's population which, in 2017, was over 69 million (UNITED NATIONS, 2019). However, the 2017 NSM annual report points out that there was an increase in visitors from every part of the country. This meets one of the aims of the NSM; to create opportunities for the public, ranging from the capital city to rural areas across Thailand, to engage with science. To serve visitors and the wider public to understand and engage with the local and global context of science, the museum may need more tools, resources, and strategies.

In my working experience at NSM as a science communicator and science educator, I found that there were some difficulties when the museum tried to communicate science to local people. In general, the context of science in the exhibitions and activities is developed based on basic science knowledge which is sometimes related to the science that people learn in primary or high school in the formal education system. It is compulsory in Thailand for everyone to stay in the formal education system until the age of 15. Therefore, all people are somewhat familiar with the concepts of scientific knowledge or Western science. Moreover, when they come to participate in museum galleries or activities, they can understand the content, but they feel it to be disconnected from their daily lives. Science in the exhibition seems alien to them. One of my experiences was of an exhibition and activity on solar eclipses. Most visitors understand that solar eclipses occur when the moon is between the sun and the earth so that the shadow of the moon covers part of the earth and temporarily hides us from the sun. However, Thai people believe that solar eclipses happen when a furious black giant is trying to eat the sun and if they do not want to lose the sun forever they have to make very loud noises by shouting, hitting something, or shooting a gun to chase the giant away from the sun. They essentially ignored the scientific information. In fact, the solar eclipse phenomenon can be studied during the day. Many scientists take that opportunity to study the universe to find answers to the most profound questions: "Where are we from?" and "What is the destination of our planet earth?". This opportunity might be hard for local people to imagine. However, I believe that the science museum can design communication that encourages people to learn science in ways that are compatible with their culture so that they can connect the two and reduce the distance between science and their worldviews while respecting both.

Intangible Cultural Heritage (ICH) refers to the legacy derived from ancestors' beliefs and practices which were influenced by their worldviews. These worldviews do not end at the items in physical form such as tangible monuments, structures, landmarks, objects, and artefacts but also include knowledge, traditions, rituals, skills, and practices that are connected to living expressions inherited from the ancestors (UNESCO, 2011). ICH is considered to be an important resource of knowledge and wisdom for communities (UNESCO, 2011). For example, traditional medicine and healing such as herbal medicine, acupuncture, traditional massage, and healing customs using hands and simple fruits are gradually becoming internationally recognised for their effectiveness and reduction of side effects. Considering this view, there is a possible relationship between the knowledge of ICH and Western science.

In my view, all kinds of knowledge and wisdom are related, and when we need to construct new knowledge or use it to apply to our lives, we try to make a connection between the new concept or knowledge and our worldview. This led me to consider the question of how museums can design their exhibitions or activities in ways that connect people in the local communities with Western science. This may allow people to learn science through their associated stories. If museums can provide an important bridge to connect people with science, then they can successfully promote science to a wider range of people in society.

1.3 The motivation of this study

This research aims to explore and understand the approach of science communication through Thai local context in a science museum. It also aims to address the disconnection between the Intangible Cultural Heritage (ICH) that surrounds rice farming knowledge and practices in Thailand; and the communication of Western science about rice farming in Thailand's science museums. There is a growing body of literature that acknowledges the value of local knowledge of science (ICSU, 2002); and the value of Intangible Cultural Heritage related to nature and the universe for sustainability (UNESCO, 2003). To date, however, there has been little to no inquiry into the potential role of the science museum in bringing the two together, particularly in non-Western contexts where Western science has been 'imported' and displaced local traditional knowledge and practices. This research has,

therefore, the potential to offer a theoretical basis that can open up the debates surrounding the merits of bringing them together and lead to new practices in the science museum.

This research, therefore, addresses the following three research questions:

Question 1: What theoretical framework should underpin the design of exhibitions that integrate local Intangible Cultural Heritage in modern science museums in non-Western contexts?

In answering this question, the research will focus on why such integration should take place in science museums. Effective science communication is a target for scientific policies worldwide (Dickson, 2012; Salleh, 2011; The Office of Science and Technology and the Wellcome Trust, 2000). In non-Western contexts, where Western science has migrated, rather than grown out of, effective communication to the public is urgently needed for formal and informal science institutions. Thailand, in particular, spends 20 percent of its annual budget on education, yet Thai students are at the bottom of international rankings on STEM achievement (OECD, 2016). Science education programmes and initiatives like the Inspiring Science, and STEM education projects with cooperation with science museums are currently rectifying this imbalance. Exploring the potential impacts on science learning of the disconnection of Western science from Thai students' cultural background can provide insights for both educational policy and public communication of science. A theorisation of the value of connecting traditional knowledge with modern science in Thailand is thus urgently needed.

Question 2: How can science museum exhibits and programmes integrate traditional Thai knowledge with Western science to enhance science communication in Thailand?

Building on the theoretical framework that will be produced in answering the first research question, the research will then turn to transform this framework into a course of action for Thai science museums. Science museum staff and curators in Thailand are often confronted with challenges when developing exhibitions for their local audiences. Exhibitions about Western science can alienate Thai audiences, as they cannot easily make connections

between exhibition content and their local lifestyles. The integration of local scientific knowledge and practices can provide the glue that connects Thai audiences with science exhibitions. With their current focus solely on Western science, exhibition design approaches in Thai science museums do not serve this purpose. This research will, therefore, look into exhibition techniques and media, as well as programming and events planning approaches, which can facilitate the combination of local knowledge and Western science in Thai museums. Importantly, this line of enquiry will also explore potential synergies between science museums and those ethnographic museums that display Thailand' s traditional scientific knowledge and practices (such as the Thai Rice Farmers National Museum, Museum Siam, and the Golden Jubilee Museum of Agriculture). Such synergies are essential, not only in order to avoid the replication of museum content but also in order to strengthen the links between local knowledge and Western science and to amplify the public message about these links.

Question 3: What are the perceived potential impacts of combining traditional knowledge with Western science in Thai science museums?

It is important to assess the real- world impacts of exhibitions and programmes which have been designed based on the theoretical framework discussed above in the first question and produced in the course of exploring the second question. Evidence of perceived impacts from e. g. museum professionals, educators, and science education policymakers will validate the theoretical framework and the proposed exhibition design approaches.

1.4 Structure of this thesis

This thesis consists of seven chapters. Chapter 1 is an introduction that provides the background, motivation, and purpose for the research and a brief explanation of the structure of the thesis.

Chapter 2 is the literature review of Western science in non-Western contexts and of worldviews. This chapter looks for connections between worldviews and Western science

learning and communication in non-Western cultures. The chapter starts by exploring what worldviews are and why they are important. This chapter also provides reasons for why worldviews in Western countries have been influenced by scientific development and examines how people in other parts of the world receive Western science. This chapter also discusses the literature on the worldviews that exist in non-Western cultures and its impacts on learning Western science in a non-Western culture using the case study of Thailand.

Chapter 3 highlights the connection between worldviews, traditional knowledge and practices, and Intangible Cultural Heritage (ICH). This chapter also provides the history of recognising the importance of ICH through a series of international conventions, culminating in the 2003 UNESCO convention that provided the scope and definition of ICH and its constituent domains. This chapter looks for the connections between ICH and worldviews as they manifest in the production and upholding of cultural symbols and practices. The understanding of the concept and scope of ICH from this literature research facilitates the understanding of ICH as an internationally recognised form of cultural heritage that is defined by accepted guidelines developed by UNESCO. Since Western science and ICH are both internationally recognised, the literature helps identify an appropriate cultural heritage for this research study that is meaningful in accordance with the scope and definition of ICH.

Chapter 4 looks at the relationship between ICH and traditional knowledge in Thai rice farming and the imported knowledge of Western science that plays a critical role in modern Thai society. This comparison shows that ICH is a major resource for traditional knowledge and played a crucial role in the traditional lifestyle of Thai rice farmers and is how Thai rice farmers imported Western science. The literature can provide a better understanding of the disconnect between traditional knowledge and Western science in Thai rice farming. This chapter also explores the potential of museums to eliminate that disconnect and connect traditional knowledge to Western science by communicating science through cultural heritage.

Chapter 5 presents the theoretical framework for interpreting the connection between ICH and Western science in Thai rice farming derived from the literature research. This chapter presents a concept to use for gaining knowledge in ICH that can be interpreted by Western science. This enables an understanding of how the knowledge of ICH can be connected to

Western science. The chapter also explores the concepts of a boundary object, Intermediary Design Deliverables (IDDs), and boundary crossing that are useful for exploring the connection between the different disciplines. Subsequently, this chapter proposes a design workshop (named ScienceICH) to examine how museums can transform the conceptual framework into a course of action that allows Thai science museums to communicate the combination of traditional knowledge, beliefs, and practices related to ICH in Thai rice farming with Western science.

Chapter 6 presents the results from an application of the design workshop and also presents feedback and recommendations from the participants.

Chapter 7 is a discussion of the findings from the research. This chapter illustrates the connections between the knowledge of ICH and Western science and how science museums can integrate both areas of knowledge to communicate science. This chapter also looks at the potential impacts of this study. The concluding sections of this chapter provide the implications and benefits of this research and recommendations for further study.

CHAPTER 2 WESTERN SCIENCE IN NON-WESTERN CONTEXTS: A MATTER OF WORLDVIEWS

2.1 Introduction

This chapter looks for connections between worldviews, which are one of the main factors that interfere with science education in classroom and in society, and Western science learning and communication in non-Western cultures, while also examining how cultural worldviews work to shape and maintain individual or personal worldviews.

The first section defines what worldviews are and why they are important. The next section then outlines how worldviews in the West have been changing under the influence of scientific developments and industrial revolutions, and how Western science spread across the world. The last section, with Thailand as a case study, discusses the relationship between the worldview that exists within each culture, including the impacts of worldviews on individual's understanding of science and science learning in a non-Western culture.

2.2 Worldviews and their importance

What is a worldview?

The term *worldview* – or *Weltanschauung* in German – refers to the view or perspective of the world and the universe (Koltko-Rivera, 2004). The term has been used for many years, not only in the field of philosophy but also in the areas of anthropology, theology, and education (Vidal, 2008). Vidal (2008) noted that the term has yet to be precisely defined. Many definitions of worldview have been put forward in different disciplines and domains. For example, Koltko-Rivera (2004) lists the following:

> *"[Worldview is] used to describe one's total outlook on life, society, and its institutions."*
>
> (Wolman, 1973, p. 406)

> *"A set of interrelated assumptions about the nature of the world is called a worldview."*
>
> (Overton, 1991, p. 269)

> *"A worldview is the interpretive lens one uses to understand reality and one's existence within it."*
>
> (M. E. Miller & West, 1993)

These examples indicate that one's worldview is a means through which people understand nature, the world around them, and reality. The breadth of meaning of the worldview concept encompasses many important issues of life, allowing researchers in many disciplines to address worldviews. Koltko-Rivera (2004) referred to the areas of knowledge in which worldviews have been deployed, including psychology (Overton 1991), environmental psychology (Altman & Rogoff, 1987), sport psychology (Kontos & Breland-Noble, 2002), general counselling and psychotherapy (Ibrahim, 1991; A.P. Jackson & Meadows, 1991), and multicultural counselling and psychotherapy (Fisher, Jome, & Atkinson, 1998; Ibrahim,1999; Ibrahim, Roysircar-Sodowsky, & Ohnishi, 2001; Trevino, 1996). The diversity of fields of application may explain Vidal's (2008) observation about the lack of a precise definition for worldview. However, the various uses of its concept could imply some similar meanings.

The term *worldview* has not been used consistently, as various other terms appear in the literature to describe similar concepts. Koltko-Rivera (2004) presented a review of such terms by scholars from a range of disciplines. Jung (1942/1954) used the term *philosophy of life* as a synonym of worldview. Peper (1942/1970) used the term *world hypothesis*. Maslow used the term *world outlook* to describe the process through which people understand their world. Frank (1973) used the term *assumptive worlds* to describe concepts that are also associated with a worldview. The term *vision of reality* was used by Messer in 1992 and 2000 in a similar meaning of worldview. Kottler and Hazler (2001) described a *self-and-world*

construct system in their work related to the concept of worldview. Kluckhohn and Strodtbeck (1961/1973) referred to a series of synonyms of worldview as *cultural orientations, value orientations, unconscious systems of meaning, unconscious canon of choice, configurations, cultural theme,* and *core culture* (Castell et al., 2014; Department for Business, Energy & Industrial Strategy, 2020; Koltko-Rivera, 2004). It is clear that many researchers and scholars have used different terms to talk about worldviews. Nevertheless, the diversity of disciplines and areas of study that have looked at worldviews is important for the formulation of a comprehensive understanding of the notion. I will make an effort to summarise these assertations below.

Foster (1966) as cited by Kearney (1975) proposed that worldview theorists, at that time, tended to interpret worldview as the activities whereby the informants behaved deliberately, and it was usually associated with cosmology or how the world and things around them were created. The analysis of worldviews before the 20th century was influenced by philosophy and religions (Koltko-Rivera, 2004). Worldview systems were looked at in relation to how they answered questions regarding theogony (how the Gods came to be) and cosmology (how the earth was created). Through these questions, worldview holders could formulate a sense of how the world works, how things were created, and what entities whether human beings, gods, or others exist in this world and universe. However, Friedrich Nietzsche (1872-1956) proposed that the analysis of worldviews needs to consider more than questions about creation. It should also include questions regarding the end of human life and every human activity (Koltko-Rivera, 2004). Nietzsche thus expanded the scope of worldviews such that attention was paid not only on how gods, humans, and things were created, but attention was also given to the end of life. The German philosopher Wilhelm Dilthey (1833-1911) stated that "worldviews undertake to resolve the enigma of life" (Koltko-Rivera, 2004). Dilthey postulated that worldviews represented a person or a culture's answers to the important questions about life and the universe, from which "are derived life's ideals, its highest good, and supreme principles of conduct" (Koltko & Rivera, 2004). This essentially equated worldviews with the tools that people need to manage their lives effectively. Sire (1976) as cited by Ibrahim (1991) postulated that worldviews comprise the presuppositions and assumptions that we create and through which we view the world. Sue (1978) defined the worldview as people's personal perceptions which connect to their world.

The worldview of individuals and communities develop from and propagate through social interaction and socialisation. Horner and Vandersluis (1981) as cited by Ibrahim (1991) noted that worldviews are connected with cultural diversity. Definitively, the reflection of the worldview in each community is shown as an identity that emphasises the difference of each community. It also reveals the actual relationship between people and the environmental context of their community. Sarason (1984) as cited by Ibrahim (1991) argues that worldviews, which result from the socialisation process, are an important cause in shaping personal goals and behaviours. An understanding of the meaning and value of worldviews provides a clear image of the importance of environmental and social contexts and how they influence people in every community. Differences in these contexts result in a variety of worldviews and cultures.

The traditional practices and beliefs that exist uniquely in each community are concrete evidence of the diversity of worldviews and their importance for the survival of communities. Ibrahim (1991) noted that our belief systems, assumptions, modes of problem-solving, decision making, and conflict resolution are affected directly by our worldviews. He also suggested that worldviews are key in enhancing or obstructing the process of communication and counselling.

Worldviews literature across disciplines has suggested that worldviews represent how we relate to the world or our surrounding environment, as well as influence and affect our thinking, belief systems, actions, and behaviour. Worldviews are therefore a necessary part of life, as they encompass the knowledge that supports and allows people to explain how the world, nature, and life work (Hart, 2010; Irzik and Nola, 2009).

Personal beliefs impact our understanding of how the world around us works. Some beliefs are the product of culture. Each culture has its own beliefs that might have been passed down from many generations, similarly to the worldviews that guide us on how to see the world and survive in our particular geographic locations and social contexts. The diversity of contexts creates a spectrum of worldviews which, in consequence, reflect diverse cultures. Understanding the worldviews of different cultures allows us to understand the people of a culture and how they organise and live in their community. Sue (1978) proposed a model for understanding the worldviews of people from different cultures in counselling sessions. The

model comprises psychological constructs in two dimensions: the locus of control and the locus of responsibility. The model associates those two dimensions with internal or external factors. The model thus identifies worldviews with an internal locus of control and an internal locus of responsibility; an external locus of control and external locus of responsibility; an internal locus of control and external locus of responsibility; or an external locus of control and internal locus of responsibility. Sue suggested that this model can help counsellors to identify specific types of worldviews when considered in relation to an individual's socio-political history, racial, cultural, and ethnic background. Ibrahim (1991) remarked that this model is based on psychological variables that tend to be situational and that the model mainly relies on outsiders (counsellors) who themselves may come from different cultures and contexts; Ibrahim argued that the model therefore provides no method to assess a worldview independent of the counsellor's assumptions and judgment. Counsellor's bias, thus, may compromise the validity of Sue's model.

Ibrahim (1985) proposed a conceptualisation of the worldview which drew on Kluckhohn's (1951) value orientation and value emphasis in various cultures. Ibrahim (1991) suggested that its use in counselling should follow two aspects. It should begin with the clarification of the counsellor's and client's worldviews, including an analysis of their cultural identities (comprising age, gender, ethnicity, culture, life-stage, socioeconomic status, education, religion, philosophy of life, beliefs, values, and assumptions). Then, he suggested that the clarified worldviews needed to be placed within a socio-political context, history of migration, acculturation level, language spoken, and comfort with mainstream assumptions and values (Ibrahim, 1991). The worldview which emerges from the application of this framework can be assessed with the Scale to Assess World Views, which was developed by Ibrahim based on the Kluckhohn method. The scale also avoided the limitations of Sue's model (Ibrahim, 1991). The uses of worldviews in counselling as discussed above highlight the links between worldviews and cultural identities. These uses uncover how contrasting and comparing worldviews and culture can increase understanding among members of a multicultural society, helping to generate a sense of trust and rapport that are most important in establishing effective communication, participation, and engagement (Ibrahim, 1991).

Cobern (1991) referred to the worldview model developed by Kearney (1984) that a worldview is produced from two main components: content and structure. Kearney (1984) as cited by George (1999) suggested that the content of a worldview comprises of a set of organised, cognitive hypotheses or presuppositions about reality. The presuppositions of the worldview are logically and structurally integrated, as the model is termed logico-structural (Cobern, 1991). Cobern (1991) also pointed out that Kearney considered worldview as a structural composite and claimed that the worldview is therefore formed from seven cognitive categories or universals. The seven categories comprise of the self, the non-self, classification, relationship, causality, space, and time. Kearney argued that everything in the universe except the self is non-self. Both self and non-self are the first-order universals of the worldview. The classification, relationship, and causality are the second-order universals of the worldview. Classification refers to people's ability to presuppose on the differentiation of the other or non-self. The relationship relates to the consideration of people when they interact with others. Causality is concerned with the nature of cause and effect. Meanwhile, space and time are the third-order universals. Space addresses the variations of the space in people's perception. The time deals with the difference of how each person considers time. Cobern (2005) argued that persons and groups of persons hold worldviews that result from the content of categories. These categories can help the researcher to identify the worldviews in a specific group of people or community.

Worldviews are an important lens which help us to understand the perception of science in particular environment with traditional practices and beliefs in indigenous communities. Many of the local wisdom or practices within such communities are science and technology in their own merit. In ancient times, the invention of tools and technologies happened before anybody tried to explain or theorise them. The term *indigenous science* has been used to describe the local wisdom and practices that result from the worldviews of each community. Many science educators and philosophers in the area of education maintain that modern science taught in schools is only one of many sciences (Irzik & Nola, 2009). We can notice that many of the practices in our daily lives embody science which cannot easily be seen or taught in the classroom. Many local communities or local cultures have developed their own knowledge – or "sciences" – through many generations. These have been called indigenous science, indigenous knowledge, or traditional ecological knowledge (Irzik & Nola, 2009).

This kind of knowledge has played an important role in helping communities to survive in the real world, and it reflects their worldviews. In the context of science education, many researchers have argued that if we can understand the scientific worldviews of the people in a community, we can use this to create links with Western science and facilitate science learning .

George (1999) studied the worldviews of villagers by the sea in the Republic of Trinidad and Tobago named "Seablast". The research investigated people's notion about nature, particularly traditional knowledge about health and the marine environment, and how this knowledge impacts learning and teaching in school science. The study pointed out the connections in participants' minds between their cultural background knowledge and the knowledge of conventional science. The research found that traditional beliefs and practices affected the villagers' scientific worldviews and the result of the research provided strong evidence that the cultural background of knowledge is a significant factor that impacts science learning. George suggested that children carry to their classes their own ideas which are affected by their traditional beliefs and practices, and these are some of the factors that influence science education in classrooms. Students from a non-Western culture who attempt to construct meaning from Western science in their science classroom will find that prior cultural aspects gained from their own experiences will interfere with their ability – or at least make it difficult to effectively construct conclusive meaning from modern science from their study (George 1999). This is the border between the subculture of science and local student's culture, and it has become an important aspect in science learning. The crossing of that threshold will occur when children are exposed to a new culture, and it will not happen without hindrances (Aikenhead, 1996; Costa, 1995; George & Glasgow, 1999; Phelan, Davidson & Cao, 1991). George pointed out that education in science is important to cross the divide between the subculture of traditional knowledge and students' subculture of science. This challenges science teachers as to how they can provide suitable facilities to enable their students to reach this understanding. This five-year study by June George created highly reliable data and suggestions that contributed to the area of science education and science learning to effectively design lessons, exercises, materials, and teaching environments suitable for bridging the gap between traditional knowledge and science.

A case study by Harrison and Rose (2010) pointed out the indigenous Australian worldviews that the indigenous ontologies tied firmly to a philosophy of "becoming". They also referred to the work of Mary Graham (2008), who identified two basic precepts that play a key role in Aboriginal worldviews: *The land is the law*, and *You are not alone in the world*. In the West the concept of dualism derived from the work of the European philosopher Descartes has served to distinguish between nature (non-human-made 'things') and culture (human-made 'things'), the material and the non-material, and the physical and the cultural world. The distinction extends to heritage, manifesting as natural and cultural heritage, or as tangible and intangible heritage. However, the work of Harrison and Rose (2010) suggests that this dualism is absent in non-Western worldviews – such as the Aboriginal worldview. Indigenous cultures tend to view the natural and the human-made world as one. Their point of view is holistic, where everything has a relationship and connection with everything else. The Western culture separates the land, rivers, forests, mountains, or the natural world from people; the Indigenous Australian cultures embrace humans, environment, living things, and non-living things in the landscape. The Land, in this perception, refers to more than space and includes everything in the space, as this culture considers the relationship of everything. Using the seven cognitive categories proposed by Kearney (1984), it might be able to conclude that the non-self is not as clearly isolated from the self in Aboriginal worldviews. Harrison and Rose (2010) also suggested that these people look for patterns, relationships, and connections among persons. This indicated that non-Western cultures understand the world differently.

These differences can have implications for the communication of modern science. For example, Gibson (1996, cited by Cobern 2000) discussed South Pacific islander views of tides and the rise and fall of the sea level. They believe that the ocean rises and falls are caused by the movements of the great sea turtles. The islander believes that the leaving and returning of the great sea turtles to their home, which is located in the sand beach of the island, causes the changing level of the sea. In other words, the moving of the great sea turtles in the ocean generates the tide and results in the tidal movements. Meanwhile, Western science explains that the tidal changes are caused by the moon's gravitation. The natural phenomenon in the indigenous view can be closely related to their physical perception. Thus, indigenous knowledge is usually tied firmly with the nature and culture of indigenous people

(Cobern, 2000; George, 1999; Lemus et al., 2014). This is in accordance with the work of Lemus et al. (2014) who explained that Native Hawaiians believe that they have a very close relationship with the natural world and with other organisms as a family, considering no physical difference between living and non-living organisms on which to base a concept of the 'non-self'. Thus, the Native Hawaiians believe that a piece of stone (non-living organism) and a cow (living organism), for example, are not different in the natural world and the existence of both relies on each other. They try to connect every*thing* and every*one* in their natural world with each other rather than dividing them (as natural science classification system would do).

Lemus et al. (2014) suggested that scientific culture concerns the elements in our environment, as they can be tangible and measurable. Thus, scientific culture does not consider metaphysical phenomena, as it is not tangible and not testable (Lemus et al., 2014). Meanwhile, the worldviews and culture of Native Hawaiians include more than physical elements. Kanahele (1978) as cited by Lemus et al. (2014) suggested that both the metaphysical and physical can be considered as one in the view of the Native Hawaiian. Lemus et al. (2014) pointed out that Western science seeks an explanation and prediction of universal truth about the natural world explicitly through theories and principles. The Native Hawaiian culture has a similar purpose implicitly through language and culture, such as through metaphors, stories and legends, chants, dances, songs, and oratories. This instance confirmed a core concept of interpreting the world as a relationship between everything in the indigenous view, while in contrast, the Western paradigm creates a dualism mechanistic consideration. Even the discourses, theories, and principles in Westerners and the cultural forms in the indigenous people point to the differences between the Western worldview (scientific worldview) and indigenous worldview. This understanding is useful for designing communication to implement science learning through a culturally sensitive approach in science education and communication (Lemus et al., 2014). Irzik and Nola (2009) proposed that local cultural belief systems or indigenous science should be taught alongside mainstream science in the classroom. I agree with this approach, and I also believe that this has the ability to enhance and support modern science in both school environments and informal science learning settings.

2.3 Western science and scientific worldviews in the West.

As we know, science is one of the areas of knowledge that provides benefits and becomes an essential for human life. The word *science* refers to more than a sense of knowledge. It also provides a sense of validity, complexity, systems, structures – including a picture of Western culture to many non-Western populations. Science originated in Greece and was reformulated into a modern science in Western countries in the sixteenth century before gradually spreading throughout the world (Chalmers, 1999; Crofton & Black, 2016; Gribbin, 2009). Science inevitably affects people's worldviews. It is worth considering how and why science, particularly Western science, has the potential to interfere with people's previous worldviews. This section looks back in history to review the development of Western science and examine how it has affected the way people see the world and why it has become the main tool for modernising society.

Since ancient times, humans have been believing in God and the supernatural (Crofton & Black, 2016; Gribbin, 2009). The mystery and power of nature influenced people's lives for a long time. Their living relied on their faith and belief. People live with natural disasters and natural phenomena that generate a sense of awe and a fear of life. People learned to live with nature, and science and religion were used, for a similar purpose, to explain and understand the natural phenomena. One of the significant differences between science and religion is that religion posits that all-natural phenomena and disasters result from God. For example, Buddhists in Southeast Asia (under the influence of Hinduism) believed that there was a certain god in the sky named Pra Pirhun who had the ability to rule the weather and could cause heavy rain, storms, drought, thunder, and lightning. As a result, farmers – whose living and livelihood relied on the weather – sought to please him in different ways; ceremonies, worship, and offerings in exchange for benefits. On the other hand, science seeks to search for the causes and theorise the understanding of the natural phenomena. For example, science provides the explanation that severe weather results from dynamic changes in moisture, air, pressure, temperature, and electricity. This leads us to understand that science and religion

both examine natural phenomena and share a similar purpose to understand life through nature. However, they usually offer different explanations.

In science, observation and experiments become the main approaches to examine the facts. Similarly, it was found that in history that many cultures had made systematic observations on astronomical events such as lunar cycles, solar solstices, and equinoxes for their agricultural practices. For example, in the lunar cycle, people observed the changing phases of the moon night after night and found that every twenty-nine to thirty days (29.5305882 days on average), the shape of the moon repeats itself. This allowed them to count a complete lunar cycle as a month, giving them a metric of time that was important to ancient farmers for managing their crops and harvests. While not explicitly articulated, science was discovered and has been used since ancient times.

Science (the thought about nature) flourished most in the Greek era. Even though Greek scientists were curious to understand the facts of nature, much of the population also believed in gods. Scientists, however, associated results with science and science's product, technology. One can say that the Greek culture is significant in that it laid the foundations of the disciplines that are now called science (Crofton & Black, 2016). Greek philosophers explored both the reality of nature and the facts of the physical world. At that time there were many philosophers who explored and discovered facts that became significant ideas which influenced followers and scientists for thousands of years, such as Ptolemy (5th century BC) with the concept of a heavenly sphere and Earth as the centre of the universe, Thales (5th century BC), who discovered the strange property of material now called electricity, Aristotle (4th century BC), with the idea that the world is made of the balance of four elements, and Galen (4th century BC), a pioneer in biology. Many concepts related to "the thought about nature" (science in the present) inspired the structures and architecture of buildings which needed to be accurately calculated in their design through high-skill civil engineering – such as in structures like the Parthenon in Athens. However, Greek natural science was considered to be derived from and influenced by Greek beliefs and practices (Brown, 1986). Greek philosophies inspired philosophers and scientists to discover and develop science.

After the Greek Empire faded away, advances in philosophy and science declined in Western culture. Europe was moving into massive changes brought about by the Roman Empire as

Western society entered the Dark Ages or the Middle ages (5th – 15th Century), the millennia wherein every way of thought must be subjected to the Christian church. However, philosophy and scientific knowledge did not disappear. Muslims (followers of Islam) were the people who adopted the kinds of knowledge from Greece and Egypt. In Europe, during the reign of the church, the knowledge of science was transferred from the west and was cultivated in Islamic soil. The knowledge of science which had emerged in Western culture even began to develop and grow in Islam culture. The golden age of Islam thus emerged during the dark ages of Western culture. There were many scientific theories and technologies which were discovered and developed in the land of Islam such as the theory of optics and medicine during that time.

Development of scientific knowledge flowed back to Europe in the late middle ages, around the 14th to 16th century. At that time, the knowledge of science had to overcome the massive obstacle in Western culture – the power of the church. However, it seemed that science had a good opportunity to win because the power of the church was declining. Some of the reasons for the falling of the church's power resulted from the split between Christians, the breakdown of the feudal order, the uncertainty of the politics in Europe, and wars. These became a permanent crisis for hundreds of years up to the late 16th century (Shapin, 1998) when the age of modern science was beginning to evolve. Europe was passing into the time of scientific revolution that significantly changed the Western culture and the entire world.

2.3.1 The age of modern science and the new way of understanding the world

It is widely accepted that modern science has been making rapid progress largely since the "new method" (Novum Organum) was launched, by Sir. Francis Bacon (1561-1626) along with the development of new scientific instruments such as the telescope, the microscope, the barometer, the air-pump, and the pendulum clock, and much significant scientific knowledge was created and influenced by public attitudes toward science. Before the time of modern science, the concept of natural science was likely formulated from belief-based rather than observed fact (Brown, 1986). The most powerful factor that influenced people's attitude before the 16th century was religion. Brown (1986) explains in his book, *The Wisdom of*

Science; its relevance to culture and religion, that one of the main obstacles to bringing science to the Western culture was literary works. Brown (1986) pointed out that the beginning of modern science's development in Western culture (before the16th century), most scholars devoted their works to religion. At that time, there was a very small number of books, and even fewer were linked to science, as most of the books available were devoted to religion. He also mentioned that in Great Britain during the 16th and 17th century, there was a great educational expansion targeting laypeople. The number of schools in Great Britain increased more than ten times compared with earlier periods. However, there were very few books in private hands, as most of the books were kept and used by the Church. During this time, learning was a monopoly of the Church, and science was not a priority of the Church. Public learning was usually based on religion and beliefs, not on science. The Church's objective was to persuade society that everything on earth including life was explained in relation to God and religion's purposes, not natural science. Brown (1986) cited one of the greatest authorities of the Christian Church, St. Augustine, to show clear evidence that learning about science was not accepted by the Church, at that time, as: " 'who can measure the heavens, number the stars and balance the elements' is no more pleasing to God than one who cannot" (Brown, 1986). Regarding these views, it is important to point out that the worldview of Western people, in the time before modern science, was strongly framed by religion – mostly by the Christian Church. During that period, people's lifestyle was affected and influenced by religion. Medieval people believed that many natural disasters such as heavy storms, drought, and the eruption of volcanos were associated with the power of their God. This worldview was reflected in many of the artworks from the period, in which it is usually found that most of the famous paintings from the middle ages were dedicated to and portrayed a connection to the stories of God, the saints, and the church, such as the last supper painted in the late 15th century by Leonardo Da Vinci.

The religious worldview in Western culture was shaken in the 16th century. The monopoly of learning by the Church was broken, in Western culture, by the significant development of printing in the 16th century (Brown, 1986). Sir Francis Bacon proposed that there were three significant things that brought Western culture to the age of modern science: the printer, the compass, and gunpowder (Crofton and Black, 2016). The increasing of number of printers ushered Europe into becoming an economic society. Many of academic works were easily

transmitted to the public through printers. Brown (1986) presented that people were more interested in progress in their society, and the merchants paid more attention to material aspects rather than spiritual aspects, as the result from books and documents printed. The general public accessed knowledge more easily than ever. People more invested in the world around them, led to the alteration of their attitude toward the world. Scientific knowledge became the fundamental importance in their lives. The compass became crucial equipment that enabled Western explorers to conquer the new world. The power of gunpowder provided a massive potential for the Westerner to have a great advantage in many important fights and wars. These factors led Westerners to further changing their worldview. They discovered new lands, new resources, new environments, new cultures, and new experiences. Other people easily accessed new knowledge and experiences through books. The worldview of religion was affected by a new paradigm of knowledge when modern science was disseminated. The popularity of science changed attitudes toward the world, and affected people's worldviews.

Important scientific discoveries were made at the beginning of the age of modern science. Specifically, there were two scientific works that were accepted as the starting point of modern science: the work of Nicoli Copernicus and Visulias in 1543 (Gribbin, 2009). In the age of Greece and Rome, many philosophers and scholars believed that the earth was the centre of the universe until the age of modern science – the 16th century – when Copernicus presented his idea suggesting that the earth was not the centre of the universe. His idea was formulated from a thought experiment, not from an actual experiment, nor was it the result of observations. Thus, Copernicus could only submit his idea without any empirical evidence (Gribbin, 2009). Copernicus's suggestion in the 16th century was later confirmed with evidence in the early 17th century by the using the telescope invented by Galileo in 1632. Galileo's observation with a telescope to present crucial evidence that the earth is a planet which is orbiting the sun was one example of a certain process to accept what is scientific knowledge. Copernicus's theory is valid but, in his time, there was not enough equipment to observe and measure objects far out in space. The popular paradigm about the earth and the universe shifted as a result of the expansion of scientific knowledge and the study of cosmology, which had extended significantly after great exploration.

During the same period, after Galileo explored and presented evidence on the heliocentric theory by using the telescope, another important scientific instrument was developed and used to explore something that changed attitudes toward the world forever: a microscope (Brown, 1986). Anthony van Leeuwenhoek, an Amsterdam merchant, and Robert Hooke, a British man, brought people to a whole new world – the world of the very small objects. They discovered the world of microscopic lives that cannot be observed by the naked eye. The discovery revealed many facts surrounding small lives. The life cycle of a small creature such as a flea was discovered, destroying the medieval theory of "spontaneous generation" that stipulated that small animals and insects were spontaneously generated from inorganic matter like dirt, wheat, or mud. As a result of using the appropriate tools, instruments, and methods, science has provided empirical evidence and endorsed itself as true knowledge. Being based on empirical evidence, the knowledge gained through science can be seen, touched, heard, smelt, or measured (Chalmers, 1999). These examples are important because they show that the evidence behind scientific knowledge created a new paradigm of knowledge and changed attitudes toward the world, which in turn resulted in the changes in worldviews.

Cobern (1991) pointed out that modern science and its mechanistic view of nature have gradually been distributed throughout the world. He referred to George Basalla's work in 1967 to argue in favour of the spread of modern science in a non-science society. He suggested that in order to apply or initiate a new concept of science to society it is imperative to be concerned about the existence of scientific knowledge before transforming into independent science. The important task of such transformation is the involvement of society's resistance to science. Traditional beliefs and religious beliefs as an important part of the content of the worldview, had to be overcome and replaced by positive encouragement of scientific research (Cobern 1991). Horton (1967) as cited by Cobern (1991) argued that the people of non-scientific societies usually have worldviews that are different from scientific-based thinking. Although they tend to be rationality based, they are generally approached in a non-scientific manner. To grow in society, independent science needs to be supported by the population and the context. It will not be acknowledged when science is the hegemony of culture and intellect (Cobern 1991). Through this transformation mechanism, science can successfully move to non-scientific areas. Populations will accept and consider the science that is compatible to use with their life.

Modern science is powerful, possessing the potential to bring societies into better qualities of life. Science and its applications – technologies – are used widely throughout the globe. Since modern science began in the 16th century, scientists and scholars have discovered many things that have been crucial to humanity (Brown, 1986). It is notable that there were so many discoveries and inventions applied during these few hundred years. Discoveries such as electrons and magnetism, for example, significantly changed the lifestyles of many. When electricity was discovered, electrical devices emerged, such as the light bulb, radio, refrigerator, and television. The discovery and understanding of new chemicals, gases, and chemical reactions brought the world into the age of the industrial revolution. The uncovering of the structure of deoxyribonucleic acid – DNA – resulted in the genetic improvement of many plants and animals.

Science and technologies are a part of everyday life. They are in foods, clothes, medicine, housing, shelters, and also in war. Science and technology have usually been used in war. In World War I, there was the development of poisonous chlorine as a chemical weapon. The First World War is usually called the Chemist's war (Brown, 1986), where the gas mask became its symbol. For the Second World War, the allies invented a mass destruction bomb which had never been used before and this war is called the Nuclear War (Crofton and Black, 2016). After World War II, science and technology has been used in many wars in many countries until the present day. The perception of science and its products became a dilemma for the general public, and the negative side of science was raised due to this power of technology in war. Science not only provides benefits, solves problems, and creates better lives for people – but it also has the potential to generate problems (Brown, 1986; Crofton and Black, 2016). In the post-war period, the public view of science has, therefore been more negative due to social and ethical questions raised by the devastating use of science and technology.

To conclude, before the 16th century in Western culture, the way that people shaped the world was massively influenced by religion and belief. When modern science began to develop in the 16th century, attitudes toward the world in Western culture gradually changed. Many beliefs and practices of the general public, philosophers, and scholars were challenged by the coming of a knowledge that relied on observed facts – modern science. There were many

conflicts between the Christian church and people outside the area of religion due to the development of science which provided and certified concepts that sometimes were not associated with the church (Du Toit, 2007). Many scientists have linked religion and beliefs to science in efforts to reconcile the two institutions, as both science and religion share importance for mankind (Du Toit, 2007).

The way people see how the world works has changed over time. As time passed, humans explored and discovered more facts, and science developed. According to the empirical evidence, people's comprehension about natural phenomenon changed. The scientific revolution in the 16th century was a significant turning point. It brought the world to a time of modernisation. Science and its result – technology – changed people's lives forever. The world advanced into the industrial age in which all societies became associated with mass production. Populations began to move to large cities for jobs, money, and better lives. Lifestyles of most people shifted from living with nature into living with materials. Western people travelled, discovered, and conquered other lands in order to search and deliver materials to their own countries such as clothes, fruits, herbs, tea leaves, and slaves. They expanded their horizons. In the meantime, Western science and technology also spread into the new lands. The native thinking about the world was unavoidably shaken by knowledge and culture from the West. The new views affected the existing paradigms. Learning new things affected the existing experiences of each person. Their worldview is one of the significant factors that provided the potential to influence learning in general, and learning science was not an exempt.

Science has been defined and applied on different levels of interaction. It has been linked to many kinds of activities and purposes from the work of scientists searching for new knowledge (basic science) to the work of scientists aiming to resolve issues or innovate (applied science) (Hathayatham, 2005). These terms have been used to refer to many activities that utilise science knowledge as a fundamental tool for developing, designing, and creating new products in fields such as the industrial sectors (Weigold, 2001). Moreover, many other disciplines can be classified as science to some extent such as social science, behavioural science, and environmental science (Friedman & Dunwoody, 1988). These perspectives can help us connect science with other forms of knowledge. Considering what

we have seen and how we have defined science from these views, it can be assumed that everything around us is science and its product; as Hatyatham (2005) stated, "science is everything and everything is science". Thus, understandings of what science is varies on the individual's educational background. The knowledge that people use in everyday life can become science in their view, but it may not be accepted as science when considered from an academic perspective because the knowledge has not been proven or affirmed by any evidence yet. Supernatural activities and local myths are examples of this disparity in perceptions of what science is. These kinds of knowledge can generate conflict in society and can become a big issue when Western science interferes with traditional science.

2.3.2 The distribution of science across the world and the alternative way people shape nature

The modern scientific worldview was originally developed throughout the intellectual movements in Europe during the 16th, 17th, and 18th centuries (Cobern, 1991). The mechanistic ideology which derived from the philosophical arguments of Rene Descartes and the works of Newton and Boyle were the crucial foundations of modern science (Cobern, 1991). Cobern (1991) argued that the mechanistic view involves considering the whole to be found in the parts. It is a reductionistic view. Kuhn used the term *worldview* in reference to his scientific paradigms concept to refer to people's world in their mind, which involves disciplines of science. Cobern (1991) extended the example to the world of biological science concerning evolution. The evolution concept is a worldview or paradigm of the biological world. This example shows that the worldview or paradigm refers to the most important concept that impacts the world (individual world). Cobern (1991) illustrated that the worldview of Europeans grounded on the Greco-Roman and Judio-Christian traditions were associated with scientific-based thinking. This is because Europeans were influenced by scientific thinking – particularly since the 16th century. This is, therefore, inferred to be a Western worldview (Cobern, 1991). Cobern (2000) suggested that the nature of science is naturalistic and materialistic, concerning natural phenomena that can be empirically tested and acknowledged by the scientific community. Western science also involves collecting data as evidence, before forming an explanation from those data (Driver et al., 1996). Cobern (1991) suggested that the Western or the scientific worldview is associated with a primary

goal of science education in modern Western education. Western science has shown many benefits to the world (Brown, 1986; Chalmers, 1999; Cobern, 2000; Yuthavong, 2017). However, we cannot claim that Western science is the whole of science. It is, in fact, one of the sciences (Cobern, 2000; Gauch, 2009; George, 1999; Kawagley, Norris-Tull & Norris-Tull, 1998). This view makes it clear that science is not the only one knowledge in society. There may be many different forms of knowledge hidden in multiple places or expressed in distinguishing ways than Western science.

Exploration and colonisation of the Europeans since the 16th century has broadened Western power, culture, and worldview – or scientific worldview – to lands outside of Europe (Cobern 2000). Western science has been used as a tool to modernise people's lives throughout the world. Cobern (2000) pointed out that knowledge within the non-Western community – or indigenous knowledge – around nature has been regarded as ethnoscience, not science. Considering that traditional or indigenous knowledge cannot be counted as science may lead to tension between the modern educational system (strongly rooted in Western science) (Cobern 2000) and local students, who are associated with traditional worldviews and knowledge (George 1999).

2.4 The worldview in non-Western culture: A case study of the Thai Worldview

Many scholars who have studied the Thai social structure have suggested that Thai society and Thai social norms were mainly influenced by Buddhism. This influence affected the Thai worldview, as the religion is rooted in and has been associated with Thai society for thousands of years (Anuman Rajadhon, 1986; Chaipraditkul, n.d.; Mahamontri, 2014; Phra Thēpwēthī, 1990; Piyadassi, 2005; Pongsapich, 1998; Tinnaluck, 2005). Thus, to understand the character and worldview of Thai people, one needs to consider Buddhism as a key factor in Thai society (Tinnaluck, 2005). In the book *Traditional and changing Thai world view,* Pongsapish (1998) referred to Hanks' (1962, 1975) perception of "the essence of Thai world view" as "a cosmic hierarchy whose levels are defined in terms of 'merit' (bun) or 'demerit' (bap)". In other words, Thai society is a hierarchy in which each level has its own value, and the individual's level is determined by what that person has done in their own past or in a

past life. For example, if I gain much merit (bun), by helping others when they are in trouble, in this present time then it will enable me to reach a higher level of the hierarchy in the future or in the next life. In the same way, if I create much demerit (bap) by making other people suffer by my actions, such as by stealing money or property from other people, it will affect me even in the present day, pulling my life down to a lower level. Thai people believe that the members of higher hierarchical levels enjoy more advantages and better well-being than those in lower levels, and hold reaching a higher level as one of the greatest goals in their life.

Moreover, Hanks (1962, 1975) also mentions that Thai society created the form of "entourages", which is comprised of a patron-clientele as the main relationship. This results from a deep root of the Buddhism tenets which suggests that Buddhists could live in harmony and should show kindness. Buddhists are expected to do good and support charities and social activities as much as they can, but the good that they are willing to do must not provide harm or exploit themselves or others. Pongsapish (1998) also referred to the work of Klausner (1964, 1972), Piker (1968), and Bunnang (1973) that the Thai worldview in rural areas of Thailand was basically impacted by religion. The work of Skinner (1954, 1957) and Evers (1966) postulated that the worldview of the urban areas was more influenced by socio-economic-political factors. The effect of these factors is that the Thai worldview will change from a traditional religious, Buddhism base to a non-Buddhism view influenced by Western and Chinese aspects. The significant factor that impacts this change came from the uncertainty of the political situation in Thailand (Pongsapich, 1998). After a big change in the political system in 1932 and a massive coup d'état by the military in the year 1973, views on social order has changed. People's lives were influenced by the political economy rather than by belief. They became more concerned about the commercial issues that relied on the stability of the government, which had a greater impact on their daily life. However, the world view of Thai people is still pivoting around the concept of 'Karma' which governs all relationships in Thai society (Pongsapich, 1998). Karma is explained that the result of the actions that a person commits – either good or bad – will be reflected in their lives. This means that when a man does something good, it will reflect a good thing into his life and it is good Karma. If a man commits a bad action such as a crime, he will get bad Karma in return and he will be punished. In conclusion, the concept of Karma, cosmic hierarchy, merit

and demerit, patron-clientele, and the changing of socio-economic-politics which were influenced by Buddhism have played an important role in formulating the Thai worldview in both the rural regions and the urban areas (Pongsapich, 1998). However, Pongsapish (1998) suggested that the traditional beliefs that are rooted in Buddhism seem to have changed gradually in the Thai social order. This has affected urban areas faster than in rural regions. Thus, the worldview may change with time, changing the context of the society.

2.4.1 Thai worldviews and Western science

It has been known that most Thai worldviews have long been influenced by beliefs and religions, especially Buddhism. Before the inception of Buddhism, Thais followed Hinduism and Brahmanism – as evidenced by ancient religious buildings such as temples, sacred, and divine figures – and Indian and Cambodian ways of thinking (Anuman Rajadhon, 1986; Chaipraditkul, n.d.; Phra Thēpwēthī, 1990; Pongsapich, 1998; Tinnaluck, 2005). A religion that worships many immortals and influences the hierarchical order in society. Thais in earlier times were animists, believing in ghosts and spirits. In this belief system, there are various types of spirits, both good and evil. Good spirits are said to include deceased ancestors, household spirits, Phosop (Rice Goddess), and Phra Mae Thorani (Earth Goddess), which protect and bring good fortunes to those who respect them. Evil spirits are those harming the living, such as Phi pop, Krasue, and Pret. When the religions arrived in Thailand (Hinduism, Brahmanism, and Buddhism), they were first adopted by royalty before spreading among commoners. Religious beliefs then combined with former worldviews and animist beliefs, probably due to the gradual acceptance of the new (Department of Foreign Trade, Ministry of Commerce, Thailand, 2016; Gomes, 2001; Gomes et al., 2001; Rice Department, 2009, 2016; Sudchaya et al., 2005; Thai Rice Foundation under Royal Patronage, 2006a, 2006b). What is beneficial tends to be adopted quickly, yet it depends on the characteristics of each community. For instance, members in a community might worship a form of spirit and conduct a form of fertility ritual. If this practice did not produce a satisfactory result, the community members might turn to another religious ritual practised by another community which they assume more effective. The new religion or set of beliefs would then be combined with the community's former animism.

Most Thai people today practice Buddhism. The Thai version of Buddhism has a distinct characteristic, as agreed upon by many existing studies. That is, it is a combination between Buddhist and other existing religious beliefs, including Animism, Hinduism, and Brahmanism deeply embedded in Thai culture (Anuman Rajadhon, 1986; Chaipraditkul, n.d.; Chutavichit, 2005; Mahamontri, 2014; Phra Thēpwēthī, 1990; Piyadassi, 2005; Pongsapich, 1998; Tinnaluck, 2005). Arriving in Thailand in the third century, Buddhism became blended with these existing beliefs. This can be seen today in the rituals ranging from local levels to royal ceremonies. One example is the celebration of newly constructed house that usually includes the merit-making in Buddhist ceremonies alongside Brahman rituals to pay respect to the deities. This is an example ritual which usually performed by Thai Buddhists. Thailand, thus, became a Buddhist-based society while still practising rituals of more than one religion. Buddhism has profoundly influenced Thai ways of living and looking at the world and dominated the worldview of most Thais, however– as mentioned above, it is a version of Buddhism which is merged with some other religions. The Thai Buddhist worldview is founded on five cosmological concepts: hierarchy, merit and demerit, Bun Khun, cool heart, and individualism (Pongsapich, 1998).

The notion of hierarchical society is based on the Buddhist concepts of rebirth and karma. Rebirth caused by karma is part of Buddhist doctrines, which can be found in major Thai literature entitled *Trailokya* or *Three worlds* (Chutavichit, 2005; Pongsapich, 1998). According to Buddhist cosmology, the universe is divided into three worlds: 1.) Karmaloka, the world of desire, greed, anger, lust, and passion, 2.) Rupaloka, the world of purity free from lust and passion, 3.) and Arupaloka, the world where souls are independent of bodies. These three worlds are dissimilar in terms of the beauty, fear, convenience, and suffering they create. Each world is divided into many different lands. It is karma that determines in which land and world a life is (re)born. Every life is subject to rebirth in one of the three worlds until it achieves nirvana, which releases it from endless cycle. As rebirth is determined by karma, those with good karma will be reborn in a pleasant world whereas those with bad karma will be reborn into a world where they need to suffer to repent their karma. It is also based on karma to indicate whether a person will be born into a well-to-do or deprived family, be rich or poor, be able-bodied or disabled. This ideology influences hierarchical order and inequality in society. Those with high social status expect respect from those in lower classes.

This idea is in fact influenced by the caste system in Hinduism, because Buddhist teachings put an emphasis on a person's action rather than their caste.

2.4.2 The concern about merits and sins.

Pongsapich (1998) claimed that the Thai worldview also related to concepts of merits and sins which have been rooted in Thai culture. These components are also related to cycles of rebirth. It is believed that merits lead to rebirth in a pleasant world or with a high social status, whereas sins result in the opposite. Therefore, Thai believers perform rituals for increasing merits and reducing sins as much as possible in order to have better present and future lives. This way of thinking is closely associated with the idea of karma. It is believed that karma is an action. Doing a good thing or creating good karma brings good results (one action causes another). The concept of karma coincidentally corresponds to the scientific law of cause and effect: one phenomenon is a result of another. For example, a tsunami is caused by an abrupt movement of a large number of waves. The triggers might be an earthquake or a giant object falling onto water causing a series of large waves to hit the shore. Thus, the scientific explanation of cause and effect is similar to the law of merits and sins. Merits, or good karma, are caused by good thoughts and actions. For example, when one gives money to a person in need, they will feel happy and proud as a helper. The satisfaction of helping another person is due to a willingness to relieve their suffering, which leads to merits and good karma. Smiling, according to Thai believers, may have a similar impact in helping others by relieving a suffering. In the Buddhist sense, happiness brings peacefulness and relaxation, which improves concentration, reduces anxiety, and then leads to success.

Bun Khun is an idea about interdependence among members of society (Pongsapich, 1998). They help one another when possible, based on the principles of gratitude, thankfulness and reciprocity, which leads to peace in society. The notion of gratitude is common among Thai families, especially in rural areas, where different generations within families live together and rely on each other. Younger generations express their gratitude by taking care of their parents, grandparents or kin, which marks a major characteristic of a traditional Thai-style extended family. Gratitude and reciprocity are considered important morals deeply rooted in

the mentality of the Thai population. Thais have a positive attitude toward morality. One with a high sense of morality is considered a good person. That is why it is common to see Thai people being interdependent on one another. Those in need are usually offered help by others. In return, they will express their gratitude to those who helped them as well as continue helping others.

Cool heart explains a principle Thai people adopt to control their emotions and feelings when facing difficulty (Pongsapich, 1998). An ability to cope with pressure in life is considered an important value. Phrases such as 'that is okay' or a smile is often expressed to remind themselves to control their temper, emotions, and feelings in order to handle the problems they are facing. This concept corresponds to the idea of karma. Many believe a problem they face is the result of a sin they committed in the past. This karma is unavoidable, but it will end sooner or later. That is the reasoning they use to calm themselves.

Individualism is another important concept in Thai worldviews (Pongsapich, 1998). It refers to an attempt to overcome a problem by oneself. According to Buddhist teachings, liberation from rebirth is the most important and ultimate goal of life. Liberation, in turn, relies on self-dependence in contemplating the truth of the world, which leads to a true understanding of the universe, freedom from all kinds of suffering and cycles of rebirth. Self-dependence, or self-reliance, are similar to self-esteem; possessing self-dependence thus also increases one's confidence in everything they do. Self-dependence tends to be a desirable characteristic among Thai people, which reflects society's individualism.

Thai worldviews are linked to people's continuous interrelatedness to both natural and supernatural elements. For example, Mahamontri (2014) analysed how proverbs reflect Thai people's attitudes towards one another as well as towards natural and supernatural elements. He found that Thai people's ideas of these three elements, namely towards other humans, natural elements, and supernatural elements, reflect the interdependent characteristic of Thai society. Further, regarding the character of an individual, Mahamontri (2014) found that everyone is expected to be a good person. Inner beauty is more important than physical appearance or social status, as behaviours are controlled by the mind, and every person is expected to behave in such a way that benefits the entire society. Finally, Mahamontri's study of Thai worldviews through proverbs also gives some insight into attitudes towards a

person's knowledge. Education, knowledge, and wisdom are considered important and valuable because they enable a person to gain higher social status, power, prestige, wealth, honour, and fame to enhance their life. A person equipped with knowledge is expected to behave well and cautiously. Mahamontri found that Thai people also believe that serious and active learning improves knowledge. Nonetheless, Thai society values a person's morals and ethics above knowledge.

Regarding their attitudes towards nature, Thai believers profess their harmonious coexistence with nature. Thai lives have been intermingled with trees, water, oceans, mountains, wildlife, and plants. Traditional Thais rely on the natural world in order to fulfil the four basic needs of food, shelter, clothing, and healthcare, and they believe that nature is out of human control. Any natural phenomenon that is beyond human control should be left as it is. Similarly, any event that is out of control is usually regarded as a natural phenomenon.

Regarding the supernatural world, Thai people believe that it has the power to determine happiness or destruction in human life. Anyone who treats supernatural beings with respect will be rewarded. In contrast, disrespect will lead to a disastrous consequence. Moreover, the supernatural is believed to have power to control the natural world, being able to do what humans and nature are incapable. To this worldview, the supernatural looks like some technologies derived from science have the ability to make rain for drought areas and some can cause pollution instead of pure air.

Additionally, Mahamontri's (2014) work argued that most Thai people, both in the urban and rural communities, have changed. Contemporary Thai worldviews tend to accept and adapt to the contemporary worldviews, which are influenced by changes in economic and political systems, the expansion of education, and the advancement of science and technology.

2.4.3 The changes in Thai worldview

A change in Thailand's economic system is an important factor behind the modern changes in Thai worldviews. The reigns of the Sukhothai (1238-1438) and Ayutthaya (1351-1767) Kingdoms operated self-sufficient economies based on agriculture such as rice and plant

cultivation and animal breeding. The leftover of domestic consumption were exchanged for other products such as silk or salt. Money did not dominate the exchange system as it does today until the Royal Court started official trading with foreigners. Since this alteration, the economic system has transformed. An important turning point is during the reign of King Rama IV (1804 – 1868), when the British ambassador Sir John Bowring with his group was sent to Siam in 1854, which resulted in Thailand entering into the Bowring Treaty. The treaty increased international trade – especially for agricultural products such as rice, which were exported to Britain. Rice was not widely consumed in Britain, but the country acted as a middleman, selling Thai products to other countries. As a result, the Thai economic system was transformed with money being an important tool in exchange. The Bureau of Royal Thai Mint was therefore established to produce money sufficient for trading with foreigners. Agriculture was then replaced by industry and capitalism, in which money – rather than their functions – became the measure of agricultural and other kinds of products. This economic system reinforced the idea that money was an important factor in life and a tool to demonstrate one's social status.

This change in the political system is considered another factor behind the change in the worldviews of some groups of Thai people. Thailand used to be a kingdom under the absolute monarchy in which the king had an ultimate power while his people had no political rights. It was not until 1932 when the country was turned into a constitutional monarchy in which people became more involved in politics. Since then, the population have played a more important role in formulating rules and regulations for their own society. Citizens' views of everyday life were therefore changed. Those who never questioned the state's power started to fight for their rights democratically. The political system that was based merely on moral rules, norms and cultures started to be replaced by notions of equality, rights, and freedom under the constitution.

Education expansion is another factor behind the changes in Thai worldviews. In the past, education was reserved for men, who received education, took care of their families, and served the king and country (Department of Agriculture, 2002; Lapruay et al., 2009; Museum Siam, 2011; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Payanun, 2000; Rice Department,

2016; Satsanguan, 2002). Meanwhile, women were restricted from education and their jobs were limited to household chores. This norm was challenged by women's roles as fighters in different historical events, which demonstrated that they were as capable as men. Thus, it was decided that education should not be reserved only for men. An important turning point in education expansion was in the reign of King Rama IV. At this time, teachings became available for women, starting from within the royal palace in year 1851 before expanding to public. During the period of King Rama VI, the Compulsory Elementary Education Act was proclaimed, which allowed both male and female children's access to equal education (Mahamontri, 2014). Education expansion resulted in younger generations' change in attitudes towards equality in society.

The final factor is the advancement of science and technology. According to historical studies, Western science and technology were promoted to the Siamese by missionaries, traders, and ambassadors during the Ayutthaya Kingdom (1351-1767). As there was ongoing warfare during this period, science was not delivered to the public nor used effectively in developing the country. It was not until the reign of Kings Rama V and VI when the adoption of Western science and knowledge became more evident. Thanks to trading with Westerners and the adoption of Western technology in developing the country, Siam became accepted as a civilised country by the colonisers at the time.

Science and technology then became more influential in Thai society. The traditional lifestyle of Thai people began to rapidly combine with Western technology. Transportation on foot, by water, and cart was replaced by cars and aeroplanes. Machines became widely used in agriculture in order to produce a large amount of products for export. Science was then recognised as a tool for achieving a goal. Traditional farming was inevitably mixed with innovative machines from the West. Western science and technology facilitated the development of the country, and at the same time, undermined the perceived power of the supernatural world which once dominated the agricultural society. In the past, Thai people, especially in agricultural communities, believed that nature is beyond human control. For them, it is only the supernatural that has power over the natural world.

Unexplained phenomena were also regarded as supernatural. Although both traditional views and modern science can explain many natural phenomena, different terminologies tend to

cause a lot of confusion for Thai tradition because the scientific explanation is rather contradictory to traditional worldviews. The solid scientific explanation, empirical evidence, and strong conclusions challenge the supernatural power valued by Thai people in the past. At the same time, a reliable scientific explanation is becoming intermingled with traditional Thai worldviews.

The advancement of science and technology has brought about not only development in basic facilities and infrastructure but also transformations in Thai people's understanding of the world. Especially in contemporary society, science and technology have rapidly changed the way they disseminate information. The invention of the Internet facilitates the distribution of information beyond the limitations of time and space. At present, as the digital disruption era occurs across the world, people in Thailand consume information and news through new media on various platforms. A report from InfoQuest on 'Thailand media landscape 2020' pointed out that social media such as Facebook, Instagram or Twitter, and over-the-Top TV (the visual and audio content broadcast through the Internet such as streaming and TV on demand) are the most popular forms of media among Thai. People are more familiar with this newest technology and begin to use of them over traditional media such as newspaper and radio (InfoQuest, 2020). A large amount of news, information, and knowledge can be distributed without being restricted. Thus, knowledge can spread more quickly and widely compared with the pre-Internet age. Communication in cyberspace has become widespread, and people have more freedom and platforms to share their opinions on different issues. These new ways of consuming information could affect Thai society and Thai people's views about science. The Internet has become an important place for the public to spread knowledge, find knowledge and create knowledge. This resulted in better understanding of natural phenomena such as a solar eclipse that is therefore widely created and learned across society through new media. However, many Thai people still consider the solar eclipse as a special occasion and mark it with customs and traditions to avoid bad luck (Sanubboon, Tangprasert & Seehawong, 2020). This story points out that even though Thai people today have the ability to access science-based information about the natural phenomena, the cultural beliefs and practices related to some certain natural events are still ingrained in the Thai way of life.

Mahamontri (2014) suggested that, in Thailand, due to the power of the media, new worldviews tend to be adopted first among limited groups of people in metropolitan areas before rapidly expanding to the wider public. As a result, an increasing number of the traditional worldviews in rural communities began to have been replaced by new ways of looking at the world. Rural communities' worldviews, behaviours, beliefs, and tastes are aligning with the worldviews of those living in urban society (Mahamontri, 2014; Noonin & Phuangprayong, 2019). In other words, the power of media, facilitated by the advancement of science and technology, is largely dominating rural society's thoughts and beliefs, which are beginning to simply replicate those found in big cities. Therefore, people in rural areas of Thailand are starting to desire urban lifestyles despite differences in the cost of living and income.

The above factors indicate that advancements in science and technology lead to the development of communication systems and devices, resulting in media's influence that changes people's lifestyles, beliefs, and behaviours. This conclusion corresponds to Mahamontri, (2014) and Noonin & Phuangprayong, (2019) referred that television, mobile phones, and the internet are the major factors behind the change in the worldviews, beliefs, behaviours, and lifestyles of Thai people in rural areas. Changes in Thai society cause changes in Thai worldviews, but the vice versa is also true – the changed worldviews can transform Thai society. Thai people, in their daily lives, are experiencing growth in science and technology as the modern world manifests in Thailand along with the accompanying uncertainties of national politics and economics. Money has become a key factor in modern Thai life. This importance of money, in turn, is intensifying the competitive struggle among Thai people to improve their lives (Mahamontri, 2014). These developments are likely to change the five cosmological concepts of the Thai Buddhist worldview, namely hierarchy, merit and demerit, Bun Khun, cool heart and individualism, though it is not yet clear how or in what direction. It is certain, however, that these changes will affect the viewpoints and interests of Thai people, and thus, the world will need to adapt accordingly in order to successfully communicate with Thailand. Although it is clearly seen that Thai people today have easy access to information, news, and knowledge, it should be acknowledged that Thai people still adhere to some traditions that are consistent with the beliefs and practices from traditional Thai culture.

2.5 Worldviews and science learning

Science and technology are inevitable characteristics of modern life, bringing significant value to society as a whole (Wilsdon et al., 2005). Negative implications of science and technology in daily life notwithstanding, communities in almost every part of the world benefit from scientific and technological breakthroughs. In many countries, science is considered a significant tool in improving life. A UK poll by IPSOS MORI was conducted by the Office of Science and Technology (OST). The poll indicated, for example, that more people in the UK support science than believe that science has an adverse effect on society (Wilsdon et al., 2005). The public survey reported by IPSOS MORI in the year 2014 and 2019 suggested that people in the UK were aware that science and technology are necessary for their lives (Castell et al., 2014; Department for Business, Energy & Industrial Strategy, 2020). Scientific literacy, therefore, has become one of the world's essential literacies, and the importance of science education and science learning have been emphasised in educational policies and curricula across the globe (Freeman et al., 2014).

Science learning is not limited to just the classroom. In fact, people often engage in informal science learning in their daily activities. Though children are required to learn science in classrooms, they spend more time learning science in other environments outside of school (Fenichel & Schweingruber, 2010). Informal learning – or 'free-choice learning', as termed by Dierking et al. (2001) – is any learning that takes place outside schools, and it bestows learners with choice and control over whether and what to learn depending on their needs and interests (Dierking et al., 2001). Learning is a process of active engagement with experience. It happens when people try to understand the world. Learning can be an essential tool to develop skills, generate ideas, create feelings, provide understanding, raise awareness, and equip individuals for survival. Learning can be driven by prior experiences which learners had before exploring the new knowledge, and it is shaped by the attitudes and beliefs that these experiences provide (Kelly, 2002).

Prior knowledge and experience, as well as personal interests and motivations, are among the major factors that affect science learning (Falk & Dierking, 2000, 2013; Kelly, 2002).

These factors, in turn, are inadvertently shaped by the practices and beliefs of the communities to which learners belong.

In developing countries and non-Western countries, science educators tend to pay more attention to the nature of human interactions in communities (George, 1999). Science and technology are acknowledged as universal knowledge; however, access to these bodies of knowledge is also disrupted by the social and cultural context that plays an important role in cognition (Fayard, 2002). Aikenhead (2001) pointed out that although science is important, it still cannot be easily transmitted to other cultures. He suggested that communication problems are a result of the lack of cultural transferability and the specificity of cultural backgrounds in making sense of nature. Put another way, Western science is not the only science that exists, but should be seen on a par with indigenous knowledge and traditional knowledge about nature. In this view, the communication of Western science to other cultures would consider this multiplicity of sciences and scientific systems that exist in other cultures. Aikenhead (2001) suggested that in order to cultivate science in other cultures, it is necessary to support audiences to cross the cultural boundary to the area of Western science. He called a helper as a broker that could bring the audiences to pass the cultural border with the cultural brokering role, and this will be one of the new roles for all science communicators.

Tinnaluck, (2005) suggested that in a non-Western country like Thailand, people respond to the science and technology that came from the west as belonging to the west. This attitude can extend the distance between the non-Western culture and science and can impact on people learning science in Thailand. This view is consistent with Maddock (1981), who was concerned that one major factor influencing science learning in school is the students' feeling that Western science is not their culture. Such feelings can create alienation (Aikenhead, 2001) which impedes learning and understanding. Hongladarom (2004) also pointed out that it is difficult to transform the Thai society into a science-based society. Thai worldviews are firmly attached to religion. Indigenous populations, therefore, are likely to be affected when endeavouring to engage in science and technology, especially in schools (George, 1999). Similar to the prior knowledge and experiences which exist in their world, the traditional beliefs and practices and also their culture that have been passed from generation to generation in communities can affect science learning when children are taught in school.

How children engage, in other words, with the science that is taught in their classrooms is impacted by worldviews (George, 1999). Based on the literature above, it is interesting why people do not feel that science is for them. Archer et al. (2015) proposed the concept of "Science Capital" that referred to an individual's science-related assets. Archer pointed out that people who own a high level of science capital tend to have positive attitudes towards science and connect their daily life to science more than those with lower capital. It has been suggested that an individual's science capital comprises science-related social capital, culture, and habitus (Archer et al., 2015). As the habitus referred to the way people perceive the world and react to it (Bourdieu, 1977), this scope is deeply intertwined with the worldview definition. This view indicates that worldview and habitus have the ability to create science capital that resulted in people attitudes toward science. This connection provides an interesting viewpoint as both worldview and science capital can be seen as an enhancer and a barrier for science learning in the real world.

2.6 Conclusion

From the literature review above, this chapter has presented the importance and influence of the worldview that lead to an understanding of how people perceive the world and the practices in societies. People's reactions to their surroundings are influenced by their worldview. That worldview can change depending on how the world around each group of people has changed and how people perceive and react to that change. The scientific worldview is based on using Western science principles to make sense of the natural phenomena. This knowledge of Western science can prove to itself as an influencing factor to the development of the world through the discovery, invention, and rationalisation of phenomena. However, views of Western science are not always positive. Many people have begun to raise questions about the applications of science that have negative impact on society. These views bring about uncertainty in the value of science to some group of people. Western science knowledge has spread widely from Europe to territories over the past four hundred years. The knowledge of Western science became a novelty to people in land that had never known science before. Some places can create acceptance, while others feel Western science as a new and different concept that may not easily blend with their traditional

beliefs and practices. This view also brings the attention to reconsider and recognise other knowledge in various forms of science.

Worldview play an important role in science learning. People's worldviews can be both a hindrance and helper in learning science, in both formal and informal settings. The worldview is also deeply correlated with the concept of science capital. This is because the science capital arises from the social, cultural capital and habitus related to science.

CHAPTER 3 WORLDVIEWS AND INTANGIBLE CULTURAL HERITAGE: AN EXPLORATION OF TRADITIONAL RICE FARMING IN THAILAND

3.1 Introduction

How we experience the world and develop knowledge about it is influenced by the beliefs and practices that we inherit with our cultural backgrounds (Cobern, 1991; Du Toit, 2007; George, 1999; Harrison & Rose, 2010; Ibrahim, 1991; Irzik & Nola, 2009; Koltko-Rivera, 2004; Pongsapich, 1998; Vidal, 2008). Personal and community worldviews underlie these beliefs and practices, which lead to the creation of rules and systems for living in the community and developing a culture (Hart, 2010; Ibrahim, 1991; Irzik & Nola, 2009). A community's cultural identity thus reflects the community's way of life as it is passed on from one generation to the next, rooted in that community's worldviews.

This chapter aims to highlight the links between worldviews, traditional knowledge and practices, and Intangible Cultural Heritage (ICH). The chapter has two sections. The first section discusses the importance of intangible cultural heritage and the history of recognising this importance through a series of international conventions, culminating in the 2003 UNESCO convention that explicitly defined ICH and its constituent domains. The second section attempts to tease out the connections between ICH and worldviews as they manifest in the production and upholding of cultural symbols and practices.

3.2 Intangible Cultural Heritage

This section examines the concept of Intangible Cultural Heritage and its importance. I turn to the UNESCO 2003 convention to define ICH and its domains, then look at the series of international events that led to this Convention and definition.

3.2.1 Defining intangible cultural heritage

This section discusses cultural heritage as the legacies that derive from ancestors' beliefs and practices, which are influenced by worldviews. It shows how cultural heritage connects people in a community through values, traditions, and customs and generates a sense of unity that plays an important role in consolidating a sense of 'community' among its members. According to UNESCO, cultural heritage is a form of culture that is unique and valuable. It originated in the past and has been passed from one generation to another. Cultural heritage not only refers to material objects, buildings and places that are connected to the past, but also includes knowledge, skills and ideas that were created by previous generations and are still expressed in the present. These items may not be tangible but are a key component of cultural heritage. Therefore, intangible cultural heritage is a living form of the legacy passed and recreated across generations. This heritage develops and evolves as people learn to live with their environment and express themselves through practices and traditions. To pinpoint a culture as cultural heritage, one needs to consider its role within the community. Intellectual cultural heritage encompasses the knowledge and skills that express norms and customs from the past as well as the contemporary ones (Harrison, 2015; Smith & Akagawa, 2009; Marilena, 2012; Stefano, 2016; UNESCO, n.d.). They continue to be valued, adopted and expressed within the community. For example, the traditional architecture is still expressed in the contemporary residential buildings. Local foods are cooked and consumed using traditional methods. Cultural heritage demonstrates the engagement and contribution of the community members although some live elsewhere (Akkerman & Bakker, 2011; Carr et al., 2012; Engeström, Engeström & Kärkkäinen, 1995; Star & Griesemer, 1989; Stefano, 2016; Suchman, 1993; Tsui & Law, 2007; UNESCO, n.d.; Venkat & Winter, 2015). Some might, for example, still have the same eating habits and cook their motherland dishes after they

moved out from their community. The contribution of community members to preserving cultural heritage gestures towards their bonding with their ancestors. They also have potential to improve and adjust the heritage to the changing environment. This increases the sense of ownership, expresses originality and contributes to the connections and relations between the past, current and future generations (Harrison, 2015; Smith & Akagawa, 2009; Marilena, 2012; Stefano, 2020, 2016; UNESCO, n.d.). Cultural heritage demonstrates representativeness (Stefano, 2016; UNESCO, n.d.). It gestures towards the close relationships between community members. Together they share and are responsible for their community's cultural heritage. This also echoes the ownership of knowledge and skills belonging to the cultural group. Community members are also ready to preserve and pass on the heritage to others within the society as well as future generations. Moreover, intellectual cultural heritage requires the acceptance from community members. It must be community-based: created by the community or a group of people (Harrison, 2015; Smith & Akagawa, 2009; Marilena, 2012; Stefano, 2020, 2016; UNESCO, n.d.). The identity that has been created, preserved and passed on must be remembered and accepted as their creation and as the expression of the heritage from their ancestors. It is only the community members that can pinpoint that the expressions, practices, beliefs, to name a few, are their true cultural heritage.

A formal definition of ICH was offered on an international scale by the 2003 UNESCO Convention for Safeguarding of Intangible Cultural Heritage:

> *Intangible cultural heritage* means the practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artefacts, and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognise as part of their cultural heritage. This intangible cultural heritage, transmitted from generation to generation, is constantly recreated by communities and groups in response to their environment, their interaction with nature and their history, and provides them with a sense of identity and continuity, thus promoting respect for cultural diversity and human creativity. For the purposes of this Convention, consideration will be given solely to such intangible cultural heritage as is compatible with existing international

> human rights instruments, as well as with the requirements of mutual respect among communities, groups and individuals, and of sustainable development.
>
> (UNESCO, 2003)

Based on this definition of ICH, it is important to explore its significance to the community in order to understand why community members maintain and safeguard their intangible heritage. ICH provides communities and groups with a sense of unity, identity, and continuity (Omoro, 2015). Each community expresses their identity through their heritage in the form of language, rituals, and traditions. Moreover, community members conserve their heritage through use and adaptation over time. ICH encompasses the immaterial elements associated with all daily human activity (Stefano et al., 2012). Although tangible aspects of human activity from the past are easier to perceive, ICH cannot be separated from tangible cultural heritage (Lee, 2017). Tangible and intangible cultural heritage are two halves of the same concept and affect not only one another but also communities. In fact, as we will see later, the tangible-intangible distinction is not equally meaningful in all cultures.

The transmission of knowledge, traditions, values, and skills through ICH is crucial for the survival of a community. ICH itself is evidence of the wealth of knowledge and skills that exist in a community. Community members must maintain, secure, and transfer their ICH to descendants. However, it is not easy to determine what kinds of daily activity in the modern world can be categorised as ICH. For example, across the world we can find people who possess local healing knowledge and skills in selecting local medicinal herbs. These knowledge and skills have been passed down to them from their ancestors and, based on UNESCO's definition, are ICH, something that the local community might not realise. This is because many daily activities have been interfered with, changed, or replaced in the modern age, resulting in changing cultures. This dynamism of culture may distort perceptions of a practice as cultural *heritage*. In order to explore the heritage character (or lack thereof) of traditional activities and practices, this research uses UNESCO's guidelines on the definitions and scope of ICH. UNESCO (2003) proposes the following five domains in which ICH manifests, which we will subsequently look at in more detail in relation to identifying and safeguarding ICH within each of them:

Domain 1. Oral traditions and expressions, including language as a vehicle of intangible cultural heritage;

Domain 2. Performing arts;

Domain 3. Social practices, rituals, and festive events;

Domain 4. Knowledge and practices concerning nature and the universe; and

Domain 5. Traditional craftsmanship.

(UNESCO, 2011)

These five domains are a useful guide for the research's case study in understanding ICH. Each of these aspects is discussed in the section below.

3.2.2 The five domains of intangible cultural heritage

Domain 1. Oral traditions and expressions

This domain includes a variety of spoken forms including proverbs, riddles, tales, nursery rhymes, legends, myths, epic songs, poems, charms, prayers, chants, songs, dramatic performances, etc. This domain is concerned with practices expressed through word-of-mouth. Spoken art forms express a community's memories and stories of cultures (UNESCO, 2011). Moreover, the spoken word is a simple process of transferring knowledge, concepts, and ideas to others. Language using oral traditions and expressions helps community members safeguard their memories and stories successfully. Some oral expressions are common and used by most community members. However, some of the expressions are restricted to a particular person, such as community leaders or priests. The stories are derived from a combination of creation, reproduction, and improvisation that make stories richer and therefore more valuable. However, this process also makes oral traditions and expressions fragile because they rely on the need to pass information from one generation of performers to the next without obligation. Moreover, the death of a language can lead to the permanent loss of oral traditions.

Domain 2. Performing arts

Performing arts cover vocal and instrumental music, dance, theatre, pantomime, sung verse, etc. This form of ICH can be found in various cultural expressions that illustrate human creativity. Furthermore, this domain can be found, to some extent, in other ICH domains. Performing arts are an adaptation of the use of language and actions along with traditional rhythms. Music is an example of this domain because it can be found in every society and often as part of other domains of ICH, such as performing arts in rituals, traditions, and festive events. The context for the use of traditional music varies. Music often connects with entertainment, legend, the stories of the community, or relevant to religion or sacredness. Performing arts also include dance, which is described as ordered bodily movement alongside rhythm or music. Dance is an expression of rhythmic movements, steps, and gestures that connect to the mood of performers, describe a story, mark a special event or the performance of daily activities. Dance is important in a variety of cultural events, representing for example, warfare, glory, hunting, or religion. Performing arts also cover traditional theatre performances, which is a combination of acting, singing, dance and music, dialogue, narration, or recitation. Theatre performances also include puppetry and pantomime. Examples include a performance with a song when people are carrying out agricultural work, music that is part of a community ritual, and lullabies. This domain also includes instruments, objects, artefacts, and spaces associated with or used in performing arts performances.

Domain 3. Social practices, rituals, and festive events

Social practices, rituals, and festive events are closely linked to the habits of community members. Therefore, the practices, rituals, or events in this domain are shared by and relevant to many community members. As we will see later in this chapter, members of a community tend to share similar worldviews that reflect their comprehension of the world in the forms of rituals, practices, and festive events that they develop (UNESCO, 2011). It is usually found that social rituals and festive practices are associated with climate, seasons, the agricultural calendar, and stages of people's lives. These events often take place at special times and places, such as festivities to mark the New Year or the end of harvest. Therefore, these social

events, rituals, and practices can remind a community of its history and memories, while reinforcing its worldviews (UNESCO, 2011).

Domain 4. Knowledge and practices concerning nature and the universe

This domain includes knowledge, know-how, skills, practices, and representations or actions developed by communities in accordance with their worldviews. These reflect the community's ways of thinking about the universe that is also found in oral traditions, language, feelings of attachment towards a place, memories, spirituality, and worldviews (UNESCO, 2011). These 'ways of thinking' influence values and beliefs, and become the root for many social practices and cultural traditions. The components of this domain are shaped by nature and the environment as they are experienced by the community (UNESCO, 2011). Therefore, this domain covers many areas which encompass knowledge, know-how, skills, practices and representations, such as indigenous knowledge, knowledge of local fauna and flora, traditional ecological wisdom, rituals, beliefs, initiatory rites, traditional healing systems, cosmologies, shamanism, possession rites, social organisations, festivals, language, and visual arts.

Like other domains, knowledge and practices concerning nature and the universe also provide the community with a sense of pride and identity. The ways of thinking about the universe and the practices employed as a result, play an important role in the way in which people live together with nature and the environment. They are derived from learning from nature and help the community to survive. However, the rapid industrialisation, globalisation, and modernisation is threatening these forms of ICH. The expansion of agricultural land results from the industrial sector's increased needs for agricultural products and has a marked effect on the natural environment and, as a result, on related forms of ICH. For example, industrialisation may lead to the disappearance of a sacred forest and local plant species used in traditional medicine (UNESCO, 2011). Indigenous people survive for centuries while embodying their traditional lifestyle, hunting, building their homes close to canals, performing rituals to a sacred forest, gathering food and medicinal herbs from the forest. They learn from nature and develop practices tailored to it, enabling them to survive within it. When the natural environment is significantly changed, indigenous lives are disrupted and so is their ICH.

Domain 5. Traditional craftsmanship

This domain is mainly concerned with the skills and knowledge associated with craftsmanship rather than its products. Traditional craftsmanship includes the creative and productive skills that are involved in the crafting of tools, clothing and jewellery, costumes, props for festivals and performing arts, storage containers, transport and shelter, decorative items, ritual objects, musical instruments, household utensils, and toys. These products of particular skills reflect the creativity of the person that creates them, but may nevertheless be ephemeral, used only for a short period of time to fulfil a specific purpose.

This form of ICH is also challenged by globalisation. Mass production yields the products needed for daily life at lower costs, with shorter production time. Local markets are increasingly bombarded with mass-produced clothes, plastic containers and other goods, and plastic toys from modern factories. The production of these items affects craftspeople struggling to adapt to the competition. Moreover, changing cultural tastes require simpler craft production for festivals and celebrations, resulting in insufficient opportunities for craftspeople to exercise their skills. Furthermore, those craft traditions that are restricted to members of one community face extinction unless an adequate number of young community members are willing to learn them.

The elaboration of the ICH domains provides a more accurate understanding and enables better recognition of the forms it takes and illustrates its value. However, sometimes, identifying which domain a particular piece of ICH belongs to is difficult, such as in the case of a tradition that includes religious rites, singing, displays of craftsmanship, and performing arts. UNESCO suggests that some forms of ICH are not limited to a single domain and can include elements from multiple domains. Moreover, UNESCO (2011) also suggests that "the boundaries between domains are extremely fluid and often vary from community to community" (UNESCO, 2011). As such, an activity may be defined as a form of ritual in one community, whereas another community would interpret it as a performing art. As the purpose of the definition is to be inclusive rather than exclusive, UNESCO suggests that countries can use a different system of domains altogether to describe their own forms of ICH. This suggestion has resulted in some countries categorising their ICH differently, while other countries use domains to those of the Convention but with alternative names. Moreover,

some countries have added further domains to cover their ICH items or created sub-categories of an existing domain to facilitate their categorisation (UNESCO, 2011).

Nevertheless, despite the variation in the number and types of categories and sub-categories, it is clear that ICH is closely associated with people's daily activities and, as I will argue later, it is constructed so as to reflect and reinforce the worldviews of the community. Before we turn to this discussion, however, it is worth examining how the term 'Intangible Cultural Heritage' came to be, what led to the recognition that intangible forms of human activity are an inseparable part of a culture. This discussion will bring us closer to then examine how ICH relates to worldviews.

3.2.3 Intangible Cultural Heritage: brief history of a term and concept

The examination of the term and concept of ICH through definition and domains from the previous section provides a flavour of the different cultural forms that manifest in everyday life. An understanding of these forms can help identify those that are best suited to the research objectives. However, understanding the background of each ICH can help to design research that is suited to the context and qualifications of each community. The problems and obstacles in preserving culture also help us understand the context for and conditions of ICH. This is useful for researchers to consider and plan to avoid any conflict and problems with people in the community who are the owner of ICH. As expressed in its many forms under a number of domains, ICH represents a community's cultural identity, generates a sense of unity and pride in belonging, and acts as a medium for preserving memories and stories of a community to later generations (Omoro, 2015; UNESCO, 2011). ICH not only is important to the community to which it belongs but also contains knowledge and wisdom that can be used to solve problems for other communities, as is the case for example with traditional medicine and environmental management (Lee, 2017). Therefore, the preservation of ICH not only guarantees the preservation of communities, but also provides opportunities to identify solutions to global problems such as water shortages, land degradation, and public health. Therefore, the absence of ICH results in a diminished sense of unity, identity, and continuity in communities and groups. This lack of identity, unity, and continuity leads to

the deterioration of communities and the valuable knowledge and practices that serve of the legacy of their ancestors. And ICH is threatened by many things.

Intangible Cultural Heritage is affected by modernisation and globalisation (UNESCO, 2011). The modern manufacturing techniques and mass production of appliances and technologies offer us a more comfortable living, faster transportation, and more convenient working. However, they also require large amounts of natural resources, which are threatening the natural environment like never before. These threats to the natural environment also affect ICH, particularly those kinds of ICH that are closely connected to the natural environment as under domain 4.

Lee (2017) explains that ICH also suffered from colonisation. In the colonial era, the cultural heritage of colonised countries was suppressed. When countries were colonised, colonial masters enforced their colony to live under their rules and use their language. Therefore, the cultural heritage of the colonised countries was gradually replaced by the new culture, causing local people to lose their national identities (Lee, 2017). Some countries in Asia and Africa lost their languages as a result, and traditional foods and customs disappeared, even over short periods of foreign rule (Lee, 2017). ICH was seriously damaged and distorted during the age of colonisation. The passing of heritage from generation to generation was interrupted, and many of the communities were at risk of completely disappearing, while others gradually deteriorated. Lee (2017) reports that movements to recover the damaged heritage were launched after independence and liberation from colonial masters. Such movements require support not only from local governments but also from other countries as much as possible.

Another threat to ICH is war, with the significant impact of the Second World War which damaged not only infrastructures but also communities' stability across the world, a case in point. The losses included not only the 64 million people who died in the battlefields (National Geographic Society, 2017), but also the destruction of cities and landmarks across the world. Many people left their communities during warfare. Communities, infrastructures, and the natural environment were inevitably threatened. City infrastructures and facilities needed to be restored, and communities had to be re-established. The war inevitably affected the cultural heritage that had existed in those communities. People in many countries became

aware that their cultural symbols, which represent their heritage, could be destroyed, infringed, and vanished as a result of intentional or inadvertent war actions (Ahmad, 2006). These concerns encouraged many countries to begin to claim possession of their cultural properties and announce the value of their heritage to the public. The sense that every item of cultural heritage should be protected, not only by its owners but also by and for all of humanity, became widespread (Lee, 2017). A restoration process was promoted after World War II by two international organisations, the United Nations Educational, Scientific and Cultural Organisation (UNESCO) and the International Committee on Monument and Sites (ICOMOS) (Ahmad, 2006). However, due to the significant infrastructural damage caused by the war, these communities required support in many areas, such as guidelines to restore and preserve ICH, expertise, and a financial budget to recover their ICH that had been interrupted and damaged.

Cultural heritage is important to individuals and their communities, and its safeguarding, reliant as it is on the community itself, cannot be achieved by the community alone. Efforts to safeguard cultural heritage began half a century ago. Many small communities confront difficulties in reaching this safeguarding goal due to factors including financial and lack of conservation knowledge. However, when many countries face similar obstacles, they can overcome them by coming together and developing common responses. The UNESCO convention is one such common response that serves as a reminder of what must be discussed when focusing on ICH and examining the differences across communities. The 2003 convention, however, was neither the starting nor the ending point of the road to recognising the value and importance of ICH. Threats to ICH like those discussed earlier in this section (war, colonisation, modernity and globalisation) sparked the first discussions at an international level decades before the 2003 convention came to be.

During the early period of the development of safeguarding of cultural heritage, both international organisations contributed significantly to conserving and safeguarding the cultural heritage of historical monuments, buildings and groups of buildings, sites, and towns (Ahmad, 2006). Through these efforts, the two organisations utilised guidelines from the International Charter for the Conservation and Restoration of Monuments and Sites, known as the Venice Charter (1964). In the process of working alongside each other, the two

organisations eventually adopted the same definition of heritage, which enabled them to develop a scope and direct roles appropriate to their goals.

Initially, however, up to that point, the two organisations had been using different definitions. ICOMOS defined heritage as "Monuments and Sites" (Ahmad, 2006; Harrison & Rose, 2010), including only tangible, physical constructions that play an important role in archaeology, architecture, history, or ethnography. "Sites" in particular referred to groups of physical constructs, created either naturally or by humans. Interestingly, ICOMOS clarified the definition of "monuments and sites" to avoid archaeological collections and movable cultural properties that are part of museum collections and open-air museums. This clarification allowed ICOMOS to achieve their goals without conflicting with the functions of museums. UNESCO, on the other hand, defined heritage as movable and immovable cultural property (Ahmad, 2006). The two definitions and, consequently, scopes of heritage were reconciled in the Convention Concerning the Protection of the World Cultural and Natural Heritage in 1972, which is commonly known as the "World Heritage Convention 1972" by UNESCO (Ahmad, 2006; Harrison & Rose, 2010). One of the goals of this Convention was to launch an international safeguarding campaign to protect heritage around the world that are under threat. As defined in this Convention, heritage included cultural and natural sites of outstanding universal value that should be protected for the benefit of all communities. At the Convention, UNESCO acknowledged both Cultural and Natural Heritage, whereas ICOMOS adjusted the definition to cover groups of buildings and regarded the cultural heritage as cultural property and monuments and sites. This Convention provided the confidence that many more forms of heritage would be covered under the safeguarding guidelines, and led to international acts and agreements for the safeguarding of cultural and natural heritage. Importantly, it introduced the notion of world heritage (ICOMOS, n.d.). The definition of cultural heritage is provided under Article 1:1 by UNESCO as follows:

Article 1:1

> *Monuments: architectural works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of outstanding universal value from the point of view of history, art, or science;*
>
> *Groups of buildings: groups of separate or connected buildings which, because of their architecture, their homogeneity, or their place in the landscape, are of outstanding universal value from the point of view of history, art, or science;*
>
> *Sites: works of man or the combined works of nature and of man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological, or anthropological points of view.*
>
> (UNESCO, 1972)

The scope of heritage based on this Convention offered a comprehensive understanding of physical heritage but was ambiguous for non-physical heritage. This ambiguity has led to the expression of concerns from some of the associate members of UNESCO about the safeguarding of other forms of cultural heritage that cannot be matched with this definition, namely traditions, rituals, folksongs, folklores, orals, and folk literature.

UNESCO subsequently took steps to rebalance the focus on physical and non-physical heritage. To address non-physical heritage, the term "intangible cultural heritage" was first added into the scope of cultural heritage in the Mondiacult World Conference on Cultural Policies (1982) in Mexico City (UNESCO, n.d.). Non-physical, or intangible, heritage was now afforded more attention and recommended in many conventions across the world to allow for outstanding universal value of cultural and natural heritage to be protected and safeguarded appropriately for the benefit of all communities.

By the end of the 20th century, the scope of world heritage was clarified with the terms physical heritage, physical cultural heritage, and natural heritage, whereas non-physical

heritage required further clarification. The report on Our Creative Diversity by UNESCO (1996) highlights the lack of clarity in the definition and scope of cultural heritage from the world heritage convention in 1972. This report led to an attempt to expand the scope of cultural heritage in order to correspond with the various forms of cultural heritage that existed within communities. The attempt to move towards a clearer scope of the non-physical heritage or ICH was fulfilled by international organisations such as the United Nations (UN). The UN was concerned with the traditional knowledge and practices of indigenous and local communities as a crucial way of thinking for local people for their daily activities threatened by globalisation. This form of knowledge is important both for indigenous and non-indigenous groups and should be respected and preserved as much as possible. Therefore, the UN launched a campaign to support this view and declared 1995-2004 as the Decade for Indigenous and Minority People (Ahmad, 2006).

In 1997, UNESCO launched the Proclamation of Masterpieces of Oral and Intangible Heritage of Humanity with the expectation to protect cultural space from global developments. This proclamation emphasised the safeguarding of oral and intangible heritage in the form of oral traditions, folk songs, beliefs, practices, rituals, and traditional craftsmanship as masterpieces of humanity. The attempt to include non-physical forms of cultural heritage did not come without difficulties. The different contexts for each country could pose significant problems in recognising and safeguarding ICH. For example, what might appear as a clear definition of ICH in one country maybe lost when translating the term into the language of another country. As such, many countries have opted to provide their own definitions of ICH (UNESCO, 2001), which, however, can potentially cause difficulties in applying the safeguarding of ICH guidelines.

In 1999, UNESCO and the Smithsonian Institution arranged a venue to seek and offer solutions to the ambiguity of ICH and the related issues on an international scale. This cooperation led to the seminar in Washington DC, *A Global Assessment of the 1989 Recommendation on the Safeguarding of Traditional Culture and Folklore: Local Empowerment and International Cooperation*. The purposes of this seminar also included finding an appropriate definition and scope for non-physical cultural heritage, which would include folklore, oral and intangible heritage, and traditions. The seminar also discussed and

looked at the possibility of using international law to support the safeguarding of cultural heritage. The success of this cooperation led to the launching of the Convention for the Safeguarding of Intangible Cultural Heritage in 2003 discussed earlier in this chapter. This Convention provided more appropriate solutions to the ambiguity of ICH following UNESCO members' coordinated efforts over the previous three decades. This Convention emphasised the value of ICH and provided a clear definition of the term and delineation of its domains as discussed in the previous section of this chapter.

This section has looked at how the term 'Intangible Cultural Heritage' emerged and became part of UNESCO's cultural heritage remit, leading to unequivocal recognition that intangible forms of human activity are an inseparable part of a culture. The literature also shows the obstacles to cultural preservation and allows us to understand the context and factors that will affect the sustainability of cultural preservation. ICH's background has provided an understanding of the necessity of safeguarding cultural heritage. Having explored the meaning of ICH and the importance of ICH for this study, in the following section I will argue that ICH can be seen as an expression of worldviews.

3.3 Intangible Cultural Heritage and Worldviews

In the previous section, I explored how the importance and value of ICH for people, communities and nations was gradually recognised by UNESCO and other international organisations, leading to the 2003 convention. This section looks at ICH more closely, to tease out the links between ICH and worldviews. These links became apparent to me as I was reviewing the literature on worldviews, particularly the kinds of human activity in which worldviews manifest and which appeared to invariably fall within the ICH domains. For example, the ritual that represents a tree connected to a dead elder in an Aboriginal community falls within ICH domain four, about knowledge and practices concerning nature and the universe as people and nature cannot be separated and must rely on each other (Harrison & Rose, 2010). This section aims to look at these links between ICH and worldviews.

Worldviews play an important role in people's daily lives. As we saw in chapter 2, although definitions of the term "worldview" are disparate, they nevertheless converge around a notion of worldview as the system of beliefs that express how we acknowledge and perceive the world, nature, the universe, and our role within them. Worldviews emerge from and lead to interpretations of nature and the universe, which allow people to conceptualise rules and limitations behind natural phenomena and the surrounding environment. The process results in the adaptation of lifestyles, allowing people to live in harmony with the perceived world (Burnett 2002, Kearney 1984, Redfield, 1953). This in turn provides the possibility to develop shared views, rules, and culture for living with each other in the community. Worldviews are therefore aligned with the natural environment within which they develop. Geographic characteristics, climate conditions and other environmental features shape the world that worldviews are called to explain, and therefore shape the worldviews themselves (Ibrahim, 1991). In turn, worldviews underpin individual and collective behaviours, giving rise to the practices and customs out of which cultural and knowledge systems develop (Inglehart & Carballo, 1997; Lemus et al., 2014). Manifestations of worldviews can thereby be seen in all areas of human activity including architecture, crafts, agriculture, as well as the cultural life that develops around these in the form of rituals, stories and myths, folklore, or traditional songs (Cobern, 1991; UNESCO, 2011). These areas of human activity comprise, as we saw in the previous section, our tangible and intangible cultural heritage. Cultural heritage encompasses community legacies that result from the history of the community and encapsulate its values (UNESCO, 2011), and it fosters a sense of unity and belonging within a group derived from members' shared views (Omoro, 2015). Cultural heritage allows a community to understand its history and origins (Omoro, 2015; UNESCO, 2011), connecting people through shared social values, beliefs, and customs, which are important for community members to live harmoniously with one another (Omoro, 2015; UNESCO, 2011).

Worldviews offer an important lens to explore and understand the emergence and upholding of cultural heritage. Shared worldviews underlie the formulation of language, traditions, belief systems, tokens, dresses, flags, and other symbols and components of culture. Lambert (2006) argues that the forming of communities and nations begins with the common ownership of homeland, historical memory, common myths, and culture (language, religion, etc.). Lambert (2006) suggests that worldviews function as a combining agent that connects

a person to a nation through the collective memory of history, glory, failure, desire, fight, action, and interpretation, which are shared and transferred across generations. The process plays a significant role in the forming of a national identity, which pivots around the sharing of history, symbols, practices, and worldviews. Lambert also argues that a nation has its own mechanisms to reinforce its worldviews, which are key in strengthening the nation.

To delineate Lambert's argument, worldviews manifest in cultural symbols and cultural practices such as poems, folklore, songs, dances, paintings, rituals, architecture, monuments, and dresses. Symbols and practices are meticulously selected by society's members and valued in terms of the community's identity. Members' valuing of these symbols and practices is evidenced by their continuing use in daily life. Seen from outside the community, symbols and practices are part of the community. These cultural symbols and practices, therefore, are the representation of the community's identity. These cultural objects not only generate a sense of pride but also create the unity that underlies a strong community (Salih, 1998). For this reason, cultural symbols and practices become devices that bring people together into a tight-knit community. The community is strengthened by people who share a similar understanding and interpretation of the world (Lambert, 2006). The production of cultural symbols and practices gives members of the community a sense of responsibility and allows them to share feelings and emotions that perpetuate the use of cultural symbols and practices.

While cultural symbols and practices are employed as a social device to strengthen community cohesion, they also depict the existence of worldviews more clearly. For example, the rocket festival Prapheni Bun Bang Fai (ประเพณีบุญบั้งไฟ) is a tradition from the Northeast of Thailand that takes place in May each year. On the one hand, this tradition embodies the worldviews of Northeast villagers, whose understanding of the rain season is personified in deities associated with control over rain. These villagers believe that humans are under the influence of God and other deities, to whom they pray and offer items in exchange for good luck, riches, and prosperity. Community members make their own traditional bamboo rockets to parade and launch in the worship of the God Phaya Thaen. Villagers believe that Phaya Thaen takes responsibility for looking after the rain in their community, and the rockets launched are a form of communication and respect for him. The

villagers believe that if they do not organise the rocket festival, then rain will not fall, with negative consequences for the community's agricultural activity. As I will discuss in more detail in chapter 4, the festival is also one of the Northeast's longest-running traditions, a defining cultural symbol of the community that people in other regions recognise as a tradition from the Northeast. The symbols and practices associated with the festival have been passed on through generations. Through this process, the festival gained its cultural value and became an integral part of the Northeast community's identity (Croissant & Trin, 2009; Francioni, 2003).

We conceptualise our cultural heritage as the legacies that derive from our ancestors' beliefs and practices, which have been moulded by their worldviews and have in turn acted to reinforce and perpetuate those worldviews across generations. Rituals, performances, art, poems, dances, songs and many other forms of human expression encapsulate how we view the world and our role in it and make these worldviews a part of our community's culture and heritage.

Cultural heritage reflects the identity and tells the story of a person, a tribe, a city, or a country through cultural symbols and practices that epitomise how people perceive and interact with the world. These depend in many ways on the part of the world where the community settles. The history and culture of people who live at higher altitudes will differ from those of people in lower altitudes in terms of as food, dress, economic and other activity. For example, the dress style of highlanders has to be suitable for low temperatures and oxygen levels; cloth patterns and dressing rituals (symbols) as well as cloth-making techniques (practices) inherited from ancestors respond to these requirements that were imposed by the specifics of the natural environment (Anuman Rajadhon, 1963; Department of Agriculture, 2002; Department of Foreign Trade, Ministry of Commerce, Thailand, 2016; Gomes, 2001; Gomes et al., 2001; Museum Siam, 2011; Rice Department, 2009; Satsanguan, 2002; Thai Rice Foundation under Royal Patronage, 2006a, 2006b; Yoo-In, 2011). Cultural heritage is thus a community's expression of its worldviews through the development of cultural symbols and practices.

If cultural heritage is so interwoven within the context in which it grows, what happens when it migrates? In chapter 2, I presented a brief overview of the history of scientific worldviews

in the West and their migration to most parts of the world through the rapid modernisation and globalisation experienced over the past few centuries. If we view western science as a cultural product of the West, what happens when it is adopted by non-western cultures? In the following chapter, I explore exactly this, using Thailand and its rice culture as a case study of a piece of (Thai) heritage that has come in contact with western science, maintaining throughout the perspective of a science communicator in modern Thailand.

3.4 Conclusion

This chapter has discussed the connection between worldviews, traditional knowledge, and ICH. Based on existing literature, it appears that the worldviews of people in a community are a key factor that has an impact on creating local knowledge and a community's culture. People's worldviews share their thinking about nature and the universe, allowing them to generate their own explanations of phenomena, practices, knowledge, and learning styles. These explanations lead to community members joining together and sharing their views to create common rules, practices, and social systems. Therefore, it may be argued that worldviews play a key role in producing community practices, traditions, performances, local arts, poems, dancing, songs, folklores, rituals, etc. and transferred to the following generations. These heritage items reflect a community's identity and may be defined as culture. The beliefs, practices, know-how, knowledge, and skills that exist within a community are crucial and transferred in many forms as the heritage of the community. Cultural heritage refers to not only tangible cultural heritage, such as architecture and painting, but also intangible cultural heritage such as knowledge, know-how, and skills. Cultural heritage includes tangible and intangible elements and is a legacy of each community derived from ancestors' beliefs and practices influenced by their worldviews. The cultural heritage that has been created, preserved and passed on must be remembered and accepted as their creation and as the expression of the heritage from their ancestors. Cultural heritage has been defined as one of the most important factors that support the sustainability of society and is a reflection of how community members perceive, understand, and interpret the world, nature, and the universe to respond to them appropriately.

This chapter has given us a clearer picture of the relationship between worldviews and ICH. It showed that there are many kinds of knowledge embedded in ICH, each created by each community's members. They reflect a picture of communities surviving in their environments by creating and applying their own knowledge and transferring it to the following generation in the form of ICH. This also highlights the parallels between knowledge in ICH and knowledge in western science. Both kinds of knowledge are created and applied to describe and interpret natural phenomena for understanding nature, albeit through their own lenses. The literature review shows that people in local communities understand the world and live with nature through their local knowledge and practices while western science shapes how people live and understand the world in modern(ised) societies. The differences should not distract, however, from the fact that both kinds of knowledge, traditional knowledge and western science, are linked in terms of purpose. Chapters two and three have shown us possibilities for connecting traditional knowledge in ICH and western science. Such connections, I will argue in subsequent chapters, can be fruitfully explored in science communication in the science museum.

Rice culture in Thailand is an appropriate case to study the knowledge offered by local communities. Thai society has been developing for thousands of years, largely as an agricultural society and rice producer. There are many stories, beliefs, practices, traditions, festivals, history, and knowledge in Thai rice culture. Therefore, it is worth looking into this kind of culture as a valuable source of local knowledge to achieve the aims of this study. The following chapter presents examples of ICH and traditional knowledge in Thai rice farming and the relationship between them and western science in order to discuss the factors key in the theoretical and conceptual framework of this study.

CHAPTER 4 THAI RICE FARMING: INTANGIBLE CULTURAL HERITAGE AND WESTERN SCIENCE, A PROP FOR SCIENCE LEARNING

4.1 Introduction

Museums are the crucial place for collecting and exhibiting knowledge through objects and stories to the public. They play an important role in the creation of public learning spaces in society (Falk & Dierking, 2000; Falk & Storksdieck, 2005; Hooper-Greenhill & Moussouri, 2002; Kelly, 2007). The museum has the potential to increase the visibility of objects and knowledge through the use of the techniques and processes of exhibition, including storytelling (ICOM, n.d.; UNESCO, 2004). Moreover, they are able to create new perspectives on the preserved knowledge that provide a possibility for the creation of a new way of thinking on daily life (Hein, 1999; ICOM, n.d.; UNESCO, 2004).

Science museums have similar multi-functions to other kinds of museum. They play an important role in driving interaction between the public and science, leading to the integration of science into the people's way of life to support their decision-making processes (UNESCO, 2017). Consequently, museums have significant potential to aid the compilation, preservation and dissemination of knowledge and, as such, they provide a possibility to connect traditional knowledge and science together, and communicate their connections to the public. This leads to the heart of this thesis, the question of how these connections can be explored in interpretation practices, by linking the two kinds of knowledge and use ICH to communicate science in science museums. As one of the most important missions of NSM Thailand is to enhance public awareness of science, the museum is looking for new approaches to connecting Thai citizens with science as much as possible. The prospect of developing more effective science communication by anchoring it in the context of local knowledge can therefore serve the museum's purposes well.

This chapter aims to illustrate the relationship between ICH and traditional knowledge that played a vital role in the lifestyle of Thai rice farmers for hundreds of years, and the 'imported' knowledge, Western science, which plays a significant role in modern Thai society and modern rice farming .Moreover, this chapter can provide a better understanding of the possibility for the museum to repair the disconnection between Western science and traditional knowledge, and how such a reconnection can enable the museum to communicate science through cultural heritage effectively. Therefore, this chapter will examine the relationship between the traditional knowledge embedded within Thailand's rice farming ICH and Western science, in three steps .First, the chapter looks at the ICH of Thai rice farming .Second, it considers the relationship between ICH, traditional knowledge and Western science within Thai rice farming. Third, it proposes Thai rice farming as a platform for the museum to communicate and bring together traditional Thai knowledge and Western science.

4.2 Thai rice farming :a piece of Thai Intangible Cultural Heritage

This section will highlight the ICH characteristics that we can identify in traditional rice farming in Thailand. The section does so by reflecting on the ICH definitions, which we examined in chapter 3, concerning the historical evolution of rice farming in Thailand .This reflective exercise benefits from our earlier discussion of Thai worldviews and their shaping in chapter 2, as we will be situating rice farming within the larger Thai philosophy that underpins traditional Thai practices .This connection between the specific practice of rice farming and Thai worldviews serves to highlight the genuine importance that traditional farming practices have in Thai culture .In doing so, this section also highlights the underlying value of traditional rice farming as ICH, irrespective of its formal recognition status within UNESCO's framework.

Rice has been lied on the basis of Thai life for a long time .It is a main agricultural product that has driven Thailand's economy for thousands of years .For Thai people, as it has been associated with their life for a very long time in history, rice is not just a staple food: it is a sacred national symbol ,Thai's honour .Rice farming and the activities it entails provide

employment opportunities to farmers, drivers, farm workers, rice traders, carpenters, blacksmiths, and food makers .Rice is represented in many forms of everyday Thai life, with people commonly greeting each other with a *" Kin Kao Ma Rue Yang? "* ('Have you eaten rice yet?') in every part of the country .This reflects that Kao (rice) in Thailand has rooted from the eating culture to encapsulate a sense of wellbeing and values of kinship. At the same time, ownership of rice fields had been a measure of nobility in the Thai social system, designating status or prestige of people in the past .These examples signify that rice is embedded horizontally and vertically in Thai culture .

Rice farming has produced culture within Thai society, including rituals, festivals, traditional events, recipes, performances, and folklore .These rice- and rice-farming-related forms of culture are referred to by scholars as *Rice Culture* (Department of Foreign Trade, Ministry of Commerce, Thailand, 2016; Gomes et al., 2001; Lapruay et al., 2009; Sudchaya et al., 2005; Thai Rice Foundation under Royal Patronage, 2006a) . Thai society has been an agricultural one that relied a lot on rice .Rice farming, particularly in the pre-modern era, relied on climate, rain, and the abundance of minerals in the natural environment .Nature and the environment were therefore of utmost concern for farmers .As rice is important not just for farmers but also for all Thai people, nature and the environment are every Thai person's concern .This leads to many others in addition to farmers contributing time, knowledge, and skills to support the agricultural production of rice .

The cultivation of rice, crop after crop, creates communities of practice who derive knowledge collectively through generations. The wisdom, knowledge, skills, and experiences that continue passing from one generation to the next become a valuable heritage for descendants. A Thai farmer's highest expectation is to encourage and support their lineage to continue and develop more effective practices and skills in order to produce the highest quality and quantity of rice. All the wisdom, knowledge and beliefs that underlie rice farming generate not only sustainable practices tailored to each geographical location, but also many forms of rice culture such as rituals, songs, oral literature, performing art, and folklore to lift the morale and happiness of farmers (Department of Foreign Trade, Ministry of Commerce, Thailand, 2016; Gomes et al., 2001; Lapruay et al., 2009; Sudchaya et al., 2005; Thai Rice Foundation under Royal Patronage, 2006a). These forms of culture, I will argue, reflect Thai worldviews.

Rice farming is laborious. It needs time, energy and also strategies to cope with the uncontrollable climate and nature. As the high quality of rice depends upon strains, soil quality, water quantity, animals, diseases, and climate, people who associate with rice farming respond to these natural factors by developing practices and techniques to enrich, maintain, and protect their rice crops. These practices and techniques derive from knowledge and experience accumulated over centuries of farming history, and are important for the abundance of crops, but they are not enough on their own: farmers also need to have high morale and the confidence that their techniques will work. The rituals and festivals related to rice and rice farming seem to do just that: they support and lift morale and increase happiness and confidence.

We can see manifestations of rice farming practice and culture in every period of the rice farming season. These are tailored to the geographic location and community in which they originate and are practised within the country .Many of them continue to be used at present, comprising valuable cultural heritage that differs from community to community and is influenced by location, geography, and local society. The goal, however, is the same: to support people to produce high quality and quantity of rice. This heritage also generates a sense of pride and unity within its originating community, because of its uniqueness to that community and its ability to encourage community members to share and support each other .

These characteristics of rice heritage are in line with the meaning and scope of Intangible Cultural Heritage as defined by the UNESCO convention 2003.

Rice farming can be divided into three main stages that span all seasons. These stages are 1. Preparation, 2. Planting and Maintaining, and 3. Harvest and Post-Harvest .Each stage entails different practices and manifestations of rice culture, some of which are examined below in relation to intangible cultural heritage.

There are many traditional beliefs, practices, festivals, and traditions in Thai rice farming. This part assembles information from many sources including books and websites and presents some of the examples related to the three main stages of Thai rice farming in order to illustrate Thai rice farming as a rich source of culture. The information is derived from books such as *Development of Thai Rice Production* from the Department of Agriculture, *Rice: Science and Technology, Khao Khwan Khong Phaendin, Rice within Art and Culture, Rice: Birthplace of Thai Culture,* and websites such as www.ricethailand.go.th, and http://thairice.org (Department of Agriculture, 2002; Gomes, 2001; Naiwikun, 2007; Rice Department, 2009, 2016; Thai Rice Foundation under Royal Patronage, 2006a, 2006b).

4.2.1 Rice Farming: the preparation stage

The first stage of Thai rice farming, *Preparation*, involves many rituals, traditions and festivals where farmers cooperate with people who live in the same area or share the same water source. The events will begin along with the coming of the rainy season and share similar goals: to ask the Gods and guardian spirits and deities for rain, luck and abundance in the forthcoming cultivation season. Cultural events in this stage include the Royal ploughing ceremony, the Bun Bung Fai festival, and the Mae Phosop blessing rituals (Department of Foreign Trade, Ministry of Commerce, Thailand, 2016; Gomes, 2001; Gomes et al., 2001; Rice Department, 2009, 2016; Sudchaya et al., 2005; Thai Rice Foundation under Royal Patronage, 2006a, 2006b).

Royal ploughing ceremony

Each year, the rain season in Thailand begins around May and lasts until October. The first rain of the season reminds Thai farmers to prepare everything ready for planting .They prepare their high-quality rice strain for planting, they clean their tools and equipment, they tidy up places for work and, in the past, they would also check that their buffalos and cows are ready for hard work in the fields. Along with the preparations for the actual farming, farmers also prepare equipment and offerings for the sacred rituals that relate to rice farming. In Bangkok, the capital city, a very important such ritual is the Royal ploughing ceremony that is led by His Majesty the King. This ceremony relates to Buddhist and Hindu rituals that have survived for more than seven centuries. It marks the beginning of rice farming just as the rainy season begins in the sixth-lunar month every year. The ceremony presents weather forecasts from the interpretation of instruments which are used to predict the weather that allows farmers prepare for plentiful or drought to their farm (Department of Foreign Trade, Ministry of Commerce, Thailand, 2016; Gomes, 2001; Gomes et al., 2001; Lapruay et al., 2009; Sudchaya et al., 2005). Similar rituals take place in all parts of the country at this period of the year, of a smaller scale, but all with similar aims: to ask for abundance and protection of rice farms from bad luck and a poor corp. This ceremony is an important part of rice farming and can be classified under the "social practices, rituals and festive events" domains of ICH (UNESCO 2003, 2011).

Bun Bung Fai festival

In the Northeast, there is another important tradition that has become a tourist attraction: the "*Bun Bung Fai*" festival (Bung Fai is a local word for 'rocket'). The purpose of the festival is to ask Phaya Thaen, the deity who controls climate, to produce rain for His people to grow rice .In this festival neighbouring village communities make their own bamboo rocket, then parade them on the roads and launch them into the sky in an act of worship of Phaya Thaen. During the parade, community members play traditional music using local instruments. Dancers in a colourful parade perform in a gorgeous local style dress that is special and different from other village communities' dresses. The parade ends in the ceremony field, where participants wait for all the villages to assemble before the rockets are launched (Department of Foreign Trade, Ministry of Commerce, Thailand, 2016; Gomes, 2001;

Gomes et al., 2001; Rice Department, 2009, 2016; Sudchaya et al., 2005; Thai Rice Foundation under Royal Patronage, 2006a, 2006b). This tradition also marks to farmers the beginning of the rice farming season. The festival itself can be classified under the "social practices, rituals and festive events" domain. The costumes and ornaments that the performers wear, which purposefully made for this festival, could be classified under the "Traditional craftsmanship" domain, while the dances and songs that are performed in the parade can be classified under "Performing art".

Mae Phosop blessing rituals

Thai people in every part of the country share belief in rice as a sacred plant. They believe that rice belongs to and is protected by Mae Phosop, the female guardian deity of rice that has the power to protect and take care of all rice farms and farmers (Anuman Rajadhon, 1963; Department of Foreign Trade, Ministry of Commerce, Thailand, 2016; Gomes et al., 2001; Gomes, 2001; Satsanguan, 2002; Thai Rice Foundation under Royal Patronage, 2006b). Thai farmers are encouraged to be careful with their rice due to the belief that as a female, Mae Phosop is sensitive to loud noises and rude behaviour. The farmers believe that if they do not respect Mae Phosop, she will go away, and their crops and farm will remain unprotected from floods, drought, and pests .In this first stage of cultivation, farmers pray to Mae Phosop and other spirits to allow them to start the cultivation and support and protect their rice throughout the cultivation process. Mae Phosop blessing rituals take place at the beginning of the rice farming season in every rice farm across the country; alongside other rituals that also seek blessing from other gods and spirits, such as Phi Nam in the North of Thailand. Mae Phosop and other gods and deities are in fact evoked in almost every stage of rice farming, accompanied by many rituals. These important rituals can be classified as "oral traditional and expression" as they consists of chants, prayers, and legends; but also as "Social practices, rituals and festive events".

4.2.2 Rice Farming: the planting and maintaining stage

Activities in this stage, *Planting*, start when rice starts growing in the field and continue until it ripens and is ready to be harvested. During this stage, farmers need to take very good care

of their fields. They have to monitor, nourish, and safeguard the rice against many controllable and uncontrollable complications that may arise such as unpredictable amounts of water, humidity and temperature, animals, diseases, and pests. As a result, many cultural events take place during this stage, which mostly aim to make offers to Gods and other guardian spirits in return for them to prevent harm and protect their farm from disaster and misfortune. One such example is the *Tam Kwan Kao* ritual which is performed by farmers in every part of Thailand to this day (Anuman Rajadhon, 1963; Department of Foreign Trade, Ministry of Commerce, Thailand, 2016; Gomes, 2001; Rice Deapartment, 2009; Sudchaya et al., 2005; Satsanguan, 2002; Thai Rice Foundation under Royal Patronage, 2006b).

After *Preparation* farmers start to plant the rice in ways that differ from region to region and depend on local geography and climate .The *Tam Kwan Kao* ritual celebrates the point in rice's reproductive process when the rice enters the 'booting' stage where the panicle emerges from the stem and continues to grow. Farmers liken this with human pregnancy, and must take as good care of the reproduced rice as they would of a pregnant Mae Phosop (Anuman Rajadhon, 1963; Department of Foreign Trade, Ministry of Commerce, Thailand, 2016; Gomes, 2001; Gomes et al., 2001; Satsanguan, 2002; Sudchaya et al., 2005; Thai Rice Foundation under Royal Patronage, 2006b). The *Tam Khan Kao* ritual is performed by a senior farmer, who sets up a chant for blessing Mae Phosop along with offerings of local sour fruits such as star gooseberry and a mirror. Gomes (2001) points out that farmers offer sour fruits to a pregnant Mae Phosop in they same way they would to ordinary pregnant women who crave sour fruits, while the mirror is for Her to admire Herself in. The ritual is usually performed by women, as Mae Phosop is shy and dislikes men who are likely to make loud noises and ruin the crops (Gomes, 2001). All precautions are taken to please Mae Phosop. Farmers attach colourful flags to poles and position them at the edge of the rice fields .They also place bananas, boiled eggs and other delicacies in a *kratong* (special containers made from banana leaves) and hang them from the poles, thereby inviting Mae Phosop to stay and protect the rice from dangers .Farmers also make a commitment to Mae Phosop that they will take very good care of, be polite to and treat gently every rice plant. This ritual reminds farmers and other community members that they need to take very good care of their rice because it already bears grains that will soon develop and mature. This ritual involves chants,

prayers, and legends and can therefore be classified both as “oral traditions and expressions” and “Social practices, rituals and festive events”.

Other rituals aim to keep animals and pests away from the crops, and the *Lai Nam* ritual to exorcize rain and excessive amounts of water. Buddhism’s concept underlies the ritual to keep away animals and pests. Karma, one of the key concepts of Buddhism, keeps farmers from killing animals or other living things. Pests are therefore kept away through other traditional practices such as the use of scarecrows to keep away birds. Farmers, in the past time, learned that they could keep birds away from the rice crops by producing a model of a farmer and install it in the field. In addition to techniques such as scarecrows, farmers also perform rituals to ask Mae Phosop and other deities to keep pests away. These traditional practices can be classified as “Knowledge and practices concerning nature and the universe” as they are the way of thinking about the surrounding environment.

4.2.3 Rice Farming: the harvest and post-harvest stage.

When rice ripens, it is time for harvest. Farmers perform rituals to obtain permission to harvest their rice from Mae Phosop and other guardian spirits .There are many events related to this stage. They have many purposes such as to show respect to rice, field, places, buffaloes, and Mae Phosop, and mark and celebrate the end of the season. Important cultural events in this stage include *Long Kaek*, *Pleng Kiaw Khao, Pleng Ten Kam Ram Khiew, and Tam Kwan Yoong* (Anuman Rajadhon, 1963; Department of Foreign Trade, Ministry of Commerce, Thailand, 2016; Gomes, 2001; Lapruay et al., 2009; Rice Department, 2016; Rice Deapartment, 2009; Satsanguan, 2002; Sudchaya et al., 2005; Thai Rice Foundation under Royal Patronage, 2006a, 2006b).

Long Kaek, Pleng Kiaw Khao, and Pleng Ten Kam Ram Khiew

When the rice is ready to be harvested, farmers in each field will ask family members, other farmers and villagers to join in the *Long Kaek* tradition, where they all work altogether to harvest the ripened rice from the field. The host farmer announces to the community that the

rice is ripening and asks for their support in harvesting and celebrating. In the past, farmers did not have any machinery for harvesting and this tough job needed more manpower than the owner and their family had alone, to finish the job before the rice got overripened. *Long Kaek* was an opportunity to ask other farmers and villagers for support. After *Long Kaek*, men and women joined in the relaxing, recreational activities of singing traditional songs and taking part in traditional performances such as *Pleng Kiaw Khao* (harvest/cutting rice song) and *Pleng Ten Kam Ram Khiew* (sheaf and sickle song). A male and a female group would perform these songs. The song is about rice activities and everyday life stories, and bears a sense of fun and happiness. The performers carry rice farming equipment and panicles and act as if they are working in the field. This traditional style of harvest and its associated cultural events is fading as harvest is now largely mechanized. As a result, both the traditional harvest practice and the related rituals can now only be found in some rural areas. The *Long Kaek* tradition can be classified as "Social practices, rituals and festive events" as it is a collaboration of community members. The *Pleng Kiaw Khao* and *Pleng Ten Kam Ram Khiew* involve traditional performances in beautiful dresses that can be classified as "Performing art" and "Traditional craftsmanship". The songs also can be classified as "Oral traditions and expressions".

Tam Kwan Yoong

This event will be taking place after the rice is threshed and is ready to be stored in the granary or barn. There are rituals to thank Mae Pho Sop and the other guardians for their help, and to ask for their permission to move the rice and store it in the granary. The Thai granary is usually raised higher from the ground, to reflect the esteem that Thai farmers hold the rice in – Thai people place respected things higher to show their high reputation. The farmers will clean up and tidy their granaries to show respect to Mae Phosop and granary guardians. When the granary is ready, Mae Phosop is thanked and her pardon asked for kind permission to move the rice for storage in the granary. The granary guardians will be blessed and asked for kind permission to use the granary to store rice and also asked to protect the rice from harm during keeping it in the granary. The moving of the rice to storage rituals can be classified as

"Social practices, rituals and festive events", while the chants used in the ritual can be classified as "Oral traditions and expressions" of ICH.

The traditional way of threshing is to hit the rice bundled to the ground or let the cattle walk on the rice bundles. Farmers are concerned that this is not good manners towards something that they hold in as high esteem as the rice, and they need to ask for the forgiveness of Mae Pho Sop through a forgiveness ritual. In this way, they believe, their panicles will be well prepared for threshing.

The examples above show that ICH related to all stages of rice farming in Thailand spans all five domains of ICH identified in the UNESCO (2003, 2011) guidelines for safeguarding ICH. Many of these festivals and rituals are still performed today, such as Royal Ploughing, Bun Bung Fai, and Tam Kwan Khao; many others however are fading and found only in some remote areas of Thailand which are trying to conserve their cultural heritage.

However, Thai rice culture extends beyond events in the rice fields. Traditional foods made from rice are also part of rice culture, as many of them appear in the Thai intangible cultural heritage list. Thai cuisine and recipes can represent Thai identity. The delicate recipes and use of local ingredients not only result in delicious dishes but also reflect a unique way of living with nature. As rice is sacred for the Thai people, rice food is on the menu in every ritual and is also part of everyday culinary life. A special rice dish in the southern part of Thailand is *Kao Yum.* This dish contains cooked rice, herbs, shrimps, pomelo, and the local sauce *Nam Budu* (fermented fish in Southern style). In Central Thailand, *Kao Chae* is an extraordinary dish with a delicate recipe and a sophisticated preparation process. In the past, this dish was always served in royal palaces and noble families ' houses. *Kao Chae* contains cooked rice soaked in jasmine water that is incubated with candle smoke within a clay container, as well as other traditionally processed meats and vegetables. This summer dish is suitable for warm climates like Thailand's as it is not spicy and is served cold. In Eastern Thailand, local people roast rice with coconut milk in a bamboo joint. The dish, called *Kao Lhaam*, is very popular not only with foreign tourists but also with Thai travellers.

Culture, traditions and rituals that relate to rice farming are important in all three stages of rice cultivation: *the rituals for rainmaking*, *the rituals for protecting the rice crops*, and *the*

rituals for a bountiful harvest. Notably, all of these rituals are associated with gods, spirits and nature. These express how the Thai people perceive the world around them and reflect their worldviews into their cultural heritage.Table 4.1 below captures this mapping between rice cultivation and rice culture ICH.

Table 4.1 Correspondence between rice farming practices and rice culture ICH in Thailand

Rice cultivation stage	Practices and techniques used in Thai rice farming	Rituals, Traditions, Events related to the ICH
Preparation	Rice strain preparation Preparation of tools, equipment, and fields	Royal ploughing ceremony Bun Bung Fai Blessing to Mae Phosop
Planting, maintaining	Seeding and transplant Nursing rice Grow and take care of the rice	Tam Kwan Kao
Harvesting and post-harvesting	Harvesting Moving rice to store in the granary	Long Kaeg Pleng Kiaw Kao Pleng Tem Kam Ram Khiew Tam Kwan Yoong Bless to thank for Mae Phosop

4.3 Thai rice farming :traditional knowledge and Western science

This section discusses the agricultural knowledge and wisdom that can be found in all stages of rice farming. In Thailand, rice farming has flourished across the country for thousands of years because of both the cultural life around rice farming and the associated agricultural knowledge and wisdom that have supported agricultural practice. The section presents a summary of the traditional knowledge and practices and the imported science that relate to Thai rice farming. A more detailed description can be found in Appendix 4.

Developments in science and technology have transformed agricultural practices across the world, including the process of rice farming in Thailand. Traditional knowledge and practices have been gradually replaced by modern technologies and techniques. However, at the moment, elements of traditional rice culture, traditional agricultural knowledge and modern science coexist in all stages of Thai rice farming in many parts of Thailand. Modern approaches to rice farming were introduced in Thailand during the reign of King Rama V, between 1869 and 1910 (Department of Agriculture, 2002; Naiwikun, 2007; Rice Department, 2009; Thai Rice Foundation under Royal Patronage, 2006b). Noticeably, modern practices were introduced in different stages of the farming process at different times.

This section will illustrate the relationship between traditional knowledge and western science in farming practices by presenting some examples of traditional and modern practices in the three stages of rice farming: *The Preparation Stage*, *The Planting and Maintaining Stage*, and *The Harvest and Post- Harvest Stage*. In addition, for every stage, I also discuss farming activity in terms of two forms of knowledge :*the explicit knowledge* that manifests in modern rice farming practice (for example, knowledge related to using modern means and methods of seed preparation which is acquired through structured training and instruction from scholars or experts); and 2) *the tacit knowledge* that is embedded within traditional rice farming practice (for example, knowledge embedded in the rituals and traditional methods of seed preparation that is acquired through hands-on experience, practice and participation in the rice farming community).

4.3.1 The preparation stage of rice farming.

The preparation process of rice farming can be divided into two major parts: seed preparation and field preparation. Both the rice seeds and the rice field are considered as important parameters in the success of rice farming. The preparation processes take place alongside the Royal ploughing, Bun Bung Fai, and Blessing to Mae Phosop rituals.

Seed preparation

High-quality seeds can guarantee rice quality and productivity. Preparing and supplying high-quality seeds that are suited to the conditions of each rice field and the ability of the farmers themselves is an essential first consideration.

In the past, the preparation of rice seeds was a simple activity. Rice farmers would separate some of the rice seeds that they harvested in that season and use it to cultivate the next crop. Sometimes, they would request good rice seeds from neighbouring farmers. Farmers kept observing their rice field to find out what are good characteristics of rice seeds, looking at how seeds 'behaved' during cultivation, from germination to harvest. Farmers would harvest the best crops first, then dry it and bless Mae Phosop before threshing it, ensuring that it stays separate from lesser quality crops. These seeds were then kept separately, in a place where it would be safe from birds and rats. Traditional seed preparation therefore included finding good varieties of rice in their own crops or requesting good variety seeds from farmers in neighbouring fields (Department of Agriculture, 2002; Naiwikun, 2007; Rice Deapartment, 2009; Sudchaya et al., 2005; Thai Rice Foundation under Royal Patronage, 2006b).

Modern seed preparation techniques were first introduced in the year 1921 by The Rice Experiment Station (RES), a part of the Department of Agriculture (DOA) (Department of Agriculture, 2002; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Naiwikun, 2007). With the cooperation of local and international experts, RES launched a project to collect different varieties of rice across the country during the years 1921-1922. It was the first time in Thailand to adopt internationally accepted methods for classifying rice strains in the country. They collected 4,764 samples of

rice varieties from all over Thailand. These rice seeds were planted and good varieties were selected using Pure Cultivation Methods according to the technical principles. Later, rice varieties were developed using modern knowledge in genetics and genetic engineering for higher quality than native species and these were favoured by Thai farmers to grow on their farm instead of the native strains.

The fundamental knowledge that modern-day scientists use to select rice varieties includes knowledge of botany and genetics, as well as statistics that work alongside the new standard and advanced tools and methods derived from western science. The government's support of these methods provides certainty for farmers who consider these seeds reliable. As traditional seed preparation relies on observation, identification, and an understanding of the surrounding natural environment, it results in unstable rice characteristics because of the uncontrollable environment and unstructured methodology of the farmers' experimentation in their fields. As a result, the farmers do not always achieve the best rice variety possible in terms of the quality of the product, but it allows them to cultivate rice varieties that are appropriate for their geographic areas in terms of the need for water and type of soil that is appropriate for the rice seed (Department of Agriculture, 2002, 2005; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008).

Modern approaches to seed preparation were adopted in earnest after 1940 when the government introduced a policy for farmers to use high-quality seeds that meet government standards and use appropriate methods to nourish the soil (Department of Agriculture, 2002, 2005; Lapruay et al., 2009; Museum Siam, 2011; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Payanun, 2000; Rice Department, 2016; Satsanguan, 2002). From then on, use of traditional seed preparation methods began to decline.

Soil preparation

Traditional soil preparation requires human resources, animals, and simple equipment. Traditional farming equipment was made from materials that could be found in the local area

and built with simple methods. There is evidence that farmers in ancient times melted metal and formed it into a shape that meets the needs of various tools suitable for use in each community (Department of Agriculture, 2002, 2005; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Payanun, 2000). The tools were designed and constructed in harmony with the surrounding environment to meet the requirements of the rice fields. Traditional soil preparation methods still rely on human and animal labour to transform the ground. Farmers dug holes for sowing rice by themselves, using the hoe or other simple hand tools. Later, they began to develop tools such as rakes and ploughs and used animal power to drag them to adjust the ground surface, preparing the field for sowing. There is evidence for such activities since the Sukhothai period, 19th century (Department of Agriculture, 2002, 2005; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Payanun, 2000; Rice Department, 2016).

Modern soil preparation methods were first introduced in 1953 by the Rice Department. They started using tractor machines for ploughing and raking the fields. It began in the RES. This station aims to serve farmers who had problems with labour costs. During that time, the Rice Department had launched a program and set up a project to develop agricultural machinery, called "*the Iron Buffalo Project*". The Agricultural Engineering Division had developed the first tractor in Thailand. It became an important labour-saving tool for farmers that reduced the time required to prepare the field compared with the human and animal power required in the traditional method. As a result, rice-growing increased dramatically at that time. The government played an important role in promoting and supporting these new methods of soil preparation for economic growth (Department of Agriculture, 2002, 2005; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008).

4.3.2 Planting and maintenance stage

Rice cultivation begun in the highland areas. Later, the farmers found that the lowland areas between the valleys were more fertile, and the soil was rich with nutrients suitable for

cultivation (Department of Agriculture, 2002; Lapruay et al., 2009; Sudchaya et al., 2005). With both plants and abundant water, humans then moved to the plains and expanded the plantation area to make enough food to meet their needs.

Planting

Traditional rice farming in Thailand was often done in areas near natural water sources and was accompanied by water management using simple tools and methods such as ridges, manual water transportation systems, and using cattle for labour-saving. Most of the tools were developed from generation to generation. The tools were made from wood and iron and were used to smooth the paddy areas. The farmers designed their own space and selected rice varieties that were suitable for the local environmental conditions. One of the earliest rice farming methods involved farmers growing rice by putting rice seeds into the prepared holes in the field. This is still done in some of the highlands of northern Thailand (Naiwikun, 2007; Sudchaya et al., 2005; Satsanguan, 2002).

Another traditional method is rice cultivation by transplanting, where rice seeds were planted in a nursery and then transplanted into the main field. This traditional style returns high yields but is suitable for areas with abundant water. Traditional rice sprout preparation needs to do in a flat surface with controllable water levels. Experienced farmers will design their field in accordance with the seasonal wind direction so that it is well ventilated, preventing seedlings from catching disease. The farmers controlled the quality of rice sprouts in the nursery field, selecting seeds with good characteristics that were healthy and free from diseases and pests. They needed select rice sprouts at the appropriate age. This requires the expertise and experience of the farmer. Removing young rice plants from the nursery field is important and needs to be done with great care as the young plants should be in perfect and healthy condition. This also relies on the skills, experience and expertise of the farmers to reduce damage on the young plants as much as possible. The preparation of the young plants also requires farmers' skills on fertilising and maintaining the water level in order to get a good quality of rice (Lapruay et al., 2009; Naiwikun, 2007; Rice Department, 2016; Thai Rice Foundation under Royal Patronage, 2006b).

The traditional transplanting of rice sprouts requires much expertise, even though the seedlings are planted at only 3-4 plants per point, but the farmer will have to use the experience to analyse how long the rice leaves must be cut or not cut in order to be consistent with the amount of water trapped in the rice field. This method is to avoid causing the whole rice to sink or fall in the water during planting. Experienced farmers can evaluate the amount of minerals and fertility in their field by themselves and plan for distances of the rice plants accordingly (Lapruay et al., 2009; Naiwikun, 2007; Rice Department, 2016; Thai Rice Foundation under Royal Patronage, 2006b).

In terms of scientific knowledge, these processes involve knowledge from many fields of science. The biology of plants or botany is one of the fields, as it refers to the stages and functions of plants' organs. The knowledge of the biology of plants can help farmers make their own decisions and to manage the transplanting process appropriately. The shape of the effectiveness of space and the distance of rice in the fields had to be designed. Mathematics and physics can inform these processes. Traditional Thai rice farmers developed water transportation system by simple methods and machines such as water wheels, ridges and water conduit. These technologies inevitably rely on Physics principles and concepts such as the force of gravity for the movement of water in the waterfall, pulley principles for producing a water wheel to transfer water from lower to the upper levels, and momentum that plays an important role in driving the water wheel (Department of Agriculture, 2002, 2005; Naiwikun, 2007; Museum Siam, 2011; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Payanun, 2000; Rice Department, 2016; Thai Rice Foundation under Royal Patronage, 2006b).

The modern style of rice farming began in the reign of King Rama V (1869-1910) (Department of Agriculture, 2002, 2005; Naiwikun, 2007). There was a policy to allow governments and the private sector to work together on a modern irrigation system in order that the farmers were able to grow rice all year round without depending on natural rain.

Rice maintenance

In the past, water management in the rice fields was vital because rice needed water from natural sources or rainwater. Farmers relied on gravity and basic tools to push the water into and drain it out of the fields, done mostly by human and cattle power with simple and basic equipment. At present, irrigation systems are developed and machinery is used that can pump and push water more powerfully. These technologies reduce the time that farmers need to spend on water management. Farmers today rely on water from irrigation systems and pumping machines rather than traditional management systems (Department of Agriculture, 2005; Lapruay et al., 2009; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Rice Department, 2016).

Soil maintenance

Nutrients in the fields in the lowlands are abundant, from sediments that were blown from various places. This allows the rice to gain enough essential elements for growing and fruiting without adding any fertilisers (Department of Agriculture, 2002, 2005; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Rice Department, 2016). The rice will absorb enough nutrients in those soil to create it stems, leaves, and seeds. However, after years of farming, nutrients were removed from the soil with each harvest. The level of nutrients in the rice field therefore gradually reduced, and farmers found that they needed to add fertilisers to their rice fields to support rice growing as much as possible.

Traditional farmers used organic fertilisers such as compost or manure or green manure obtained from the fermentation of plant debris and manure that allows the process to decompose into nutrients by microbial activity in nature. Farmers would deliberately select certain types of raw materials, control the duration of the fermentation period and then control the amount of fertilise to use in the rice fields. The knowledge and skills of the organic fertilisation process would be transferred from farmer to farmer.

Modern chemistry and microbiology knowledge was 'imported' to support the production and use of fertilisers. Modern soil maintenance began in 1916 when the government set up experiments for adding fertilisers and chemicals to maintain soil conditions in the rice fields in the central region of Thailand. Since 1948, new chemical fertilisers begun to be used to increase soil fertility. The government also invested in the development of fertiliser formulations by using scientific methods and knowledge to design experiments so that the resulting fertilisers are suitable for the area and rice varieties of Thailand (Department of Agriculture, 2002, 2005; Sudchaya et al., 2005).

Weed control

Weeds in rice fields affect the growth of rice plants and may also cause diseases and insects to damage rice in the field. Weeds survival depends on many factors of rice production, ranging from rice varieties, location of the field, the cultivation methods, water management, nutrients in the soil, and chemicals used in rice fields (Department of Agriculture, 2002, 2005; Museum Siam, 2011; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Rice Department, 2016).

In the past, there was a selection of rice varieties that are easy to grow and strong so that they beat the weeds naturally. The traditional farming usually used five methods to protect their rice from weeds (Department of Agriculture, 2002, 2005; Museum Siam, 2011; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Payanun, 2000; Rice Department, 2016; Satsanguan, 2002). The first method was the development of rice varieties to be able to grow against weeds. Farmers often observed and searched for the excellent characteristics of rice to be used for sowing. In the second method, farmers would design the land use and prepare land for rice cultivation. To do so, they would adjust the ground level smoothly for the purposes of water management and maintenance of dampness in the soil. The third technique is to choose the appropriate cultivation methods. Rice cultivation with the water trapped can enhance healthy growth of rice. Also, the high level of water can be a problem for weeds.

The fourth technique is water management. Determining water levels and soil moisture is an essential factor in the management of various types of weeds. Farmers know at a certain height of water, some weed species would be drowned. The last technique is soil preparation. Farmers use the ploughing method to turn the lower part of soil to the ground surface. This can control the common weeds in the field before cultivation. The weeds that are growing on the soil surface will be flipped and die naturally.

The modern style of weeding took place after 1957 when the Thai government brought a new rice strain that can be grown all year round and distributed to Thai farmers after breeding with the native strain (Department of Agriculture, 2002). This hybrid strain enabled farmers to cultivate rice two seasons a year. However, the strain is not of enough strength to compete with weeds compared to the native strains. Thus, the government had to find a solution to this problem. Farmers started using the ploughing machines to turn up the dry soil before it rains to uproot the weeds and prevent their germination. This way, the weeds are destroyed for good. They also used irrigation and water management to control the weeds (Department of Agriculture, 2002, 2005; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008).

Rice disease control

In the past, rice diseases did not often affect rice farming because farmers planted rice once a year and relied on natural rainfall. Moreover, farmers used native rice varieties with different varieties grown nearby in other rice fields and did not require fertiliser. Once harvested, the stubbles were burned and pathogens would be destroyed by the heat. Farmers would not grow anything in the field until the next rainy season. These conditions were not suitable for diseases to disseminate (Department of Agriculture, 2002, 2005; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Payanun, 2000; Satsanguan, 2002).

Since 1953, the Thai government set up the RES and encouraged farmers to use rice varieties with better qualities, most of which were the hybrids. Farmers were also encourage to enrich the soil with fertiliser according to the new agricultural principle (Department of Agriculture,

2002). This principle resulted in a decreasing number of rice strains grown by farmers in every area. The modern farming style used in this situation is the breeding and selection of rice varieties to resist diseases systemically. It also includes the design of the rice fields that can control humidity relative to the seasonal wind direction. Moreover, chemicals and antibiotics are applied to prevent and eliminate rice diseases in the field thanks to the imported knowledge in chemistry, microbiology, and botany.

Rice pest control

Rice pests can destroy vast amounts of rice production both in the fields and after harvest. In the past, farmers grew rice in only once season a year and used various of rice strains. These conditions were not suitable for rice pests to live in the rice field throughout the year and could reduce rice pest infestations. When the farming methods are changed, the rice fields are enlarged, cultivated with similar strains that cannot resist pests and grown throughout the year, causing rice pests to become a significant problem. The traditional practices for pest control mainly consist of four ways: superstition, mechanical methods, traditional cultural control, and chemical use (Department of Agriculture, 2002, 2005; Museum Siam, 2011; Naiwikun, 2007).

The modern rice pests control began after World War II by the introduction of synthetic chemicals to remove pests and keep them away from the rice fields (Department of Agriculture, 2002, 2005). The first synthetic chemicals used are DDT and phosphorus derivatives which are very effective in controlling many kinds of weeds and insects. However, the use of chemicals in pest control triggered many side effects such as chemical and toxic residues that are harmful to consumers. The development of insect-resistance rice strains is one of the modern methods to handle pest infestations. These practices can be supported by many fields of scientific knowledge, including microbiology, chemistry, biology, and physics (Department of Agriculture, 2002, 2005; Museum Siam, 2011; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Payanun, 2000; Rice Department, 2016).

Animals control

The traditional methods to control of animals in agricultural areas such as rice field are simple mechanical methods and chemicals use. The mechanical methods include hunting with conventional weapons, digging, trapping, and blanketing (Department of Agriculture, 2002, 2005; Museum Siam, 2011). The chemical methods include the use of medicinal plants and baits. The modern methods to control rats' population in the fields were first observed in 1975 (Department of Agriculture, 2002). The government had introduced the method known as "*Systematic Preventive Rat Control in Rice*" which consisted of two essential stages. The first stage is to reduce the population of rats during the soil preparation stage. The second stage is keeping the low population of rats during planting by mechanical methods, cultural control, and slow-acting chemical use (Department of Agriculture, 2002, 2005; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Payanun, 2000).

Birds can also cause problems in the rice field. Both traditional and modern practices usually use such scare techniques as creating the noises and the use of scarecrows (Department of Agriculture, 2002; Museum Siam, 2011). The imported sciences used for animal control are related to the fields of physics, chemistry, biology, zoology, and microbiology.

4.3.3 The harvest and post-harvest

Although Thai agricultural development has taken place since 1892 during the reign of King Rama V, the modern methods of harvesting and post-harvesting were not seen until 1977 (Department of Agriculture, 2002). At that time, the government created guidelines to enhance rice production in three ways: expansion of rice planting area, application of high technology in rice planting, and improving the harvesting and post-harvest practices to minimise the loss of quality and quantity. There are six main stages for the practices of harvest and post-harvest in Thai rice farming, including harvesting, dehumidification, transportation, threshing, impurity separation, and rice storage (Department of Agriculture,

2002, 2005; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Payanun, 2000; Rice Department, 2016).

The harvesting

Traditional harvesting was the use of human labour with basic equipment, and modern practise is to use machines to replace manpower. Also, the effective harvesting methods have to take into account the appropriate harvesting time. Experienced farmers know that the appropriate harvesting period is related to the term called Plubpleaung (ระยะพลับพลึง) period during which rice is not too old or too young (Department of Agriculture, 2002). The government has introduced modern methods to rely on scientific information to help farmers determine the best timing for the harvesting. Counting from the starting date of the next 28 to 30 days is the appropriate harvesting date. The main field of the scientific knowledge involved in this stage is botany that used to analyse various stages of rice accurately and leads to determining the precise timing for harvesting.

Dehumidification of rice.

The traditional method of dehumidifying rice after harvesting was to tie rice together into bundles and sundried in the fields. This method has been widely practised among farmers until the present due to convenience and lower cost from the dehumidifying machine. The modern methods of dehumidification of rice started in Thailand around 1992. It was the use of machines to reduce moisture in rice before moving to the storehouse (Department of Agriculture, 2002). Although the humidifier machines offer more convenience and efficiency, the majority of Thai farmers prefer to use the traditional method in the fields rather than paying for the dehumidifying machines (Department of Agriculture, 2002, 2005; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Payanun, 2000).

The transportation

The traditional rice farming, to transport rice, relied on human resources, cattle, and basic equipment that were created from materials and crafts of local people. The traditional basic equipment included the traditional style of the palanquin, wooden carts, and wagons (Department of Agriculture, 2002; Museum Siam, 2011; Sudchaya et al., 2005). The modern transportation method had been used in the same period as the ploughing machine. The engine truck replaced the traditional style. In Thailand, farmers prefer to use small 4-wheeled vehicles modified from the ploughing machine, called Rod E-Tan (รถอีแต๋น). This vehicle has become part of Thai rice farmers' way of life until today.

Threshing

In ancient times, before rice was cultivated for consumption, people used their hands to separate seeds. Later, farmers learned to bring some materials to hit rice bundles to force the grains to separate from its panicles, followed by the using of cattle to trample on the rice bundles in order to separate seeds (Department of Agriculture, 2002, 2005; Sudchaya et al., 2005). The traditional threshing by manpower was to use a piece of wood firmly tied together with a rice bundle and hit the bundle to the specially built floor. Threshing by cattle was done by placing the harvested rice on the prepared floor. Then, a strong pole was set at the centre of the floor. Buffaloes or cows would be then tied to the pole and forced to move forward and trample on rice bundles. Rice seeds would be separated by trampling (Department of Agriculture, 2005, 2002; Rice Department, 2016; Satsanguan, 2002; Sudchaya et al., 2005). The traditional threshing was mentioned in many parts of rituals such as Tam Kwan Kao for a very long time (Anuman Rajadhon, 1963; Satsanguan, 2002; Sudchaya et al., 2005). In the ritual, some parts of the narrative were about threshing by using cattle and, therefore, the farmers needed to apologise to Mae Phosop, the goddess and goddess of rice.

The modern threshing machines were imported for use on the farm in 1920 (Department of Agriculture, 2002). The popularity for farmers of the use of threshing machines began to increase from 1972. At present, farmers turned to use more threshing machines because they

are more cost-effective than manpower and threshing with cattle. This all-in-one machine, currently and preferably used by farmers, comprises harvesting, threshing, and pre-packaging. It dramatically reduces the workload of farmers (Department of Agriculture, 2002, 2005; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008).

Impurity separation

The impurity separation is a method to distinguish and remove the impurities that might contaminate rice. Impurities include such materials as dirt, soil and sand particles, part of the unwanted plants, and debris that can cause disease and reduce the quality of rice. The traditional methods range from using naked eyes to distinguish them and remove by hand (Department of Agriculture, 2002, 2005). The farmers also searched for devices such as large leaves in order to blow the impurities away. Some farmers used the sprinkling method by making the rice fall while the wind blows. The unwanted impurities and empty rice seeds will be separated from the good rice grains by falling in a different location due to weight in response to the wind. It is a hard work and usually done by men.

Another essential piece or equipment used to separate the impurities is the winnowing machine. This traditional machine relies on manpower to rotate the turbine to create wind before winnowing rice grains into the machine in order to blow the impurities away from the good rice grains (Department of Agriculture, 2002, 2005; Museum Siam, 2011; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Satsanguan, 2002).

With the modern method, engines and motors are installed with the ordinary winnow machine. As a result, manpower is no longer needed. Modern tools also bring high technology to enhance the efficiency of separating impurities such as electronic devices, measuring instruments, and computers along with the knowledge about gravity force and mechanic engineering. These help to develop machines that provide more potential to separate impurities that are similar in size, shape, colour, and weight to the rice grains (Department of Agriculture, 2002, 2005; National Bureau of Agricultural Commodity and

Food Standards Ministry of Agriculture and Cooperatives, 2008). However, these modern devices are expensive, and therefore, they are only used by private companies and agriculture trading businesses.

Rice storing

The traditional method of storing rice was to move the rice into the well designed and maintained storage areas such as granaries and barns. Some places stored rice in some specific containers made of woven bamboos, such as Krapom (กระพ้อม, a kind of large bow), or large baskets. The traditional Thai granaries (Yoong (ยุ้ง)) and barns (Chang (ฉาง)) are specific buildings for storing rice. If the farmers did not have a granary or a barn, they used bamboos to make a special container and used cattle dung to fill the holes of the container to store rice (Department of Agriculture, 2002, 2005; Museum Siam, 2011; Naiwikun, 2007). This traditional practice has been passed on from the ancestors and is still used in many places in Thailand. This traditional method is the natural control of moisture and temperature as they can spoil the rice.

The modern method of storing rice began in 1972 (Department of Agriculture, 2002). It was a storage that had special control for the environment. Due to high costs of instruments, space, and operators, it was usually found in rice trading companies and rice exporters rather than ordinary farmers. The modern rice storing uses air conditioning with the environment-controlled buildings to prevent moisture transfer and air exchange from outside. New methods have a limitation on costs that general farmers cannot operate on their own. The current storage of rice is, therefore, using the original method combined with new equipment and tools such as using hygiene principles for storage management, using the synthetic chemicals to prevent, eliminate, and chase rice enemies (Department of Agriculture, 2002, 2005; Naiwikun, 2007; National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008; Payanun, 2000; Rice Department, 2016). However, since general farmers do not have enough space to store their rice, the costs to keep

their rice at rice trading businesses become a new burden for farmers (Department of Agriculture, 2002).

The traditional methods of rice cultivation in Thailand are similar to those used for other plants. Traimongkonkul et.al. (2001) study the transformation of rice cultivation practices in the central region of Thailand and discuss the traditional and modern practices, particularly in terms of the use of technologies for rice farming in Thailand. Their research focuses on the Maharacha field in the Ayudhya province to examine the traditional practices. This area has been used for rice farming for a very long time in history. The field has provided a high rice yield for communities in the past. The farmers in this area employ traditional rice cultivation practices and continue to apply them despite the existence of modern, high-quality technologies, or new methods of cultivation utilised in many other rice farms in other regions of Thailand (Traimongkolkul et al., 2001). However, the farmers at Maharacha faced difficulties as their land lost the essential elements and were affected by changing environmental and social factors. These changes led farmers to a financial crisis due to high costs. Traimongkolkul et.al (2001) argue that the traditional style of rice farming in this area is similar to that of the past and those of other farms that have attempted to conserve their traditional practices. Maharacha farmers grow, maintain, harvest, and transform their products by themselves, using mostly manpower and animal power. These farmers accurately understand the whole system of rice farming and control every stage using their own skills. Only one or two farmers were able to manage a large farm. When the size of the farm grew larger, many farmers were no longer able to manage the farms and would seek to co-operate with neighbour farmers or community members without offering them compensation. Traimongkolkul et al (2001) further discuss traditional methods of rice cultivation and how each farm manages almost every process of farming with limited use of technology. Rice farming tools have been devised and made based on farmers' traditional knowledge and practices.

Traimongkolkul et.al (2001) also studied the Banglain field in the Suphanbury province. This area has been promoted and supported by the government as land for modern rice cultivation. Banglain's geographical structure is a delta like the Maharacha field. The government has established an exemplary irrigation system to supply sufficient water to Banglain's farmers

in order to produce rice throughout the year. In contrast to the Maharacha field, new systems and technologies have been introduced to this area, whereas Maharacha's farmers are still using traditional tools and growing native strains of rice such as Khao Loi (floating rice), which is a special rice strain that has the ability to extend its nodes above the water level when the Maharacha field is flooded. The modern methods at the Banglain fields include efficient irrigation systems, the use of machinery in almost every stage of cultivation, the using of chemical fertilisers, pesticides, high-quality technology tools, and specialists (Traimongkolkul et al., 2001). The main purpose of rice farming in this area is large-scale rice production for the global market. Farmers can grow their rice whenever they want due to the sufficiency of resources and tools, whereas the farmers in Maharacha rely on natural climate and encounter flooding in most years. The farmers at Banglain incur high costs and rely on machinery more than human and animal power, meaning that rice cultivation becomes intensive and mechanised (Traimongkolkul et al., 2001). Farmers at this location seemed to serve more as managers on duty rather than farmers, as they tend to hire specialists for almost every stage of the cultivation process.

The high demand for rice in international markets has led to the intensification of rice production with modern technologies and practices. But despite this and the serious problems that traditional rice farmers like those in Maharacha face, traditional rice farming is still practiced in many Thai regions (Traimongkolkul et al., 2001). The two approaches are practiced in parallel, with a number of differences and similarities in how the process is managed, what tools and technologies are used, etc. (see Figure 4.1). Nevertheless, despite the changes in rice farming practice that modern rice science has brought, in chapter 3 we saw that many of the cultural traditions related to rice farming continue in present day Thailand. The question that arises is, how do museums in Thailand deal with traditional and modern rice farming practices, and their relationships rice science and rice culture? The following section explores this question.

Figure 4.1 Correspondence between rice farming practices and rice culture ICH in Thailand

Table 4.2 Some examples of Rice farming practices, rice ICH, and rice science in the three stages of rice farming in Thailand.

Rice cultivation stage		Rice farming practices		Rice ICH	Rice science
		Traditional Practices	Modern Practices		
Preparation	Rice seed preparation Field preparation	Observing and experimenting in the field, or a request from a neighbour Manpower, cattle, and simple tools	Experiment in the laboratory and in the field Machinery	Royal ploughing ceremony Bun Bung Fai Blessing to Mae Phosop Blessing to Phi Nam	Biology, Genetics, Botany, Chemistry, Physics
Planting/Maintaining		Manpower, cattle, and simple tools Planting without fertiliser or using organic fertiliser Relying on natural resources Simple tools and management of water and land Traditional cultural control Superstitions, Mechanical methods, natural chemicals use Digging, trapping, and blanketing Birds scaring, scarecrow	Synthetic chemicals use Machinery Modern cultural control	Tam Kwan Na Tam Kwan Kao Lai Nam Ritual	Biology, Geology, Botany, Genetics, Plant Physiology, Physics, Microbiology, Mathematics, Mechanical Engineering, Environmental science, Ecology, Chemistry, Zoology
Harvesting and post-harvesting	Harvesting Dehumidification Transportation Impurity separation Storing rice	Manpower, cattle, simple tools Sun-dried in the field Traditional palanquin and carts Manpower, cattle, and simple tools Manpower and simple equipment Traditional granary, barn, and especially containers.	Machinery, high technology instruments and modern techniques.	Long Kaeg Pleng Kiaw Kao Pleng Tem Kam Ram Khiew Blessing to thank Mae Phosop	Biology, Geology, Botany, Genetics, Plant Physiology, Physics, Microbiology, Mechanical Engineering, Environmental science, Ecology, Zoology

4.4 The story of rice in museums in Thailand

The previous sections showed how closely aligned ICH, traditional practices and modern practices are, along all stages of rice farming. In this section I will explore their museological connections, by turning to look at museums in Thailand that display stories about Thai rice farming. As will be seen in the following subsections, most of these museum stories focus on the value of rice and farming and the lives of farmers, and many of the rice farming processes have been presented through exhibitions.

The Golden Jubilee Museum of Agriculture, Pathum Thani province.

One of the largest museums that tell the story of rice is the Golden Jubilee Museum of Agriculture which was opened to the public in 2002, in Pathum Thani province. The main purpose of this museum is to showcase His Majesty's initiatives in the agricultural sector and to disseminate to the public the Philosophy of Sufficiency Economy as it relates to agriculture. The term Philosophy of Sufficiency was introduced by King Bhumibol Adulyadej in 1997 and represents ideas for Thai people to be able to solve problems and live under the rapid changes caused by economic growth. The theory is based on three main ideas: moderation, reasonableness, and self-immunity alongside the overarching conditions of knowledge and morality (Office of the Royal Development Projects Board, n.d.). The museum is operated by the Ministry of Agriculture and Cooperatives Thailand. It is located in an area that has been surrounded by rice fields in the past.

This museum offers exhibitions, demonstrations, and indoors and outdoors learning space. The indoor exhibitions mainly present the His Majesty's biography including his principal work, royal work on the Philosophy of Sufficiency Economy in agriculture programme, as well as knowledge, innovations and developments in Thai agriculture. Some of the exhibition content is supported by scientific information, such as Thailand's geography and the wise use of land, which lists categories and types of soil in different parts of Thailand. The exhibitions are presented with panels, interactive exhibits, hands-on activities, and various media.

Focusing on the topic of rice, this museum presents the development of rice farming from the use of traditional methods to the use of modern methods. It also presents the combination of both and introduces the Philosophy of Sufficiency Economy that can guide the farmers' lifestyle. Many rice-related exhibits show models and artefacts such as land preparation machines and rice cleaning machines, the story of which is told in relation to His Majesty's work. This is because he is an influential person who has influenced Thai people in many areas, including agriculture.

The content of the outdoor exhibitions is related to that of the indoor exhibitions, providing evidence and examples of how we can apply the Philosophy of Sufficiency Economy successfully. The outdoor museum space is also a place for practicing agricultural skills such as rice farming, through bookable activities. It also presents the lifestyle of Thai communities such as local Thai farmers in Central and Northern Thailand. Figure 4.2 below shows parts of the exhibitions and activities at the Golden Jubilee Museum of Agriculture.

Figure 4.2 Examples of indoor and outdoor exhibitions at the Golden Jubilee Museum of Agriculture

<u>Thai Rice Farmers National Museum, Suphan Buri province</u>

Figure 4.3 Thai Rice Farmers National Museum, Suphan Buri.

This is the latest local museum launched by the National Museum of Thailand in 2017. It is located in a compound that belongs to Suphan Buri District Office. This museum is operated by the National Museum and is fully supported by the government. It mainly presents traditional Thai homes and the life of Thai farmers. The museum has two floors. The ground floor houses exhibitions about the history of rice farming that provide a clear view of the

development of rice cultivation over time. It also presents rice farming related equipment and shows the Thai farmers' lifestyle through exhibits, panels, and models. On the first floor, there are showcases which represent the Royal patronage of Thai kings and their role in supporting and developing rice farming throughout history.

The Thai Farmers' Lifestyle Museum, Nakornpathom province

This is a private museum operated by the owner and his family members that is located in the Nakornpathom province, next to Bangkok. The Nakornpathom province is famous for its agriculture, particularly Thai rice and Thai fruits such as pomelo and lychee. The museum belongs to a retired farmer who has tried to conserve and present how Thai farmers lived and produced rice for Thai people in the past. The museum was opened to the public in 1999. The museum displays equipment, utensils, tools, and processes that were used in rice farming. Most exhibits in the museum are text panels and static models. The museum comprises two parts. The first part is used as an office for a local women's volunteer group and also doubles up as a place for a brief introduction to visitors of the museum and its community. The second part has two floors and is an exhibition about rice farming and hand-made products made from hyacinth. Most of the exhibition is on the ground floor and includes farming equipment, household utensils, fishing and carpentry tools, the demonstration of traditional rice milling and winnowing. The upper floor is set up in a way that invites visitors to explore and feel the atmosphere of a traditional Thai farmer's house. Within the museum area is a handicraft-training centre that provides a place for community members to join and be trained to make craft products. The training centre was founded as a place for members to spend their time after the rice farming season, to gain more money from the transformation of local resources.

The Lifestyle and Spirit of Thai Farmers Learning Centre, Suphan Buri province

Figure 4.4 The Lifestyle and spirit of Thai Farmers Learning Centre, Thailand.

This is a private rice and rice-related learning centre that aims to preserve the culture of Thai farmers' ancestors. One of the main purposes of founding the museum was for it to be a place for people who are interested in and would like to have information about rice farming and Thai farmers' lifestyle in the past. This learning centre displays outdoor and indoor exhibitions. In the rice fields, as the founder is a rice strain developer, it shows the varieties of rice strains that are popular for Thai farmers. The indoor exhibitions are displays in a conserved Thai house cluster. They offer visitors opportunities to learn about the Thai farmers' lifestyle in the past through the equipment and utensils they used in their everyday

life as well as the typical layouts and contents of a kitchen, a living room, and a bedroom. Through the genuine artefacts and excellent decoration, it generates the atmosphere of how ancient Thai farmers lived with nature wisely. In the cluster, there is a Mae Phosop (Goddess who is respected by most farmers) house that displays wood sculptures of her from different time periods, since the early Rattanakosin period (approximately 270 years ago). The indoor cluster also presents a granary reconstruction, with real artefacts. Inside the granary are displayed rice farming equipment, fishery equipment, and woodcraft equipment, with a buffalo house nearby. Next to the field, a watch tower was reproduced from a real tower that was used in the past to watch the farm and warn the farmers if something was wrong.

The rice and farmers school, Bangkok

The rice and farmers school was founded to be a place for providing knowledge, skills and information about rice farming in Thailand. The school offers three main training programs for people who are interested in rice farming. The first program is for the general public, people with no farming skills. The second and the third programs provide deeper knowledge and skills of rice farming, and were created for farmers. This school is located in Bangkok and is operated by the Rice Department of the Ministry of Agriculture and Cooperatives. The school also provides knowledge and information about rice farming developments and research about rice. As this school belongs to the Rice Department, it has the potential to collect and provide information and knowledge from the 7,000 – 8,000 rice information centres, supported by the government, that exist around the country. With its powerful network of connections with rice centres, the Rice Department and other Departments which relate to rice farming in Thailand, this school is not only a place for studying how to grow rice but also a valuable resource for rice farming knowledge and practices of the country.

Knowledge about rice cultivation is important for Thailand because rice is a plant of major economic importance that also nourishes the country. Many museums in Thailand exhibit stories about rice farming, ranging from national to local community museums and belonging to the government or non-governmental organizations. The five examples presented above provide knowledge related to rice and rice farming at different levels. The Golden Jubilee

Museum of Agriculture and the Thai Rice Farmers National Museum are supported by the Thai government and are open to the public at the national level. These two places provide information and exhibitions that represent the whole picture of Thai rice farming, developed by experts and professionals in Thai rice farming. Reliable information derived from experts and relayed in the exhibitions is the strength of these two museums. The Thai Farmers' Lifestyle Museum and The Lifestyle and Spirit of Thai Farmers Learning Centre exhibit stories about rice farming at the community level, as these two places provide information and exhibitions that related to the surrounding community. The strengths of these two places are local stories and staff who are ready to tell a story about traditional knowledge and practices of rice farming in the past along with the traditional equipment that belonged to real, professional rice farmers. The final example is the Rice and Farmers School, which is a government initiative, its strength being its forward outlook, as it focuses on the training and development of modern rice farmers.

What is noticeable in all five examples, however, is that while most of them display both traditional and more recent rice farming stories and practices, they have not fully connected rice farming ICH with modern rice science. The Golden Jubilee Museum of Agriculture is the one coming closest to achieving this, as it uses the Philosophy of Sufficient Economy to draw parallels between traditional and modern rice farming practices and methods. It does not, however, connect either of these explicitly to modern rice science and its relationship with traditional knowledge. The Thai Rice Farmers National Museum, the Thai Farmers' Lifestyle Museum and the Lifestyle and Spirit of Thai Farmers Learning Centre, all focus on the lives of farmers, but none of the three explores explicit connections between the knowledge that guided the farmers' practice in the past and now. Finally, the Rice and Farmers School paid more attention on modern practices and technique to guide farmers across the country and not intended to connect knowledge in ICH with science.

4.5 Conclusion

In this chapter I explored rice ICH in Thailand, in the form of the rituals and traditions that are associated with traditional rice farming; and also the rice science behind modern approaches to rice farming that Thai farmers have adopted from the West. Through a close look at the three stages of rice farming and what they looked like in the past and now, this chapter has drawn a clear picture of the connections between cultural heritage, traditional knowledge and Western science in Thai rice farming, summarised in Table 4.2.

The chapter has demonstrated close alignment between ICH, traditional practices and modern practices, along all stages of rice farming. It also demonstrated how Western science has come to support rice farming, including biology, botany, and chemistry which provide understanding on the nature of rice, its environment and the processes of farming. Finally, it illustrated that rice ICH engages aspects related to nature and the environment of rice farming, which are central to the success of the practice. Farmers make offerings to Gods for fertile rice fields, asking for example for the blessing of Mae Pho Sop to protect their rice fields from disaster, understanding that nature and the environment can both nourish and damage the rice farm.

The impacts of nature and the environment on rice and rice farming is also the concern of modern rice science, which thereby maintains a close relationship not only to rice farming practices but also to rice ICH. This is a relationship that has not yet been explored in the context of communicating rice science to the public in Thai museums, as the review of rice-related exhibitions showed. While modern rice farming practices differ from the traditional ones, rice ICH to a large extent survives until today and acts as a reminder of how Thai farmers understood the world and learned to work with their natural environment, while also acting to reinforce the Thai worldviews through rice farming. However, very little of the scientific knowledge that underlies rice farming is explained in the many and diverse rice-related stories and exhibitions in Thai museums.

The potential of exploiting rice culture and traditional farming practices to communicate modern rice science is of particular interest to the National Science Museum, which aims to communicate modern science to the public through various communication media and techniques. An important question that arises is, what can the Science Museum do in order to communicate and engage people with modern rice science while inspiring a sense of pride and belonging for Thai people whose cultural practices are still more aligned with the traditional Thai worldviews as expressed in traditional rice culture than with Western rice science? The next part of this thesis explores a design workshop methodology that brings into dialogue Thai rice culture and rice science for the communication of rice science in the Science Museum.

CHAPTER 5 WESTERN SCIENCE AND LOCAL KNOWLEDGE: INTERPRETIVE SYNERGIES IN THE SCIENCE MUSEUM

5.1 Introduction

This chapter will draw on chapters 2 to 4 to propose a methodology through which science museums can enhance the effectiveness of science communication by building into their interpretation traditional knowledge and ICH. Continuing with the case study of rice science and rice ICH in Thailand, the chapter is divided into two parts. The first part will propose a conceptual framework for the bringing together and co-interpretation of ICH and Western science. This part will also introduce the concepts of boundary object, Intermediary Design Deliverables (IDDs), and boundary-crossing as tools for exploring the connections between the different sciences and heritage disciplines. The second part will demonstrate how the derived conceptual framework can be applied in the context of a science museum for the above purposes through a workshop methodology. Figure 5.1 outlines the components and processes in the conceptual framework, and its design application in the science museum.

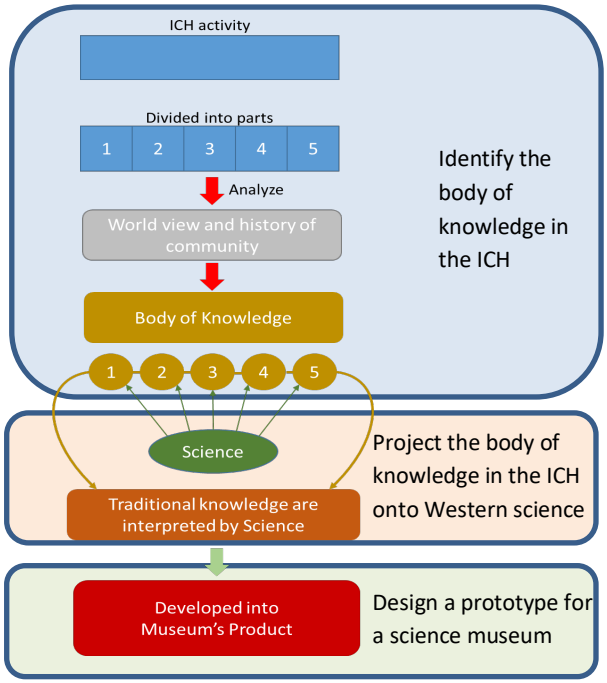

Figure 5.1 A conceptual framework for uncovering connections between Western science and ICH and developing these connections into a museum product

5.2 Part A: A conceptual framework for co-interpretation of ICH and Western science

5.2.1 The Science that is hidden in ICH

The interpretation of ICH through science is valuable. Understanding the way of thinking of our ancestors, their worldviews and how they developed ways of living with nature, is essential in today's context of an intensifying climate emergency and the increasing strain on the earth's natural resources. But also importantly, making the connections between ICH and the traditional practices that it is built upon on one hand and Western science on the other, can bring important benefits for individuals. An awareness of these connections can help to lower the barriers that can exist between indigenous populations and Western science. These barriers arise when Western science is seen as an 'import', as a foreign body of knowledge that does not fit with our worldviews and our relationship with our physical and social environments. In Chapter 2 I discussed how such worldview discrepancies can lead to misconceptions in science learning and/or failure to engage and connect with science communication on a personal level. Making explicit the parallels between Western science and indigenous worldviews and associated practices, can inspire local people to engage with science on a level that feels more personally relevant. At the same time, such associations between local ICH and Western science can bring benefits to the field of ICH as well, as they highlight the value and relevance of ICH and make the case for the need to safeguard it. In order to make these links and associations effectively and in order to be able to understand and interpret ICH through science, we need first to understand the nature of the relationship between these two areas of human knowledge.

The Thai rice farming case study contributes to this understanding. Earlier chapters in this thesis showed that there are many practices, rituals, and performances within rice farming ICH that relate to Western rice science. Traditional practices such as rites and performances are influenced by the perceived world of the community they are embedded in and serve its purposes. Such practices, developed over centuries, are made to fit local contexts through the community's intimate knowledge of these contexts - the history, the environment, the living conditions of the community. Viewing traditional practices under this lens of local expertise

allows us to move closer to the local knowledge that was developed and then 'hidden' and encrypted in ICH; while also allowing us to reveal the relationships between local knowledge and Western science.

The previous chapters allow us to formulate a conceptual framework based on which we can interpret the traditional knowledge in rice farming ICH through understanding how Thai worldviews have shaped it and then mapping it onto Western rice science. The process resembles reverse engineering (Chikofsky et al. 1990): we look at a product (rice ICH as it is practiced today) and trace back the original ideas, principles and processes behind its creation. Beginning with rice ICH and studying deep into its associated activities to consider their nature, we then explore that nature through worldviews and the context of the local community. This can allow us to find out what messages are in the practices, how messages are encrypted and why. After the body of knowledge is clarified, it can be projected onto Western science in order to identify connections and equivalences, which can then form the basis for the development of museum exhibitions and programming.

5.2.2 Identifying the local knowledge and wisdom that is woven into rice farming ICH

The selected area of ICH, in this case rice farming ICH, will be considered in detail to identify the body of knowledge that underlies it. Each area can be divided into series of activities, such as cultivation stages in the case of rice ICH. Looking at each of these series of activities separately allows a more direct and straightforward comparison and matching against Western (rice) science, which enables the interpretation of ICH through Western science. In this section I exemplify this process through my case study of rice farming in Thailand.

Thai rice farming ICH manifests in various forms including songs, rituals, festivals, and practices. Breaking an instance of ICH into its constituent parts can help us understand its purpose and meaning. The body of knowledge that underpins instances of ICH can be explored by considering them as a type of media and examine their purposes with the support of worldviews. Through this analysis, the main objective of the ICH instance can be identified.

However, each instance of ICH can include more than one form of ICH, each with its own meaning. Many of the rituals and festivals comprise a number of processes: a ritual can include a series of chants, each of which has its own meaning or objective; a dance includes a number postures, each symbolizing different actions, feelings or events. Each element of an instance of ICH can be interpreted to unveil its meaning and value. This helps us to identify which of these elements relate to the body of knowledge under question (in our case, rice farming knowledge) and what messages related to that knowledge are communicated. Moreover, looking closely at an element of an ICH instance through the lens of worldviews enables a deeper understanding of the purpose of that element.

One example are the postures and gestures within the traditional Thai rice farming dance *Ten Gum Rum Kyow*, where dancers dress in traditional rice farmer clothing with a traditional hat and carry a sickle with a bunch of rice while their posture mimics working in the rice field and they sing a unique lyrics. People who have never known about this traditional performance or are watching this dance for the first time, will have difficulty to imagine why the dancers are dressed in this clothing and wear an unusual hat in very warm weather. These dress details relate to the farmers' world, particularly in the past when they had to spend long hours in the sun in the rice field with numerous insects and small animals, many of which were dangerous. The conditions of the farmers' natural and social environment have influenced their way of life, including how they dressed. Examining each element of the dance, the lyrics of the song, the postures and clothing of the dancers, allows us to understand the story and the meanings of the event. Importantly, it also allows us to make connections between the dance and the body of practical knowledge it manifests.

Another example is the *Tam Kwan Kaow* ritual, which consists of chants. If we study the chants and what they refer to, we will find that they were created to boost the farmers' morale. We will also find that some of the chants provide information about names of rice strains, the rice farming process and how to protect the farm in ways that are aligned with and suitable for the local environment. In this case the chants act as 'messengers' from previous generations of rice farmers who, through the chants, communicate their practical knowledge while also reminding farmers that the guardian spirit of Mea Phosob is there to help them.

Examining the different elements (chants) of this instance of ICH (ritual) allows us to identify the body of practical knowledge that is transmitted alongside Thai worldviews through ICH.

5.2.3 How can local knowledge weave into Thai rice farming ICH?

Understanding the way in which previous generations integrated practical knowledge within their traditions can help us to uncover that body of knowledge from within ICH. In order to achieve this we need to know about the context of those generations, as it is this context that will help us identify the practical knowledge within the rituals and traditions. In the case of Thai rice farming ICH, our understanding of Thai worldviews can be used as the foundation upon which to build our understanding of how Thai rice farmers perceived their world and reflected those perceptions onto their way of life. Thai worldviews and Thai history provide valuable information on Thai society and the social and natural environment within which this ICH developed.

Historically, the transmission of knowledge in Thailand involved the conveying of experience from one generation to the next without recording this local knowledge in the form of books or manuscripts (The Science Society of Thailand, 1982). Consequently, there were limitations in knowledge distribution and sharing, and literacy levels were very low particularly in the remote areas (The Science Society of Thailand, 1982). Traditionally the keepers of books and manuscripts, temples were the centre of the community but they primarily kept books and objects related to religion such as scriptures, psalms, and inscriptions (The Science Society of Thailand, 1982). Local communities used other means to safeguard and pass on their local knowledge and wisdom, in forms as diverse as chants, poems, plays, songs, dances, games, paintings, and sculptures. For example, a wall painting in a temple might not only tell a religious story but also illustrate the surrounding natural environment and depict traditional practices of the community. This diversity of form and media is equivalent to the diversity of communication media and methods that contemporary institutions use to communicate science: an infographic showing human evolution, an e-book about the planet earth, a virtual reality game about the dinosaur, a music video about a chemical reaction, a science film, or an exhibition. The choice of media and method relies

on the availability of resources, the type of message, the communicative limitations of the media themselves, and current trends.

The ways in which local knowledge is woven into ICH are impressive. For example one of the chants in the *Tam Kwan Kaow* ritual that I mentioned earlier lists specific rice strains that are appropriate for the local area. This has led to variations of the chant across different areas. Other chants in this ritual convey traditional processes of rice farming and address ways in which farmers can protect their rice farms. Both these chants were developed to convey knowledge that is essential for Thai farmers; their ancestors delicately placed this body of knowledge into the chants while keeping them respectful and consistent with their religious beliefs. Another way in which knowledge has been woven into ICH is through lyrics and scripts for performances, songs, and plays, formats that are easy for people to memorise and pass on to their descendants. Knowledge that is crucial for the community is thus preserved and safeguarded, in ways that are respectful, fun, and compatible with their beliefs and ways of life. An awareness of the functions of such 'pedagogical' approaches allows us to identify the traditional knowledge and wisdom that is woven into ICH.

5.2.4 The importance of the knowledge that is woven into ICH

It is clearly impossible to identify an individual who deliberately put knowledge into the rice cultural traditions, yet it seems that the ICH element was meticulously selected for encrypting the knowledge, ensuring that the most valuable knowledge for the community is secured and passed to the next generation. The techniques and skills for growing, managing, and looking after rice farms are an example of such valuable knowledge that has found its way into rice farming ICH, which thereby assumes, in addition to the roles we examined in chapters 3 and 4, the additional role of safeguarding local rice farming knowledge and wisdom.

Let us consider the importance of this knowledge within rice farming. The knowledge about rice strains in the *Tam Kwan Kaow* ritual is important because it names the strains that are suitable for a specific location, letting farmers know that they should keep these strains. Farmers are implicitly reminded to study these strains in order to identify and memorise their specific characteristics as seen in the rice field; this will be useful in the process of selecting

a new strain of similar or better quality in the case that some natural or other disaster affects the currently cultivated strains. Such uses of local knowledge are no different than uses of Western science and technology in rice farming, and the parallels in the overall goals and objectives can provide a connection between traditional local knowledge and Western science.

5.3 Part B: A design workshop methodology for applying the conceptual framework to science museum communication activities

The second part of this chapter presents a design workshop as methodology for supporting the design of science museum exhibitions and other museum programs that aim to highlight the connections between traditional knowledge and Western science. The *ScienceICH* design workshop (see section 5.3.4) supports science museum staff to co-interpret traditional knowledge through Western science in collaboration with colleagues in related ethnographic/historical museums, and to highlight the connections between the two through design representations. In doing so, *ScienceICH* also tests the design viability of the ICH-Western science interpretive synergies proposition that was articulated in the first part of this chapter. Before I delve into the details of the design workshop, I will use the following subsections to outline how the format of *ScienceICH* fits with exhibition design methodologies (5.3.1) and analysis of multidisciplinary design work as boundary crossing (5.3.2), as well as to discuss the workshop as design methodology (5.3.3).

5.3.1 Exhibitions and exhibition design

Exhibitions are central to museums; people expect to see them when they plan to visit museums (Belcher, 1991; Falk and Dierking, 2013; Lord & Piacente, 2014). Exhibition design is a collaborative process which necessitates work across disciplines (Hughes, 2015; Kensing & Blomberg, 1998; Lord & Piacente, 2014; MacLeod, Dodd & Duncan, 2015; McKenna-Cress & Kamien, 2013; Vavoula & Mason, 2017; Vavoula & Sharples, 2007). Recently, there has been an increasing number of collaborative and experimental approaches to museum exhibition design. Since the turn of the 21st century, museum design research including on museum architecture, exhibition design, visitor experience and interpretive

design, has been significantly transformed and advanced, through expanding collaboration among a wide range of professions such as curators, visitor studies practitioners, education program developers, exhibition designers, theatre and animation designers, researchers, as well as combining and working with experts across various disciplines (Hughes 2015).

Many exhibition design development concepts have been developed to guide exhibition developers. For example, Bertron et al. (2012) proposed five phases to develop an exhibition: Concept, Design, Planning, Production, and Implementation. They suggested that the success of the exhibition development depended on effective collaboration among various professionals in order to create public engagement with complex themes. Similarly, McKenna et al. (2013) proposed six stages of exhibition development (Concept development, Schematic design, Design development, Construction documents, Bids / Fabrication / Installation, and Opening / Post opening / Revisions and Documentation), in conjunction with five exhibition advocacies (Institutional advocacy, Subject matter advocacy, Visitor advocacy, Design advocacy, and Project & Team advocacy) that have different roles at different stages. Lord and Piacente (2014) proposed three phases for exhibition development to help developers to define their position in the process and to facilitate communication between exhibition designers and non-designers. The three phases are *Development*, *Design*, and *Implementation*.

While the breakdown of design stages differs in the three models, the underlying tasks and processes are similar. Lord & Piacente's (2014) description of their three stages covers much of these tasks and processes in the other two models. In the Development phase the main idea and central concepts of the exhibition will be created, tested, and refined. The purpose of the exhibition will be clarified in this stage, spelling out what the exhibition is about and why the museum is doing it. This phase will generate the interpretive plan that will be used in the next phase. The second phase is the Design phase. The interpretive plan and other research related to the topic will be transformed into a three-dimensional reality. In this phase, the designers will work closely with other museum staff, representatives of various museum departments, interpretive planners, and evaluators. The output of the work in this phase will be a three-dimensional design drawing, including details for implementing the exhibition. The last phase of the development process is the Implementation phase. This includes the

building and installation of the exhibition on-site and also the exhibition launch (Lord & Piacente, 2014).

What is highlighted in all three exhibition design methodologies, is that exhibition development is a collaborative endeavor. McKenna et al. (2013) suggested that there is no universal recipe for creating exhibitions, and that each exhibition project depends as much on the specificities of the design context as it does on the composition of the development team. As discussed above, this team includes members from different departments and disciplines. With the objective to co-interpret ICH and Western science for science communication in the museum, this interdisciplinarity is not only unavoidable but it is central. The following section therefore looks closer at issues and processes of interdisciplinarity in exhibition design and how concepts from boundary crossing theories can aid our understanding of how different areas of knowledge can connect in practice.

5.3.2 Connecting different areas of knowledge through boundary crossing

There are benefits to be derived from multidisciplinary working. However, working across disciplines is challenging. Bridging together the domains of Science and ICH involves the crossing of disciplinary boundaries. Such boundaries exist by virtue of differences in background and expertise, and specialisation in different areas of knowledge (Akkerman & Bakker, 2011). Associated sociocultural differences can lead to creating a 'central tension' among a diverse group of participants (Star & Griesemer, 1989) and lead to discontinuity in action or interaction (Akkerman & Bakker, 2011). Akkerman and Bakker (2011) point out that all kinds of learning involve boundaries which result from specialisation and the development of expertise (Akkerman and Bakker; 2011). Experts in one area can find it difficult to acknowledge and act with knowledge and concepts from unfamiliar areas. Disciplinary boundaries can be thought of as situations where we are standing up with one leg on a stable floor (our specialism) and the other leg on an uneven floor (unfamiliar area). This requires concentration and effort to keep our balance and be able to stand or move forward. Lofthouse and Wright (2012) suggest that boundaries have the ability to create tension during participation, however, they also have the potential to be a powerful source of learning. Crossing boundaries can result in new perspectives and innovations and also the validation that results from the coordination of diverse specialisms (Akkerman & Bakker,

2011; Carr et al., 2012; Engeström, Engeström & Kärkkäinen, 1995; Star & Griesemer, 1989; Suchman, 1993; Tsui & Law, 2007; Venkat & Winter, 2015).

Star and Griesemer (1989) illustrated that one of the essential characteristics of participants in cross-disciplinary work is sharing a common goal and that such work pivots around what they called 'boundary objects'. When participants with diverse backgrounds come together translation, negotiation, debate, triangulation, and simplification are needed in order to work together. Star and Griesemer (1989) explain that 'boundary objects' play an important role to support the coordination of activity in these cases:

> *"Boundary objects are objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual site use."*
>
> (Star and Griesemer, 1989).

They point out that boundary objects can be abstract or concrete. The boundary objects, therefore, contain the common meaning that can be shared and recognised by people with different areas of expertise. They can contribute to multidisciplinary collaboration as they facilitate the emergence of new perspectives from the involved disciplines.

Star and Griesemer's study in the year 1989 found that there were four types of boundary objects. The first is *Repositories* that refers to "piles" of common objects that can be used or borrowed, like those found in a library or archive. People from different disciplinary areas can utilise or borrow from the pile for their own purposes. The second is the *Ideal type* which refers to objects that provide common meaning in symbols or graphic shapes such as a diagram, an atlas, or a description. Objects of this type are abstracted from all domains and can be adapted to a local site of knowledge. The third is *Coincident boundaries* which are common objects that derive from the work in different sites of knowledge and perspectives but share a common referent. Star and Griesemer (1989) provided the example of different details added by participants to a map that contains an outline of the state. The last is

Standardised forms which are the common or standard methods of communication that can be commonly used across workgroups. These four types allow us to identify and explore the objects that are encountered or created in boundary crossing. The concept of a boundary object itself provides an understanding of how objects and artefacts can play an important role in bridging the gaps between different areas of knowledge and expertise.

The concept of boundary crossing was developed to describe the moving into an unfamiliar space and the use of boundary objects to do so (Venkat and Winter, 2015). Akkerman and Bakker (2011) suggested that professionals who need to get into an unfamiliar domain "face the challenge of negotiating and combining ingredients from different contexts to achieve a hybrid situation" (Engeström et al., 1995). Tsui and Law (2007) also suggested that boundary crossing can be an important driving force that leads participants to achieve deep learning. Akkerman and Bakker (2011) have summarized four mechanisms of learning at the boundary that constitutes the learning potential of boundary crossing. These four dialogical learning mechanisms can enhance the learning potential of a boundary (Carr et al., 2012). The first mechanism is *Identification* that referred to participants managing to understand the same thing even when it is used in different places and their practices. The second process is *Coordination* which refers to the collaboration between diverse practices or perspectives through efforts of translation or interpretation and results in making the boundary accessible. The third mechanism is *Reflection* which refers to the creation of new perspectives from diverse participants that enable them to develop a common understanding of the same goal. The last mechanism is *Transformation* which refers to the effects of interventions that lead to changes in practices, creating something new or something hybrid from the combining of different practices.

The concepts of boundary objects and boundary crossing can be used in exhibition design. The output of design is seen to be an appropriate answer to a specific question or an appropriate solution to a problem. In their study of Questions, Options, and Criteria as the elements of a design space analysis, MacLean et al. (1991) pointed that the design space can be a place for exploration and finding the appropriate solution. This implies that there is more than one solution that may emerge from the design process. They also suggested that the design rationale, which represents the designers' thinking and reasoning behind the design

decisions, is essential not only for designers themselves but also for other participants who are involved with the product of the design such as the production and maintenance teams. This helps them to understand and deal with the artefact appropriately (MacLean et al., 1991). Generally, the design space is multi-dimensional which provides many advantages (Whitworth and Ahmad 2014). Its dimensions are defined by criteria including requirements, expectations and conditions of the design. In this regard, the design is created in order to search for an appropriate solution in accordance with all or as many of the criteria as possible (Whitworth and Ahmad 2014).

Vavoula and Mason's (2017) study on the role of boundary crossing in digital exhibition design focuses on the intermediary design deliverables (IDDs) and the processes of consent that they embody. The digital exhibition design in their study involves collaboration between teams of different socio-cultural and disciplinary contexts, including from the museum and an external digital design team. Vavoula and Mason (2017) suggest that successful design requires participants (museum curators and digital designers in their study) who have individual competencies and who will provide appropriate alignment in accordance with their disciplinary contexts and objectives. In this case, the understanding and appreciation of the other's disciplinary framework and contribution are important motives for crossing the boundaries of their own discipline (Vavoula and Mason, 2017). This can lead to sharing knowledge, viewpoints and approaches that Akkerman and Bakker (2011) have pointed out results from the boundary crossing process when people from diverse sociocultural backgrounds work together. Vavoula and Mason (2017) propose as boundary objects, Intermediary Design Deliverable (IDDs), which play a key role for boundary crossing. These objects are produced during multidisciplinary work and induce the participants to make negotiations, discussions and exchanges that lead to consents and agreements. In the design space, the IDDs are produced and continue to be used as boundary objects that facilitate these processes of consent in each phase of the design process (Vavoula and Mason, 2017).

The concepts of boundary objects, intermediary design deliverables, and boundary crossing are useful for this research as they provide an understanding of how we can bring together diverse disciplines to create new products and effective designs. I will return to these

concepts later in the thesis to appraise the *ScienceICH* design workshop as a platform for cross-disciplinary work.

5.3.3 The design workshop as exhibition design methodology

The workshop as a methodology has a long history in qualitative research. Isaksen et al. (1994) referred to the original idea of Osborn in 1939 who coined the term *'brainstorming'* as a method of creative group problem-solving. However, it was in the early 1960s that the term '*workshop*' became widely known and used as one of the methods for seeking answers or solutions for complex problems such as social challenges, policy-making, technology or innovation change and design. A wide range of workshop formats and processes have been developed for use in various areas. Examples include the Future Workshop, SWOT analyses, soft systems methodologies, and participatory design (Ørngreen & Levinsen, 2017). In the 1990s, the term 'workshop' and the term 'participation' would usually be found to be used in a similar way (Cornwall and Jewkes, 1995; Kensing and Blomberg, 1998). It is because the term workshop implied the participation of workshop members in finding solutions. While today the word 'workshop' has become a part of our everyday language it is worth noting the Association for Qualitative Research[1] definition of workshop as a research method:

> "An interactive session, often taking a full day or more, in which clients, researchers and/or other participants such as customers work intensively on an issue or question. The process often combines elements of qualitative research, brainstorming and problem-solving. They may involve larger numbers of people than conventional group discussions, and often involve more than one moderator or facilitator."

This definition contrasts with other multi-perspective methods like the focus group as, unlike the focus group, which seeks to explore ranges of ideas, opinions, viewpoints and possibilities (Seale 2012; Parker & Tritter 2006), the workshop also provides a platform for these to be combined fruitfully through working together on a defined issue or question. Lain

[1] https://www.aqr.org.uk/glossary/workshop

(2017) pointed out the workshop's high potential for creating engagement that leads to collaboration, discussion, interaction through collaborative work, and results in generating qualitative ideas, analysis, and feedback between participants and facilitators. This is the key to success in finding a solution qualitatively to an established problem (Spagnoletti, Spencer, Bonnema, Mcnamara, & McNeil, 2013).

The collaborative space of the workshop cultivates potentially powerful interactions in the course of seeking solutions. (Erlandson, Harris, Skipper & Allen, 1993; Pandey & Patnaik, 2003; Shenton, 2004). These interactions can also help to build trust between the participants and the facilitator, helping participants to feel valued and encouraging them to contribute their knowledge and skills to address the workshop's topic. In addition, these intense engagements also allow participants to share their views with others and learn from others (Ørngreen & Levinsen, 2017). In the research context of this thesis, the workshop method thus enables the gathering of critical information and knowledge from the participants' experience and expertise (Creswell & Poth, 2017). The focused nature of the work involved in a workshop not only provides a wealth of research material, but also enables researchers to examine in depth the issues and relevant aspects that emerge during the workshop (Lincoln & Guba, 1985). The workshop therefore can contribute appropriate, reliable, and quality research data (Lincoln and Guba, 1985; Pandey and Patnaik., 2003, Houghton, Casey, Shaw & Murphy, 2013).

The use of complementary data collection strategies such as interviews can enhance the credibility of the collected data, as can the researcher's reflexive practice. Owen (2006) points out that a researcher can become a research instrument when he or she becomes an active participant, that can open space for other workshop participants to interact, respond and share their experiences. This can generate an environment conducive to sharing views and gain rich data for the research. The workshop also supports written descriptions in the form of field notes that enable the researcher to transfer the what and how of the workshop to others (Lincoln & Guba, 1985). In this way, other researchers can perform similar studies using the same procedures, to validate and/or enrich the research findings.

A workshop with a small group of participants has the potential to allow the researcher to facilitate, moderate, and encourage the participants to formulate and co-design, by

conceptualising ideas for a particular topic together. It is an appropriate opportunity for effective cross-disciplinary work that provides ample space and opportunities to create the boundary objects that facilitate processes of consent. It can foster a community of practice that solves problems together and allows members to generate suitable solutions for a particular problem. Workshop participants can engage each other during the workshop through discussions, exchange of ideas, interpretations, negotiations, interactions, and forming agreements. This leads to a reliable result that derives from a series of thinking and re-thinking, design and re-design similar to design-based research (Ørngreen and Levinsen, 2017). This also similar to the concept of design thinking that allows participants to engage in collaborative problem solving through five stages (Cross, 2011). The design thinking begins with "Empathise", where the participants engage in understanding the situation and the problem. This understanding can help participants to get insight on the real situation and what is going on. The second stage is "Define", where participants analyse their findings from the fist stage to define the exact problem they need to solve. The third stage is "Ideate", in which participants are encouraged to brainstorm new ideas in order to solve the problem. The fourth stage is "Prototype", in which the facilitator encourages participants to narrow the ideas down to a set of realizable solutions. The crystallised idea for a solution will emerge in this stage. The final stage is "Test", where the prototype is tested to check whether the solution solves the problem.

There is a limitation concerning researcher bias in the application of the workshop approach in research. However, Ørngreen and Levinsen (2017) point out that the active engagement space within the workshop can reduce bias from the researcher. The researcher acts as a facilitator who fulfils participants' needs while the participants interact, ask, argue, and feed back to the researcher whenever they want during the workshop. This allows the workshop as a methodology to produce reliable and valid data for the purposes of exhibition development (Orngreen and Levinsen, 2017).

5.3.4 ScienceICH: A design workshop for combining rice farming ICH and rice farming science in museum exhibitions

Participants

The aim of the ScienceICH workshop was to bring together professionals from museums and related areas with expertise in ethnography and/or the sciences and with exhibition development expertise in Thailand. Cross-sector multidisciplinary design teams can bring significant benefits to exhibition design (MacLeod et al., 2015). The selection of participants for this study, therefore, ensured the inclusion of practitioners, designers, and researchers with varying expertise. Collins and Evans (2002) note that science knowledge in the present day is easily accessible, and there are many experts in society. These experts are not only the scientists, but also those who have the ability to do or apply science (Collins and Evans, 2002). Scientific knowledge is not limited to scientists; anyone with knowledge, skills, and experiences in an area of science in society can be an expert and the collaboration of different experts is crucial.

In this study, the workshop is used to provide a space for interaction where solutions can be formulated, while creating processes for balancing expertise. The workshop therefore involved collaboration between teams of different socio-cultural and disciplinary contexts that provide a potential to create a successful design (Akkerman and Bakker 2011, Vavoula and Mason, 2007, 2017), by recruiting experts from both science and ethnographic backgrounds. Four specialists in Thai ethnography and four specialists from the science museum took part, to ensure a disciplinary balance in terms of participant numbers. Informed consent was sought from all participants and a time for the workshop was arranged that was suitable for all.

Workshop participants were recruited from the researcher's network of professional contacts. Participants were chosen on the basis that they work at the National Science Museum or at a cultural museum, and that they have been involved in the past in curating collections and/or producing exhibitions related to Thailand's rice farming, cultural heritage and/or science. The researcher contacted the participants via telephone, email or in-person meeting, in order to outline the process and objectives and to invite them to take part in the workshop. It was challenging to identify a suitable date for the workshop that would suit all eight experts, all

of whom were in full-time employment with busy schedules and some of whom worked in remote provinces. Although a suitable date was identified and agreed by all, 17 days before the workshop one of the participants had to cancel and the workshop had to be rescheduled to allow time to recruit a new participant.

Informed consent was sought at this point, with the researcher sending an invitation letter to the participants and their line-managers (if applicable) in order to explain the objectives in more detail and invite them to discuss the project and ask questions. The invitation letter was complemented by a Project Information Sheet, which detailed the project background, research methodology, confidentiality rights of the participants, and a Consent Form which sought permission for the researcher to record the workshop according to the research methodology (see Appendix 2 and 3). The ethical protocols adopted by this project were approved by the University of Leicester's College of Social Sciences, Arts and Humanities Research Ethics Committee prior to the commencement of the research activities. Ethical approval included permission to conduct a workshop as a research methodology in Thailand with the science museum and ethnographical museum professionals as participants. In terms of the participants, there was no one forced to take part in the research. It was made clear to participants that they have the right to withdraw their participation at any time without penalty. The researcher provided adequate information to the participants, ensuring voluntary participation with informed consent. Consent forms from participants in this study were collected and are deposited with the School of Museum Studies, where they will be kept securely for six years after the end of this research. Before conducting the workshop, participants were given a general introduction about the purpose of the study, the research approaches, the right of the participants, and also information of the researcher as a facilitator at the workshop. The research gave an explanation of the benefits of the research findings and provided participants with an assurance that their responses would remain anonymous and confidential if they so wished. The participants were informed that they were free to discuss and provide their opinions during the research. The researcher allowed all of the participants the opportunity to see the transcripts of their discussions if they wanted. The participants were informed about the purpose of audio and video recording during the workshop as a part of data collection used for analysis after the workshop.

The group of participants included:

- The Director of The Office of Public Awareness of Science, who is a science communicator with science knowledge background (participant S1)
- The Director of the Collections Division of the Natural History Museum (participant S2)
- A science communicator with experience in science communication in the Science Museum and knowledge of rice farming (participant S3)
- The Director of the Collections Division of the Science Museum, who is a science communicator with a background in physics, science communication, and museum studies (participant S4)
- An exhibition developer from the Science Museum (participant S5)
- A museum studies lecturer from Mahidol University with experience in lecturing in museum studies and in anthropology in Thailand (participant C1)
- An exhibition developer from Museum Siam (a Thai history and culture museum) who has experience in developing a variety of Thai cultural exhibitions (participant C2)
- An expert in Thai history and culture who had been a lecturer in science and technology and is an author of several articles and textbooks about Thai history and culture (participant C3)

A place for the workshop

For the workshop to be most effective, a suitable place should be considered with attention paid to safety, the availability of facilities, and how convenient access would be for participants. Furniture, stationery, and workshop equipment were provided for the workshop, which took place at the Science Museum at Chamchuree Square. The Science Museum at Chamchuree Square is a part of the National Science Museum Thailand, which is located at the heart of Bangkok city with easy access by road / public transport. The workshop was held at the main conference room of the museum which is well equipped with security, lighting, audio-visual systems, tables, chairs, and relevant utilities. The venue was prepared two days in advance in order to set up the room. The facility was organised in a way that would make it easy for all participants to participate with the facilitator, other members, the slide show, and the flip chart (at the rear of the room). The researcher arranged the tables and chairs in

two groups. The video and audio recording equipment was installed and set up on the morning of the workshop day, in order to record the sessions for later analysis. The preparation of the venue and security arrangements were kindly facilitated by staff members of the Science Communication Division, the Science Square, and relevant authorities of the National Science Museum Thailand.

The ScienceICH design workshop: 6 stages

The workshop focused on the use of intangible cultural heritage (ICH) for the interpretation and communication of Western science in non-Western science museums. The goal of the workshop was to explore and understand how ICH can support science interpretation and communication at Thailand's National Science Museum. This workshop introduced a series of design activities in order to discover how we can combine knowledge from the cultural heritage about rice farming with Western science while obtaining feedback and having a potential impact via the workshop approach. Within the process of exhibition development proposed by Lord and Piacente (2014), the workshop, as a methodology, can play an important role in the first two phases: development and design. In the development phase, the ScienceICH design workshop allowed participants to propose and discuss their ideas to create, test, and refine the exhibition concept, resulting in the conceptual idea for the exhibition. In the design phase, participants shared ideas and designed the content and visitor experience, through drawing and written works. The intended outcome of the design workshop was a representation of a science exhibition that makes a connection between ICH and Western science about Thai rice farming.

The workshop was designed and conducted in Thai. The title of the workshop was *"การทำนา" ภูมิปัญญาของชาติกับวิทยาศาสตร์สมัยใหม่: การตีความความเชื่อมโยงเพื่อสร้างรูปแบบการนำเสนอในพิพิธภัณฑ์วิทยาศาสตร์".* In English, this means, "The Rice farming" Thai wisdom and Western science: Interpretation of the relationship in creating the Science Museum's communication".

The ScienceICH design workshop was audio and video recorded, and the researcher also took notes for subsequent analysis. The data collected from the recording was analysed in regard to how the participants blended traditional knowledge with science and how they developed the connections between traditional knowledge and science into the museum's

communication. It was intended that this analysis would provide more understanding and justify how this method of blending ICH within science communication can be achieved through productive interactions between ICH and science museum experts. To achieve these aims, the workshop contained three main parts: identifying knowledge, exploring the connection between ICH and Western science, and designing a prototype for a science museum. Each workshop part involved one or two activities (five activities in total), which introduced and focused on the following questions:

1. Regarding rice farming in Thailand, what main factors can help farmers increase crop quality and quantity?
2. What is the science/culture behind that success?
3. How do cultural practices or rituals work, and how does science contribute to the success of the process?
4. How can we communicate these combinations?
5. How can we produce the prototype to communicate rice farming by combining intangible cultural heritage about rice farming and Western science?

The first part of the workshop was designed to encourage participants from diverse disciplines to identify knowledge from ICH about Thai rice farming. This part included an activity to identify the most important aspect of Thai rice farming that allowed participants to share their viewpoints and discuss knowledge that supports successful Thai rice farming. The second part was designed to encourage all participants to explore the connection and relationship between ICH and Western science about rice farming. This part had two activities: discovering the science and cultural practices behind this success and finding the connections between knowledge in cultural heritage and Western science. The third part also contained two activities: communicating the connections and designing a science museum prototype. This part intended to encourage participants to produce a design representation that could be an exhibition, educational programme, activity, or media related to the connection between the ICH and Western science about Thai rice farming for the Thai science museum. Participants were asked to engage in activities including brainstorming, sharing ideas, discussing, and presenting. The ScienceICH design workshop was designed in

accordance with the conceptual framework of the relationship between ICH and Western science about Thai rice farming, as shown in figure 5.2.

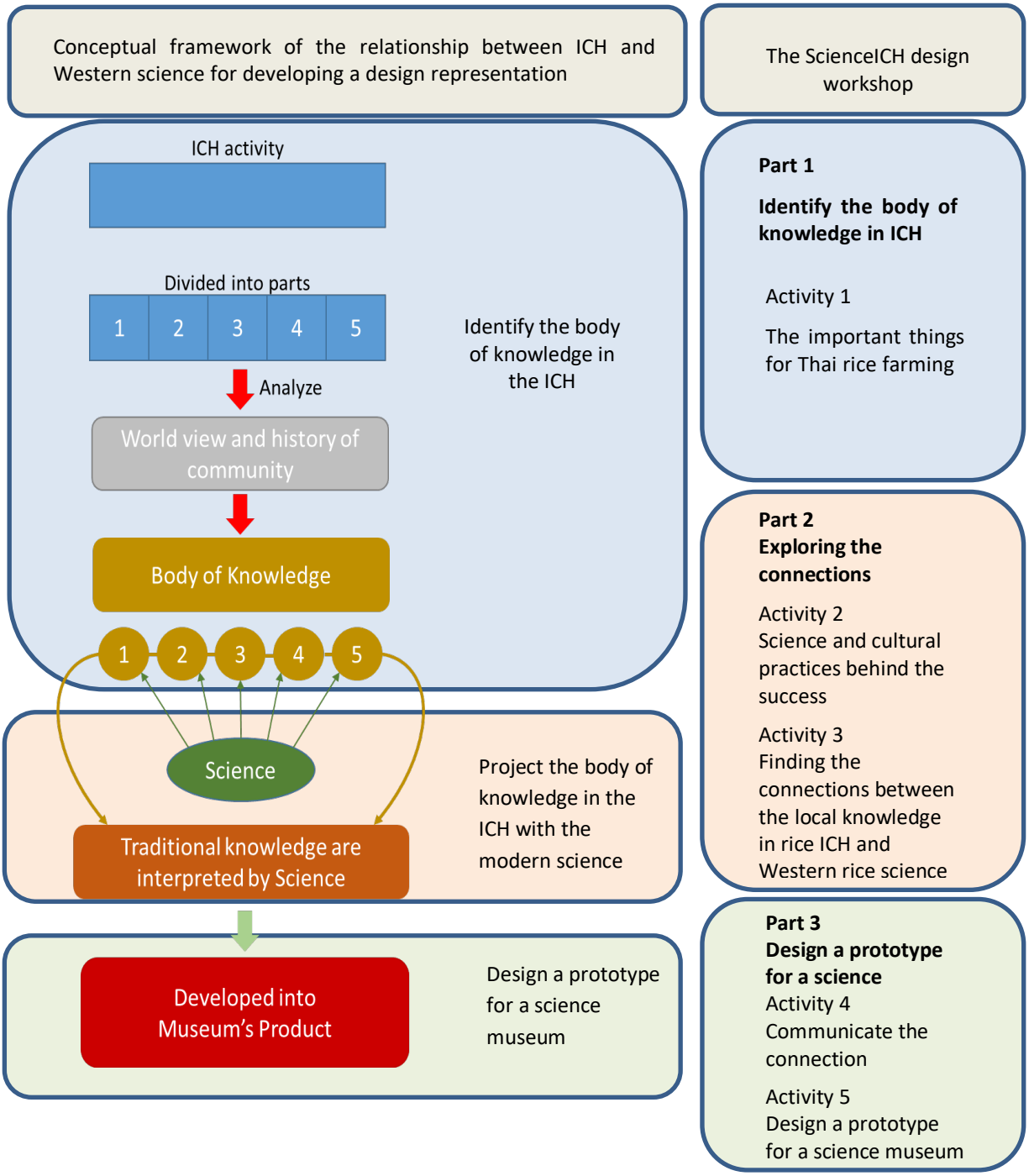

Figure 5.2 Diagram shows the conceptual framework of the relationship between ICH and Western science and the ScienceICH design workshop.

To begin, information related to the workshop was presented to the participants. It consisted of the research background, the workshop objectives, and the workshop activities. During the workshop, the researcher acted as a moderator and facilitator to provide information, control the direction of the workshop, and facilitate the participants' needs. The participants were asked to engage in the designed activities to find solutions that serve the objectives through five activities. The researcher did not interfere with brainstorming, discussions, negotiations, or idea sharing, but only ensured that the workshop plan was followed.

Introduction to the workshop

All of the participants were asked to bring material to the workshop related to rice farming – this could be anything, a picture, a poster, a book, a brochure, a leaflet, or equipment related to Thai rice farming. Before the first activity, the researcher provided information about the workshop through a presentation. The information included the name of the workshop, ScienceICH, and a few details about the researcher and the workshop's schedule. Information related to the workshop followed as:

- The research background
- Aim and objective of the research
- The hypothesis of the research
- The research questions

Brief information related to the main theories and concepts for this research were:

- Worldviews
- Intangible cultural heritage and Thai rice farming
- The development of Western science in Thailand
- The purpose of the workshop

After all information was presented, the researcher transitioned the participants to the workshop activities.

The first activity: "Important factors for Thai rice farming"

The first activity was brainstorming the question, "What important factors support the success of rice farming in Thailand?" The researcher encouraged each participant to identify the answer individually without restrictions. This open-ended question allowed the participants to think about what surrounds the success of rice farming in general. The researcher guided the participants to focus on materials they were asked to bring. The primary goal of this activity was to guide participants to the topic of Thai rice farming and think about everything that contributes to its success. The answers were placed on Post-it notes and returned to the facilitator.

All the participants' opinions were displayed and discussed before grouping the answers. The facilitator then summarised and presented the grouped categories to the workshop.

The second activity: "Science and cultural practices behind the success"

The categories related to what factors support the success of Thai rice farming were derived from the first activity, and were used in this activity. During this stage, participants were divided into two groups and convinced to focus on answers derived from the first activity while relying on their expertise. The researcher chose group members before the workshop. Each group contained three to five members who are professionals from both science and ethnographic museums. The researcher made the transition to a new stage by asking, "What is the science behind rice farming? And what are the cultural practices behind rice farming?" in response to the categories from the first activity. All participants were encouraged to discuss and share ideas within their groups. The researcher suggested they give their point of view as it related to their area of expertise. The science museum professionals shared their viewpoints about the science behind what supports successful Thai rice farming; ethnographic museum experts provided opinions about the cultural practices or traditional knowledge behind successful Thai rice farming. Each group was asked to write their viewpoints on a flip chart and present them to the workshop. All participants then discussed those viewpoints regarding the science and cultural practices behind successful Thai rice farming.

The third activity: "The connection"

After participants had explored the science and cultural practices that exist in Thai rice farming in the second activity, this stage invited them to provide further opinions on how to apply science and cultural practices into Thai rice farming. Participants discussed this within their groups and proposed the connections between cultural practices or traditional knowledge and Western science. After discussion, the viewpoints from each group were presented to all participants.

The fourth activity: "Communicate the connections"

In this activity, both groups shared their opinions on what approaches or products a museum can use to communicate the combination of intangible cultural heritage and Western science about Thai rice farming in order to engage Thai science museum visitors. Every participant was asked to share ideas and work on a large piece of paper. A presentation of all ideas regarding communication approaches and how to apply them in a science museum followed. The results were displayed to all workshop members.

The fifth activity: "Designing a prototype for a science museum"

The participants were asked to design a prototype for a science museum in order to engage Thai science museum's visitors with Western science and Thai ICH or traditional knowledge about Thai rice farming. Both groups were encouraged to consider and select a topic from the categories derived from the first activity and one of the communication approaches from the fourth activity to develop a prototype. Without restrictions, group members were asked to share and discuss ideas to develop a prototype. Each group was asked to write, draw, sketch, or draft a proposal and present it to the workshop at the end of the activity. Workshop members discussed the results and considered how to develop them for the museum and any other real-world concerns they might have.

After the design workshop was completed, the researcher requested feedback, suggestions, recommendations, and concerns regarding the workshop and gathered the participants' research. As time allowed interviews with the participants, held to gather information and feedback and completed after the workshop. The interviews were based on a qualitative

research protocol. This means that participants allowed to describe significant things for them resulted from the ScienceICH design workshop. To fulfil the primary purpose of the research, collected workshop results and interviews were analysed to understand how the intangibles of cultural heritage can support science interpretation and communication at Thailand's National Science Museum.

Table 5.1 Structure and plan of the ScienceICH Design Workshop

Stage of workshop		Actions	Purpose and output	Note
1.	Preparing the workshop			
	Identify participants.	Contact in person	Eight to 10 experts in the areas of science and ethnographical museum and related areas	
	Provide consent form and Information sheets.	Email, phone, in person	For confirmation	
	Ask the participants to bring material related to rice farming to the workshop.	Email, phone, in person	An idea for discussion in the workshop	The material can be an object or content about rice farming, a picture, a song or a written work related to rice farming, ICH, and science.
	Make an appointment for the workshop	Email, phone, in person	Make an appointment and confirmation in preparing workshop venue and date, and preparing materials for the workshop.	
	Prepare materials, place, and facilitation for the workshop.	Contact NSM in person and ask for permission.	Get permission to use the facility and the supporting team for running the workshop.	
	Test the workshop activities.	Mockup a workshop.	Preparing for the workshop. Check and test the content, and the process of running and ensuring the workshop is ready to launch.	NSM's staff members who have experiences in exhibition and content development related to science and non-science background.
2.	On the Workshop day			
	Ask the participants to introduce themselves and provide consent form before running the workshop.	Sign a consent form.	Rapport Consent and ready to do the workshop	Keep all consent forms safe and secure.

Presentation				
	Present the introduction of the workshop.	Present by using a PowerPoint presentation.	Point out the background and purpose of the research and the aim of the workshop	The aims of the research and workshop
	Explain the hypothesis of the research.	Present by using a PowerPoint presentation.	Express the hypothesis of the research.	The connections between local knowledge and Western science Thai science museum can communicate science through those connections suited to the role of the museum in Thailand. Museum professionals can bring scientific content together with ICH content Museum professionals can make the exhibition more powerful, more engaging, and more meaningful for educational objectives through the combination of local knowledge and Western science.
	Introduce the selected content, ICH about rice farming and Western science to the participants.	Present by using a PowerPoint presentation.	Point out the topics and introduce the possibility to connect traditional knowledge about rice farming and Western science.	The connection between worldview and ICH The scope and importance of ICH ICH about rice farming Some examples of knowledge from ICH about rice farming connected to Western science, such as seed preparation and genetic engineering.

Designed activities				
	Activity 1: “The important things for Thai rice farming”	Brainstorming with all participants	Identify the important things that support the success of rice farming (in general). Categorise the things that support the success of Thai rice farming.	Use the question, “What are the important things that support the success of Thai rice farming?” Guide participants to use material they were asked to bring with them to the workshop.
	Activity 2: “Science and cultural practices behind the success”	Brainstorming and discussion within a small group	Encourage participants to share experiences on rice farming and rely on their expertise in order to identify science and cultural practices that exist in Thai rice farming.	Use the question, “What is the science behind rice farming? Moreover, what are the cultural practices behind rice farming?”
	Activity 3: “The connection”	Brainstorming and discussion within a small group	Map and connect the value of science and the value of the traditional knowledge and culture regarding rice farming practices. Discover the connection between scientific knowledge and ICH about rice farming.	Use the question, “How do science and cultural practices support the success of Thai rice farming?” Identify the connection between scientific knowledge and traditional knowledge in ICH about rice farming.
	Activity 4 “Communicate the connections.”	Brainstorming and discussion within a small group.	Search for the museum’s communication approaches that can be used to communicate the connection of science and cultural practices about rice farming and how to communicate these connections. Encourage participants to share ideas on how many and what are the museum’s tools, methods, and channels that can be used to present	Use the question, “What kinds of museum communication approaches can be used for communicating these connections?” Use the question, “How can we communicate these connections to engage visitor about science and culture of rice farming?”

			these connections and think more about the styles and narrative of the presentation.	
	Activity 5: “Designing a prototype for a science museum”	Select some of the ideas to develop a prototype for Thai science museum. Brainstorming and discussion within a small group	Search for the possibility to develop a prototype to communicate the connection between cultural heritage and Western science about rice farming with the information gleaned from the workshop. Find a recommendation for using the designed prototype to develop an actual museum’s communication approaches.	Use the question, “Can you pick a topic and communication approaches to develop a museum’s communication approach that communicates the connection between traditional knowledge and the science about Thai rice farming for a science museum, and how can you develop this prototype?”
Request suggestion, feedbacks, recommendation				
	Discussion about the workshop and the research	Ask the participants to provide feedback, suggestions, recommendations, or concerns to reflect the workshop and the research study. Interview each participant.	Gain feedback, potential impact, recommendations, and suggestions.	Ask participants to provide their opinion about combining traditional knowledge with Western science for presentation in Thai science museums. The process applied in the workshop to gain a prototype of the approach for a science museum. Concerning the development of the prototype as an approach in a science museum. What can help to connect cultural heritage with science? The potential impact of this study.
The workshop was audio and video-recorded and notes taken by the researcher. The data is kept safe and secure.				

5.4 Conclusion

This chapter begun with formulating a conceptual framework that spells out the relationship between ICH and Western science. It started by identifying the traditional knowledge that has been woven into ICH, followed by mapping this knowledge onto Western science. The connections between ICH and science can be used to design science communication exhibitions and programmes in the science museum. In order to combine these different areas of knowledge, Western science and traditional knowledge in ICH, we need to be working across disciplines. The concept of boundary crossing was applied to this framework in order to understand how best to facilitate it. The ScienceICH design workshop was designed to be a platform for multidisciplinary working for this research. The design workshop was designed to contain three main parts, *identify knowledge, explore the connection between the ICH and Western science,* and *design a prototype for a science museum* in accordance with the conceptual framework.

The ScienceICH design workshop was trialed in Thailand with eight participants, who were museum professionals with expertise in ethnography or science communication. Participants were also interviewed by the researcher after the workshop, to collect additional feedback, reflections and recommendations for ScienceICH. The outcomes of the workshop and the findings from the participant interviews are presented in the next chapter.

CHAPTER 6 THE RESULT OF THE WORKSHOP

6.1 Introduction

This chapter presents how the conceptual framework derived from theory and presented in the previous chapters can be utilised in the museum space and what its impacts are. The ScienceICH design workshop format described in chapter 5 was used to facilitate such utilisation of the conceptual framework (see also Table 6.1). The chapter presents the outcomes of the ScienceICH design workshop step by step, corresponding to each workshop activity. The chapter thus provides an overview of the evidence that leads to conclusions regarding the suitability of the design workshop approach for supporting museum professionals to connect and interpret traditional knowledge through Western science in order to appropriately develop science communication in Thailand's science museums.

Table 6.1 Outline of the ScienceICH design workshop

Sessions	Brief outline	Duration time (Start at 14:00)
1. Introduction	Explain the ScienceICH workshop's schedule, the background of the study, purposes and agenda of the workshop, and the roles of the researcher and participants.	15 minutes
2. Activity 1: The important things for Thai rice farming.	Identify the important things that support the success of rice farming (in general) and categorise them.	35 minutes
3. Activity 2: Science and cultural practices behind success.	Identify knowledge of science and cultural practices existing in Thai rice farming.	45 minutes
4. Activity 3: Finding the connections between knowledge in cultural heritage and science.	Connect and map the knowledge of science and traditional knowledge in Thai rice farming.	30 minutes
5. Activity 4: Developing the concept for telling the story about success factors in rice farming	Develop the conceptual idea for communicating the connection between traditional knowledge and science about Thai rice farming.	40 minutes
6. Activity 5: Design a prototype for a science museum.	Develop a prototype to communicate the connection between cultural heritage and Western science about rice farming with the derived information from the workshop.	40 minutes
		205 minutes

6.2 ScienceICH design workshop results

The ScienceICH workshop started at 2.00 p.m. on 25 June 2018, according to the schedule. The participants were divided into two groups, with four persons each. Each group consisted of experts in science and Thai culture. Group 1 included participants S1, S2, S3 and C1. Group 2 included participants S4, S5, C2 and C3. During the workshop, the researcher, as a facilitator in the workshop, received warm support from the Science Communication Division, the Office of Public Awareness of Science, and the National Science Museum Thailand in terms of equipment, place, and helpful staff who assisted the researcher in setting up the room and the video and audio recording.

The workshop began with an introduction to the venue and the participants. The researcher gave an explanation of the role of the researcher as a facilitator. A presentation

of the background of the research followed, describing the focus on finding an effective approach that has a potential to link intangible cultural heritage with science, and to interpret the stories of local knowledge, ceremonies, and beliefs that are deeply rooted in the Thai way of life and culture by using science in order to develop new ways of science communication in Thai science museums. It was also remarked by the facilitator that museums could be one of the institutions that play an important role in this purpose because they are rich in stories, artefacts, experts, and networks that could be developed into an effective way to make these links and present them to the public. Success in these efforts would require cooperation from experts in the relevant disciplines who could provide useful insights and collaboratively design suitable science communication. After that, the facilitator explained the objectives of the workshop. All of the tasks and activities in this workshop had been designed based on the literature on worldviews, ICH and science communication as a conceptual framework that enable the exploration of connections between ICH and modern science. The agenda of the workshop was explained to the participants before starting the first activity.

It is important to state that the researcher had informed participants during the workshop; they were free to think, discuss and share their ideas in every activity with everyone. The researcher would only act as a facilitator to control the time, to manage the activities and to facilitate and support the participants' work. The researcher also informed them that he would not offer any opinions, show any suggestion, or take any part that would influence the outcome of each activity. Participants' opinions would be respected and used only for data analysis.

Figure 6.1 The room for the ScienceICH design workshop and the introduction session.

6.2.1 Activity 1: The important things for Thai rice farming

In this activity, the facilitator guided the participants to think about the factors that may contribute to success in Thai rice farming in general. The participants were allowed to brainstorm freely, regardless of their expertise. It might begin with something that they were asked to bring to the workshop. The participants wrote their ideas on Post-it notes and brainstormed to get as many ideas as possible. The workshop assistants posted the notes on the whiteboard at the back of the room and participants worked together on grouping the ideas into categories.

In Group 1, participants explained the success factors by using the items that they brought to the workshop and discussing their impressions about the items. One of the participants brought a small bag of fertiliser soil and commented that this is essential for farming and agriculture. Another participant presented a bag made from animal feed sacks to the group and explained that farmers are determined and trying hard to adapt to social changes in the modern world and that is a crucial factor in helping them overcome obstacles. The third participant mentioned money and expressed the opinion that funding is necessary for farmers in all aspects of their work. He added that modern farmers are buying

everything, from seeds to harvesting machines. All group members agreed with the presented ideas and individually wrote down their additional ideas about the factors that contribute to success in rice farming.

Figure 6.2 Group 1 with the first activity.

The second group began by showing each other the items they had brought with them, including books from an exhibition, documentary books, articles, and a leaflet for the ploughing ceremony. The group members elaborated aspects of success, including the produce, economy, and social, cultural, and environmental sustainability. They started writing down their own ideas before discussing with other members and followed this by adding further information from the group.

Figure 6.3 Group 2 with the first activity

After the brainstorming activity, the facilitator asked the participants to group their ideas into categories. According to the participants, there are several and various success factors in rice farming. The activity was open for free analysis, critique, and discussion. They considered the success factors both in separate rice farming stages and the overall rice farming process. All of their ideas were posted on the whiteboard and allowed all participants to group the ideas into categories together. The result, five categories of success factors in Thai rice farming, represented the viewpoints of all participants, in relation to the important things that affected Thai rice farming. This activity took approximately 10 minutes, and the resultant categories can be summarised as follows:

1. Wisdom and behaviour of farmers: knowledge, experience, expertise, farming skills, knowledge and understanding of nature, knowledge transfer, preference and proficiency of farmers in different localities, and ways of raising morale.

2. Nature and environment: soil, weather, water and irrigation, ecosystem, organisms in rice farms, the richness of minerals in the soil, seasons, natural disaster, and local rice varieties.

3. Equipment and technology: labour-saving devices, e.g. rotary tillers, rice harvesting machine, rice farming and yield-enhancing technology, modern digital equipment which plays an important role today.

4. Maintenance: rice seed selection, fertiliser, and pest control and prevention.

5. Management: water management, area management, data access, news and knowledge about water in the irrigation system, weather, flood, drought, rice markets, purchasing after harvest, and advertisement.

In total, the first activity took approximately 35 minutes.

Figure 6.4 Participants grouped the results into categories (Activity 1).

The first activity indicated that participants were able to work across disciplines. They shared ideas that derived from their daily lives. What they shared was a reflection of their worldview. The boundaries among them were illumited during the activity and appeared to be defined by their worldviews and lifestyles. Participants with worldviews that tied to the indigenous lifestyle referenced issues related to morale and spirituality; those with worldviews that tied to the urban lifestyle, referenced issues related to materiality aspects such as the financial aspects of rice farming.

6.2.2 Activity 2: Science and Cultural Practices behind the success

In this activity, the participants brainstormed in their group to identify the kinds of scientific knowledge and intangible cultural heritage that relate to the 5 categories of success factors that were identified in the first activity.

In Group 1, all participants agreed that the success factors in rice farming relate both to science knowledge and intangible cultural heritage, including traditional knowledge, beliefs, and practices. All of them agreed that, in fact, the traditional knowledge of Thai rice farming is fully of the scientific knowledge but not often be described as science. According to the participant who was an anthropology expert, intangible cultural heritage relates to farmers' psychological needs (e.g. morale) and their personal conceptual understanding of rice farming which includes concepts that are described and explained differently by science. Another group member recommended that the analysis be performed for each sub-process of rice farming, to examine relevant local knowledge and think about where science steps in. For example, not only does the ploughing ceremony lift the morale of farmers (local knowledge), but it is also a strategy for supplying farmers with high-quality rice seeds to improve their farming (science knowledge). The use of scarecrows to chase away birds (local knowledge) relates to knowledge about bird behaviours (science knowledge). Some traditional farmers control the populations of rats and other destructive animals by using other animals or insects which are their predators (local knowledge). This demonstrates the principles of biocontrol (science knowledge) which do not cause negative destruction to natural environment.

One group member raised an interesting idea to the group. He mentioned that the farmers' way of life and residential settings foster local knowledge. The rice silos are usually entirely closed and elevated from the ground to keep away mice, birds, insects, and the seasonal floods that usually occur in the Thai climate area. Group members went on to compare the knowledge and processes used in the past and the present to identify links. For example, in the past, farmers used scarecrows or biocontrol to keep away pests while today they tend to use pesticides and chemicals which are more effective and efficient. For weather forecasting, the farmers' ancestors observed the sky to predict the weather, taking note of the movement of the stars, the moon and the sun to determine the seeding season; today, farmers are relying on the calendar and weather news from different media channels.

Figure 6.5 Group 1 working with the second activity.

Group 2 discussed rice farming processes to point out cultural aspects and ceremonies included in those processes and to explain how ceremonies and traditional activities link with science. For example, they discussed how water and area management (science knowledge) in the past and present is linked with the Bun Bang Fai Festival and the cat parade of the rainmaking ceremony (cultural heritage), and the recording of precipitation as the collecting the statistical data. They also mentioned the development of labour-saving machinery (science) in relation to the harvesting activity that gathered together workers within the local community (cultural heritage). All these were discussed as links between scientific knowledge and cultural heritage. One of the participants also pointed out that, culturally speaking, rice is the product of sacredness. It is protected by a goddess, it has life. That is why farmers need to take good care of rice, starting from carefully selecting the rice seeds, and caring for it when it bears the grains as they would care for a pregnant woman. It is respected in the same way as the rice goddess (Phosop). Farmers also perform the Encouragement ceremony to ensure that life is well taken care of (like a motivation strategy). These ceremonies are similar in different regions of Thailand, with

minor differences in the lyrics and accent of the singing. The group also discussed how the Royal Ploughing Ceremony is aimed at encouraging farmers to be ready for the next rice season.

Figure 6.6 Group 2 working with the second activity.

In total, the second activity took approximately 45 minutes.

6.2.3 Activity 3: Finding the connections between knowledge in cultural heritage and science.

Following the second activity, the facilitator then asked the participants to give their opinions about how the instances of scientific knowledge and intangible cultural heritage they identified in the previous activity contribute to success. Each group was asked to write their ideas down on paper and give a presentation.

The discussion and idea-sharing in the two groups developed through defining sub-topics of rice farming and trying to see the benefits and the knowledge behind everyday practice, both traditional and modern. Some of the topics were quickly related to scientific knowledge while others took the groups some time to analyse. The discussion atmosphere was pleasant and friendly, and all experts took turns to share their stories and ask in-depth and interesting questions. The experts shared their knowledge and experience and learned from each other. Each group gave a presentation of their ideas about the questions, which are summarised below.

Group 1

This group explained that their analysis focused on the process and the factors that impact rice farming, particularly in terms of scientific knowledge and intangible cultural heritage, including ceremonies and traditional methods. They divided their data into ‘science’ and ‘culture’ categories. Table 6.2 below presents the examples they gave of ‘science’ and ‘culture’ in rice farming and how they contribute to the five success factors.

Table 6.2 Result of activity 3 group 1 on science or modern practices and traditional knowledge on five success factor of Thai rice farming.

Topic	Science, modern practices	Traditional knowledge, culture, and ceremonies
Traditional knowledge and farmers' behavior		
Soil preparation	Soil conditioning by adding fertilisers, chemicals, and minerals in the soil; physics and chemistry knowledge	Grass removal, ploughing over the seeds, growing legumes, grass burning, fallowing; traditional behaviour and beliefs.
Rice seed and maintenance	Seed selection, seed improvement, genetic modification, knowledge about genetics and DNA, seed storage with environmental control devices, machine harvesting, technology knowledge, pest control chemicals, and rice winnowing and milling machines.	Seed selecting (with traditional methods e.g. floating on water), germination of seeds using traditional methods, storing rice in the silo in the traditional way, manual harvesting, pest control with biocontrol and scarecrows, application of manpower and natural powers in milling and winnowing
Water technique	Water-wheels and water pump with electricity, modern irrigation.	Traditional water diversion techniques, observation and selecting areas according to the natural environment, moat and irrigating system of rice terrace.
Ceremonies, spiritual encouragement, and systems in rice farming	Encouragement strategy for rice farming and guideline for taking care of the rice farm (rice farming guidebook); sign and warning about changes in the rice fields so that farmers can tackle the problem in a systematic manner (rice field monitoring).	Royal Ploughing Ceremony, the rice and field Encouragement ceremony performed for an abundance of water and fruitfulness of rice fields.
Nature		
Preparation about weather	Weather forecast.	Observing the behaviour of animals, insect, sky, and environment for forecast and prediction.
Tools and technology		
Labour-saving and time-saving	Machines, labour-saving device, digital knowledge, artificial intelligence system used in the processes; mechanical and modern technological knowledge	Animal labour, e.g. buffalo; using local materials as the ploughing tools, e.g. tiller, harrow, and containers.
Caring and maintenance		

Improving yield and quality of rice	Using modern methods for improving the rice seed; maintenance and yield improvement. Rice storage with high-accuracy environmentally-controlled tools. Application of knowledge in the environment, geography, and climate.	Relying on manpower according to the traditional way of rice farming, e.g. sowing and transplanting. Building the silo according to traditional beliefs and methods.
Management and marketing (This group was unable to present in the time given. They shared that the traditional way of receiving news and information in the form of public gathering as well as the modern method via new media allows farmers to track the updates about statistics and rice marketing).		

Figure 6.7 Group 1 presenting for the third activity.

Group 2

This group looked at the big picture of rice farming and the key ceremonies commonly observed. They made a comparison and analysis in order to identify how scientific knowledge and intangible cultural heritage help farmers. Their ideas are summarised in Table 6.3 below.

Table 6.3 Result of activity 3 group 2 on science or modern practices and traditional knowledge on five success factors of Thai rice farming.

Topic	Science	Traditional knowledge, culture, and ceremonies
Traditional knowledge and farmers' behavior		
Helps in making a decision and taking actions with confidence	Trial and error, reasoning, and knowledge transfer according to the environmental context. The knowledge of storing rice seeds.	Chants and Folk songs recording the process of rice farming. Ceremonies and beliefs about the rice goddess as means of knowledge transfer. Mural paintings in the temple and local landmarks give the guidelines and practices for each season.
Nature		
Preparation about weather	Use scientific knowledge for an accurate weather forecast.	Observing the behaviour of animals, insects, sky, and the environment. Encouragement by performing the Royal Ploughing Ceremony.
Tools and technology		
Labour-saving and time-saving	Use modern machines and devices. Apply mechanics and physics knowledge to improve the tools and processes, e.g. winnowing. Use international standard.	Rely mainly on manpower and animal power, e.g. gathering relatives for harvesting, using buffaloes for ploughing. Gathering activity helps strengthen the relationship among people in the community. Using the windmill to divert water is a way of learning how to make tools using natural energy. Hold on to the farming season. Belief in the rice goddess, the farms guardian spirits, the rain god, and the ceremonies as the guides to practice.
Caring and maintenance		
Improving yield and quality of rice	Use modern methods. Rice storage with high-accuracy environmentally-controlled tools. Application of scientific knowledge in the environment, geography, and climate.	Keep the rice in the traditional silo. The silo is made from local materials. Use natural method to prevent pests. There are ways to care for rice and control pests, e.g. scarecrow. The silo is designed to be elevated. The pillars are outside. Space is designated in column for convenient storage.
Management and marketing		
Preparing for problems and helping to solve them	Use academic principles and technology to distribute and improve access to data promptly.	Physical gathering and direct communication. Using community management like a cooperative system.

Figure 6.8 Group 2 presenting for the third activity.

As the two tables above show, both groups analysed and detailed the science knowledge hidden in the intangible cultural heritage through examining the bigger picture of rice farming and its sub-processes, the key methods and contexts, and examining the reasons behind the practices and ceremonies related to Thai rice farming. They pointed these out clearly in intangible cultural heritage before analysing the scientific knowledge behind them. The outcomes were consistent with the objectives of the workshop and the previously developed theoretical framework.

In total, the third activity took approximately 30 minutes.

Activities two and three belonged to the second part of the ScienceICH workshop. This part aimed to encourage all participants to explore the connections and relationships between rice ICH and Western rice science in Thai rice farming. Boundary objects were created during these activities through sharing, discussion, and negotiation processes. Considerably, these objects seem to be very closely related to the personal experience and educational background of those who created them. Thus, experts with a scientific

background tended to reference the scientific practices and technologies of rice farming, and those from non-scientific backgrounds tended to reference traditional beliefs and practices. Once both groups had successfully created these connections, the next activity encouraged the group to use the discovered connections to design rice science communication, for example, through an exhibition.

6.2.4 Activity 4: Developing the concept for telling the story about success factors in rice farming

In this activity, the participants were asked to develop a story concept that could underlie museum programming and illustrate the scientific knowledge and intangible cultural heritage behind the factors that contribute to successful rice farming. The outcomes of each group are presented below.

Group 1 proposed that scientific knowledge and intangible cultural heritage should be combined and presented in the same story. The story could be told through the following six different techniques:

Technique 1: A comparative technique to tell the story with a focus on problem-solving. The traditional wisdom used to solve rice farming problems is explained and compared with modern solutions or improvements based on science applications. This technique highlights interesting aspects of the changing process of problem-solving. For example, farmers in the past used buffaloes for tilling; farmers in the present, faced with difficulties in taking care of buffaloes and the limitations of buffalo capacity, have turned toward using power tillers instead.

Technique 2: The story is told chronologically following the rice farming processes. Traditional rice farming processes, including seed selection, cultivation, and storage, are described and then explained in terms of scientific knowledge. This technique highlights the connections between scientific knowledge and the intangible cultural heritage of the rice farming process. For example, farmers in the past would pollinate rice at the right

time of the year. Scientific justification of pollination practices would refer to botany and genetics, and explain why such practices continue to be used for improving rice seeds today.

Technique 3: The farmers' social context and way of life is used as a basis for the storytelling. It focuses on the problem-solving skills among farmers and is told through the lens of traditional and modern knowledge. The group outlined the plot of the storytelling about rice farming. They came up with storytelling about a farmer's experience of growing rice and solving problems by using both traditional methods and modern solutions.

Technique 4: Interactive engagement techniques are used in an exhibition which stimulates visitors to learn through experience. The activity should be designed to cover all processes of rice farming, including maintenance and processing rice production.

Technique 5: The deities and symbols are used for storytelling. A spirit based on the beliefs of farmers and villagers can be used as the narrator in the story. The spirit in this story will get the visitors to learn about the ceremonies that relate to rice farming and explain the science behind those ceremonies, beliefs, and practices. For example, the story about arranging the direction of the silo door can be told from the spirit's point of view. The spirit itself should not have an intimidating look. It will narrate the beliefs and practices around building the silo and answer questions about the direction of the silo door, which is closely related with the direction of the wind and the light when rice is kept in the silo.

Technique 6: The story is told from the engineering and architectural perspective. As part of rice farming cultural heritage, unique and fascinating tools and architectures will be displayed and told to underline their value and importance as art and culture. It is then followed by scientific and engineering explanations that justify the design. Visitors will be exposed to the tools and models of architects from their perspectives. After learning

the story, they may be able to apply similar ideas to solve problems common in rice farming.

Figure 6.9 Group 1 presenting the six techniques for telling the story (activity 4).

Group 2: The ideas of this group were similar to those of Group 1. They looked at the rice farming process as part of a wider picture and presented scientific knowledge and intangible cultural heritage in the same story in a balanced manner. The group members discussed and shared their ideas before presenting the four techniques described below.

Technique 1: The scientific knowledge behind key ceremonies related to rice farming is explained. Well-known ceremonies such as the Royal Ploughing Ceremony are explained from the art and culture perspective while also explaining the process from the scientific point of view. The problems and obstacles related to rice farming in the past are discussed, as well as applications of science to solve these problems in modern farming practice.

Technique 2: The story is told based on the different points of view, but with the same goal. Different practices of rice farming in different regions, such as rice terrace farming

in the north, highland rice farming in the northeast, lowland rice farming in the centre, and the valley rice farming in the south are compared in order to highlight their different environmental and social contexts that resulted in different ways of thinking about and practicing rice farming. Thus, science is used to explain these regional differences, while it is also pointed out that Western science can minimise the differences.

Technique 3: The story is told as a documentary of environmental management in the traditional form of rice farming. This technique presents the traditional knowledge of farmers in the past that helped them deal with environmental problems. The process of rice farming and its environmental management implications is narrated, including traditional knowledge about water management for rice farming. This knowledge is then interpreted from the perspective of Western science.

Technique 4: The story is told so that scientific knowledge and intangible cultural heritage are presented in parallel. The story is narrated by teenagers, representing new generations, who tell the story from a Western science perspective; in parallel, it is also narrated by their grandparents, representing the older generations, who tell the story from a traditional knowledge perspective. The two stories are told in parallel to demonstrate rice farming on the same field then and now. They confront the same problems but solve them in their own traditional and modern ways. This storytelling technique leads to mutual learning and sharing of knowledge about overcoming the problems and achieving satisfactory outcomes. The personas from different generations are also meant to demonstrate the ageing society and to attempt to minimise the generation gap by facilitating access to their different but related bodies of knowledge.

Figure 6.10 Group 2 presenting the four techniques for telling the story (activity 4).

In total, the fourth activity took approximately 40 minutes.

6.2.5 Activity 5: Design a prototype for a science museum.

In this activity, both groups had to choose one of the storytelling approaches they developed in the previous activity and develop it further for use in an actual museum setting. They were free to choose platforms and forms of display, for example, they could choose to have a science activity, a show, a film, a science drama, a website, or an exhibition. Each group was required to draft an outline that would detail the form, objective, target group, development time, storyline, and issues that should be considered about implementation. Each group's work is summarised below.

Group 1: The members agreed that, for an exhibition in the science museum, it is important to have a punchy and interesting point. This group decided to choose the spirit, which influences beliefs, for their presentation. A group member proposed that digital technology can be used to make the presentation more interesting. Although an exhibition based on a ghost spirit may seem out of place in a science museum, it would attract more attention. The group members considered seriously the target group and came to the conclusion that they would target teenagers aged 13-18 because these teenagers are still living with their parents and are starting to get curious to learn about science. Their parents might function as their link to traditional knowledge if the teenagers have any questions.

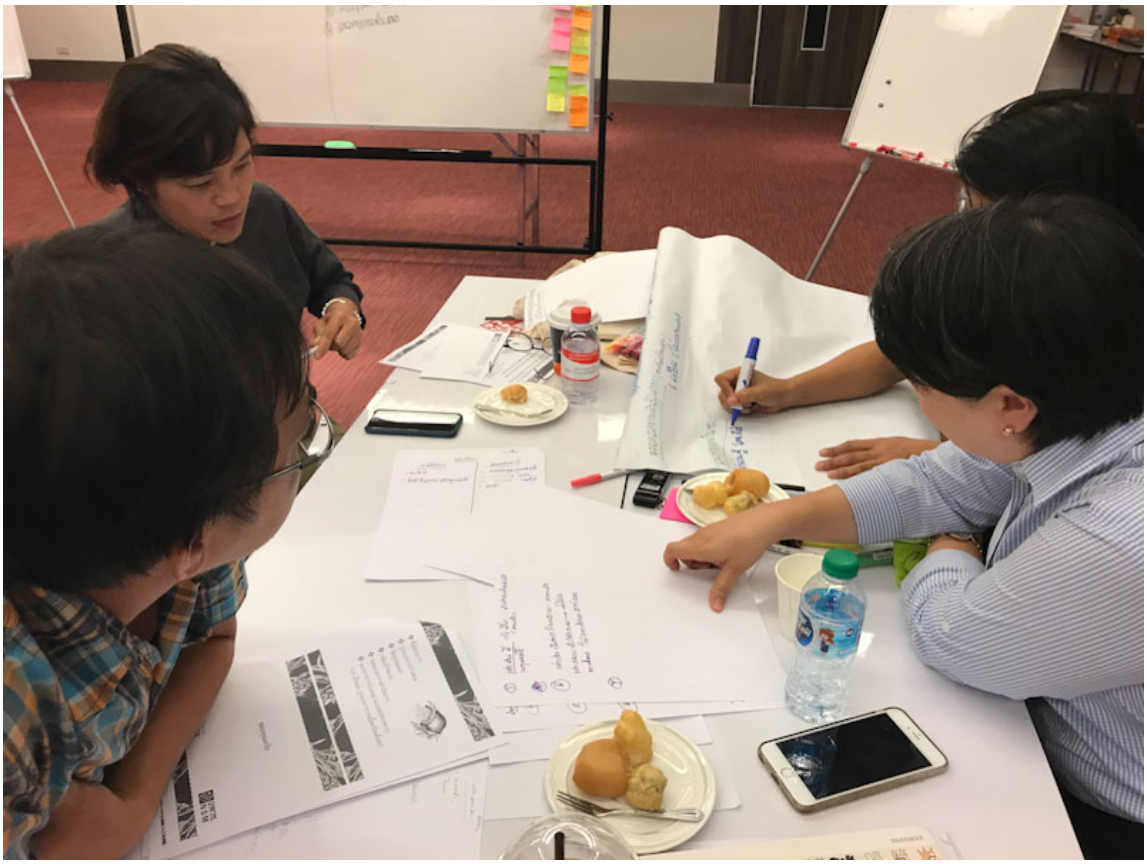

Figure 6.11 Group 1 discussion for the exhibition design in the fifth activity.

Group 2: The group members discussed among themselves and decided to use the comparison technique. They planned to use comparison of traditional knowledge, culture, and Western science as the theme. The story would be told by people from two generations: a grandfather and his grandson. The grandfather represents the traditional culture and knowledge while the grandson represents modern science and rice farming processes. The group members brainstormed about the time that would be required for the design process, the display, the budget, and the target group. The cultural experts in the group raised the global issue of the ageing society. They deemed that it would be an excellent opportunity for museums to be the medium that links two generations. The group members concluded that they would display a temporary exhibition in the science museum for six months. The exhibition will open at the start of the rice-growing season. The issue that the group emphasised was how to keep a balance between information about the cultural and science sides of rice farming. To clarify, in the comparison of traditional and modern ways of rice farming, the way data is presented should not be biased or simply about which one is better than the other. Furthermore, it should not

present cultural practices as credulous or ridiculous, because they are sensitive issues. One thing that everyone in the group agreed upon is that every activity or ceremony in rice farming encompasses strategic traditional knowledge. For example, the lyrics of the songs in the ceremony rhyme helped people who could not read to remember the content better, and made it easier to spread the knowledge they contained widely through the oral tradition. Regarding the storytelling aspect, this group designed the rice farming activities by the grandfather and the nephew so that they encountered various crises, such as water shortage, pest outbreak, and problems about rice produce and seed storage. The main purpose of their proposed exhibition is to create a link between two different dimensions of rice farming and to make them logical and understandable and to point out this kind of links in order to develop old and new ideas in a more effective way. The exhibition's main message is that these new ideas should be developed to fit the cultural context sustainably, and seeing the value of knowledge from both culture and science helps to keep the balance. Both sides, therefore, valued the views of each other and employed the storyline to conciliate the two aspects.

Figure 6.12 Group 2 discussion for the exhibition design in the fifth activity.

After the group discussion, both group's spokespersons presented the group's exhibition ideas to all workshop participants, to explain the technique they chose and the decisions they made about how to implement it. More details from the groups' presentations are below.

Group 1: This group presented an exhibition called "Telling a Story through Ghost Spirits", focusing on Thai farmers' religious beliefs and having Ghosts narrate the story. The exhibition would target teenagers, young people aged 13 – 18. Group 1 estimated that the exhibition would take approximately six months to develop, including conducting background research and designing the content and the exhibition, but not including construction time. The presenter clarified that ghosts represent religious beliefs, and they are strongly linked to traditional knowledge and ceremonies, which is why they were chosen to narrate the exhibition. The presenter also explained that the exhibition would be accompanied by a number of activities, and its objective would be to communicate how traditional wisdom and beliefs related to rice farming are linked with scientific knowledge.

Going into more detail about the exhibition's storyline, the presenter explained that ghost spirits featuring in beliefs related to rice culture would be used to describe ceremonies and rituals related to rice farming. Spirits such as Mae Phosop, goddess of rice, represent the deep-rooted beliefs of Thai farmers and can be used to narrate traditional knowledge respectfully and without compromising the importance of Western scientific knowledge. The plot will follow the rice farming processes. The spirits will make sure that the relevant ceremonies are performed appropriately, according to traditional beliefs, and will additionally use scientific principles to explain why farmers did what they did and how it is useful. The group emphasised that it is important for the exhibition to be respectful and allow the audience to think about the connections between rice culture and rice science, enabling them to ask further questions without confuting anyone's beliefs.

Figure 6.13 Group 1 presenting the proposal for the exhibition for science museum.

Group 2: This group decided to use representatives of scientific knowledge and intangible cultural heritage as the narrators in the exhibition. The grandfather represents tradition, and the teenage nephew represents modernity. The exhibition is called *All Rice* and includes objects from museum collections and multimedia interpretation. The exhibition targets young people over the age of 13, and its objectives are 1) to link scientific knowledge and traditional knowledge about rice farming, 2) to organise rice farming knowledge more systematically, and 3) to narrow down the generation gap. The group estimated development time to be approximately one year, from research to installation.

The story is told by the narrators who come from different generations but have the same goal: to grow rice successfully. Following the rice growing process, the exhibition presents the narrators with crises and conflicts which they have to resolve. Working on resolutions helps to link the knowledge from both sides and allows them to share ideas in order to overcome the crises and achieve success (symbolised by the golden rice field).

This symbol not only represents the plentiful yield, but also the glorious learning from sharing both sides of the knowledge.

The group considered several issues that would need attention during exhibition development. These included standard issues, like considering the target audience, the budget, the policies of the organisation, the development of partnerships, sponsors, sourcing objects and information, and the selection of media that are appropriate for the target message. They also considered the need for data balance and impartiality, and how to ensure that the presentation is unbiased and does not discredit either side. They specifically argued for a presentation that balances academic content with the first-hand experience. Finally, the group considered evaluation an important aspect of the exhibition, in order to assess knowledge gains and overall visitor experience of visiting the exhibition.

Figure 6.14 Group 2 presenting the proposal for the exhibition for science museum.

In total, the last activity took approximately 40 minutes.

Activities four and five are in part three of the ScienceICH workshop. This part aims to encourage participants to produce a design representation that could be an exhibition, educational programme, activity, or media related to the connections between the ICH and Western science about Thai rice farming. The result of both activities indicated that participants were able to combine the ICH and Western science and create a design representation for the science museum. During the last two activities of the workshop, all participants shared their viewpoints in order to achieve their goal. Several boundary objects were created and used in the activities, such as local wisdom, technologies, gods, ghosts, festival, economy, rice strains, life style, biodiversity, management, story telling, narrative, documentary, exhibition, and multimedia. The result of the workshop is shown in table 6.4. The analysis revealed that individual boundaries transpire over time when interacting with unfamiliar topics. Those boundaries are also influenced by the individual's worldview. It is also found that those boundaries become important factors that lead to creativity. This view is consistent with Collins and Evans (2002), who discussed the incompatibility of worldviews that play a significant role in balancing science with other subjects and provides a possibility to create new ideas through interaction. Further discussion on the result of the workshop and the research is included in chapter 7.

Table 6.4 Result of the ScienceICH workshop in summary.

Structure of the ScienceICH Workshop	Sessions	Objectives	Output	Analysis
Part 1 Identify the body of knowledge in ICH	Activity 1: The important things for Thai rice farming.	Participants share viewpoints and discuss knowledge that supports successful Thai rice farming.	Categories of the success factors for Thai rice farming reflect participants' view.	Boundaries emerge while sharing ideas. Almost ideas related to daily lifestyle
Part 2 Exploring the connections between rice farming ICH and rice farming science	Activity 2: Science and cultural practices behind success.	Sharing opinion about scientific knowledge and cultural practice related to the success of Thai rice farming.	Relationship between success factors of Thai rice farming and science or modern practices and traditional knowledge and practices.	Participants found different approaches shared with a similar purpose. Boundaries were created and related to daily lifestyle and educational background of participants.
	Activity 3: Finding the connections between knowledge in cultural heritage and science.	Discussion and sharing on how scientific knowledge and cultural practice can contribute to the success of Thai rice farming.		
Part 3 Design a prototype for a science museum	Activity 4: Developing the concept for telling the story about success factors in rice farming	Discussion and sharing on how the connection can be communicated.	Conceptual ideas to communicate the relationship between the scientific knowledge and ICH about Thai rice farming. A prototype to communicate science in a science museum.	Participants shared experiences and expertise. Boundaries were created and related to experience and expertise.
	Activity 5: Design a prototype for a science museum.	Design a prototype.		

6.2.6 The recommendations from the design workshop's participants.

One month after the workshop, the researcher arranged interviews with all the participants individually in order to receive their feedback and recommendations regarding the process and the outcome of the workshop. The interview allows an individual participant to actively engage in describing additional information that is useful for the design process (Kvale, 2007). The post-workshop interviews were conducted face to face with six of the eight participants, including participants S1, S2, S3, S4, S5, and C3; and over the telephone for the other two participants, (C1 and C2). All interviewees were asked the same questions, which were:

Questions for the individual post – workshop interviews:

1. What do participants think about combining *'traditional knowledge'* with Western science for presentation in a Thai science museum?
2. What do participants think about developing the science museum's products through the workshop, by sharing the ideas between experts from various areas?
3. What comments do participants have on the design prototype process used by the workshop?
4. In the participants' view, what can help to combine cultural heritage or traditional knowledge with science?
5. In the participants' view, what are the benefits or potential impacts of this study?

Before interviewing, the participants were informed that the interview would be in Thai with a series of questions that would aim to collect feedback and recommendations regarding the process and the outcome of the workshop. Participants were also informed that the interviews were to be audio-recorded in addition to notes taken by hand. After the interviews, the collected data were transcribed in Thai before coding and analysis according to Grounded Theory methodology (Glaser & Strauss, 1999). This approach allows the study to be able to frame the key concepts for the feedback and recommendation of the participants in using workshop as a platform to make a connection between science and ICH. In average each interview lasted approximately 25-30 minutes.

Subsequently, the key themes derived from the workshop interviews can be divided into five themes as follow:

1. Opinions on combining Traditional knowledge with Western science for presenting in a Thai science museum.
2. Opinions on developing the science museum's products through the workshop, by sharing the ideas between experts from various areas.
3. Opinions on the possibility of using the design workshop to design the prototype in reality.
4. In their views, what can help to combine cultural heritage or traditional knowledge with Western science?
5. The benefits or potential impacts of this design workshop.

Finding from the interviews.

1. Combining ICH with Western science for presentation in a Thai science museum

According to the participants' viewpoints, combining ICH with Western science for presentation in a Thai science museum was a concept that all of the participants appreciated, it can provide a new and exciting way to create museum content and communication. Moreover, this concept should be applied and practice in reality. Many of them agreed that this could be a great approach to present science along with local ICH that could reduce a gap between ordinary people and science. One of the participants (S1) suggested that:

"the understanding of their cultural heritage and their context allows the museum to easily communicate with them, particularly, introduce them to new things such as science and technology in the modern world."

One participant (C1) also asserted that *"…through this concept and the idea, science can be made more accessible and traditional beliefs and practices more reasonable."*. This participant also recommended that this idea can help in adding value to the ordinary exhibition by making it unique through ICH in a way that can be adjusted to suit each local community.

Another participant (S2) recommended that:

"...this challenge should be done. It helps the science museum to make the distance between the public and science closer, because it is a science presentation through stories directly related to them. And then it could be made in other kinds of museum or other public spaces. It is an interesting way of presenting the context of life based on shared knowledge."

This recommendation is in accordance with another participant, (S5) who said:

"It is to open the area for culture to be in the area of science and to open the area for science to be in the area of culture."

All of the participants agreed that this concept can increase the value to the viewpoint of conservation as they concern that the traditional knowledge, beliefs, and practices can be studied and developed as a new technology or used along with technology that will be useful for living in the modern world as stated from one of the participants (C2) that:

"This approach may help us find a way to deal with problems that cannot be solved currently or may arise in the future. It is like preparing a backup plan for emergencies."

2. The developing of the science museum's products through the workshop, by sharing the ideas between experts from various areas

There were stunningly positive feedback and recommendations on working across disciplines, by diverse professionals. All the participants agreed that this provided many beneficial outcomes not only for the science museum but also for developing any other kinds of museum project. Sharing ideas, discussion and communication among a group of professionals from different expertise could be a powerful method in formulating new projects in the museum. When people exchange ideas and their expertise, they are communicating with others to both share and obtain knowledge. Collaboration and negotiation are an important part of this communication, as the exchange of this information could lead to creative ideas for developing new approaches and innovation for museum interpretation.

One of the participants (S4) stated the beneficial outcome of the workshop:

"The process of allowing all participants to discuss during the workshop was effective. It could allow all participants to share their information, opinion, and perspectives in ways other participants may have never known or thought about that kind of information before. In this way, the discussion allowed us to think differently. From this workshop, they learnt to think about the process of rice farming from different points of view which are different from scientific information"

Another participant (S1) asserted that:

"We normally assume that we have our expertise in science and are able to communicate science to the public by presenting all facts and scientific information. Science is powerful information and sometimes it can dominate other information. When I was asked to think about the science museum's exhibition on rice, I was thinking about only the scientific approach to the process and science behind rice farming, which is a bit plain and dominated by science. During the workshop, I could think about blending all information from the cultural approach, which was very impresive and interesting..."

One of the participants (S3) from the area of science museums recommends that:

"The discussion during the workshop was a platform for all participants to exchange their idea and data. This could be a powerful approach to drive more creativity and provide the missing link and knowledge from people in different areas of expertise. This could help to make the science museum's exhibition more meaningful"

One of the participants (C2) fed back on the process of this workshop thus:

"I do agree that the process of sharing ideas and information is beneficial to support the creativity and sense of inclusion. More importantly, in this process the moderator or facilitator is the most important person. The moderator needs to be very skilful in managing, encouraging, and stimulating all participants to provide as much information

and knowledge as poosible that would be useful for the discussion. In addition, it is also vital to mediate and maintain a balance between the information from cultural and science approaches"

One (C3) claims the benefit from the workshop to be:

"The discussion widened my perspective on the information presented in both science and culture approaches. It was an approach that could fulfill both points of view"

Another science museum professional (S5) recommended that:

"Exchanging ideas and information with professionals from different fields is good because you can interact with the real experts. In this way you can learn and get to the point of knowledge very fast. In the workshop, I could ask many questions directly of the experts and get back the answers that I might not be able to find anywhere else in a very few minutes. This might be one of the super-productive approaches for developing new ideas and concepts for a museum project and for creative networking across museum professionals"

One suggestion from one of the ethnographic professionals (S2) was:

"The process of chattering and sharing was magnificent; however, it might have been better if we could have a longer time for the discussion"

3. The using of the design workshop for designing the prototype in reality.

Overall from the interviews after the workshop, most of the participants agreed that the design workshop had the potential to adapt and to be applied to museum practice in developing exhibitions or other educational programs. Moreover, in order to put the design workshop into practice for a museum project, the participants shared the same concern which is the policy of the museum, the number and selection of participants, and skills of the moderator. One of the participants (S1) suggested that:

"It is important to follow the museum's policy, as some of the cultural issues are sensitive; for example the belief and practice about ghosts and the supernatural, which might not be suitable to present in the science museum."

Another participant (S5) described the process and role of the moderator thus:

"The small number of 4-5 peoples in the discussion group was well organised and suitable for the workshop. It allowed every participant to express and exchange ideas and information. The most important process might be the process of selection of the participants. In order to design a museum product that suits the general public, the museum needs to gain as much as information as possible from participants who have a wider age range and variety of expertise, and may be from various organisations. For example, it might worth including a real farmer, who has acquired his or her expertise in real-world experience, within the group discussion with scholars and exhibition designers. In this way, we can collect all information from different perspectives of individual participants"

Another participant (S4) gave their opinion on the role and the importance of the moderator as:

"It is crucial that the moderator or facilitator must be very skilful in managing and mediating the discussion during the workshop. At the beginning of the workshop, the facilitator needs to be very clear on the objective and agenda of the discussion, and during each topic of discussion, it is also important to control the time for each process. In addition, the moderator has a vital role in stimulating and encouraging everyone to express their ideas and in trying to prevent the domination of any participant in the group discussion. And finally, the moderator needs to be able to nail and make a conclusion from each point of information collected from the workshop. This could be a difficult part of the workshop, and in selecting such an effective and skilful moderator"

Participants pointed out that the activities in the design workshop allowed them to extend their thinking about knowledge within both ICH and Western science. They identified that the workshop's activities enabled them to think further about the processes and detail

of rice farming and encouraged them to make a connection between ICH and Western science. One of the participants (C1) suggested that:

"it seemed that the question of each activity led us to look logically for more detail of rice farming and reasons for cultural events and practices. When we looked into the reasons, I understood that they are linked to science, but I may not be able to explain how this is so."

Another participant (C3) said:

"After we finished the discussion of the second activity, we knew that science and ICH, traditional knowledge, and practices, are related at one point, but we can't tell where it is. One of our members said that 'they are the same things, the same purposes, they have just been explained and use in different languages and locations.'."

One of the participants (S3) suggested the use of the example of images when delivering this workshop in reality:

"It would be great if there are examples of images related to the topic, such as examples of exhibitions about ICH and science. This will help expand the imagination for designing."

Another one (S2) commented about the language related to the topic (ICH):

"The language used for this topic, especially in Thai, requires much interpreting, so it can cause confusion and waste time on the job."

4. In participants' views, what can help to combine cultural heritage or traditional knowledge with science?

Most of the participants agreed that they gained many useful points of information and techniques for combining different contexts about science and culture heritage from the discussion during the workshop. Based on the information from the interviews, all of the participants were confident that this workshop format had a high possibility to bridge the knowledge from ICH and Western science effectively. The majority of participants

suggested that some things play a key role in supporting and bridging those two disciplines together, such as the goals, the curiosity of participants, the diversity of expertise or experiences of participants, the aptitude of moderator, and the collaboration between participants and moderator. As articulated by one participant (S4) that:

"One of the vital elements that successfully helped in combining the two knowledges together was the curiosity of the participants. The sense of wonder allowed us to be open minded and listen to other people. It helped me to get to know more about the story of cultural heritage and rice. In addition, I enjoyed listening and knowing that the context of culture is very impressive and interesting"

Another participant (C1) said in relation to the diversity of expert or experiences, that:

"I have learnt a lot from the discussion in the workshop, it is important that everyone can share their idea, knowledge and experiences. We are not only able to depend on our understanding by talking with experts, but also able to widen our perspective by discussing with people from various fields of expertise. This helps us understand the connection."

One of the participants (C2) said:

"It could be said that everything is related to each other and the knowledge about science and culture heritage is unexceptional. Apart from the selection of the workshop participants, the most significant component is the facilitator or moderator who can facilitate and master the situation during the workshop. The skilful moderator is able to support the participants from both sets of expertise in order to point out useful information, elaborate the connection between the two disciplines and lead to the conclusion findings from the workshop."

Another participant (S2) suggested that:

"Goals are very important. We can use anything to create a connection by using the same goal to be an indicator of the connection."

5. The benefits or potential impacts of this design workshop.

All of the participants agreed that the design workshop provided many beneficial outcomes not only for the science museum but also for other kinds of museum and other areas. Many of the participants suggested that the process of a design workshop could be adapted to use in many contexts for innovation derived from multi-disciplinary working. In terms of benefits, all participants agreed that this design workshop helped them to make and communicate the connection between ICH and Western science that allows ICH and Western science benefit each other.

One of the participants (S1) from science said that:

"This design workshop can help museums, particularly science museums. The combination of ICH and Western science makes science museums more accessible for the general public, particularly in rural areas. It helps us to present science in a new style, through cultural heritage. People will pay attention to the stories that are close to their daily lifestyle; for example, traditions, festivals, or traditional practices then inserted with science. In this way, science will strengthen culture and culture will make science more accessible to people.

Another participant (S3) suggested that:

"This activity helped us to create a logical story about everything around us. It can be applied to all matters, whether it is an exhibition, activity, or media, and it is not just only for the science museum but also for every area of practice."

One science museum professional (S5) recommended that:

"One of the benefits for the museum is that it helps museums to have new concepts to present. I have never seen an exhibition about the kind of things we did in the workshop. It will bring out a new trend. It allows the public to see the benefits and values that come from integrating stories that people think are completely different. There are benefits and values of the differences derived from the same human origin."

One of the ethnographic professionals (C1) stated that:

"It is very helpful for the new generation to learn and appreciate their cultural heritage, to know about their traditional knowledge. This can create positive attitudes toward both Thai cultures in the past that is not just storytelling from their parents, and there are reasons to support it. And, yes, it also creates positive attitudes toward science at the same time."

Another ethnographic professional (C3) asserted that:

"Museums will get a new perspective to develop stories differently from before. It will make the museum more fun and interesting, especially with the new perspectives on the same story. Cultural issues will become more interesting and not boring for Thai people as before."

Another ethnographic professional (C2) recommend that:

"In the view of the museum professional, I believe it will bring the museum's collection, both archives and stories to life again and make them talk to both old and new generations. In the ageing society that will occur very soon in Thailand, it will make the public, including the new generation, see the elderly as not worthless. This is because the knowledge and experiences of the old generation will be studied and learned by the public. In the future, those senior citizens may become volunteers to provide information and explain their traditional knowledge and practices combined with knowledge that has been accepted internationally as science. It not only creates pride for the owner of the culture but also helps to safeguard that cultural heritage for the future. The new generation might be the people who can expand traditional knowledge and practices to use for solving problems that we are currently facing or may face in the future."

The participants provided useful and overall positive feedback on the workshop. They suggested that it was a process that provided the potential to connect modern science and traditional knowledge. They also pointed out that the ScienceICH workshop could support both science museums and other museums to create and innovate a different way to communicate stories in museums. It could help museums present science alongside local stories. This could lead to bridging the gap between science and the public effectively. The interviewees also indicated that the sharing and discussion process brought about by bringing together professionals from different disciplines was a very

powerful approach. It could be one of the powerful methods in formulating new projects in the museum, particularly in Thailand. The design workshop as a method for designing a prototype exhibition has great potential to be adapted to suit the museum's media development process for exhibitions and educational programs. However, it was suggested that the policy of each museum and the number of experts available has to be taken into account. All participants believed that this workshop created the possibility of linking scientific knowledge to ICH. All participants also suggested that some things play a key role in supporting and bridging those two disciplines together. They suggested that could be goals, the curiosity of the participants, the diversity of experts or experiences of participants, the aptitude of the moderator, and the collaboration between participants and moderator. Based on the interviews, all participants appreciated this design workshop and agreed that it helps and can potentially also be applied to work settings other than the science museum.

6.3 Conclusion

This chapter has presented the findings of the design workshop that developed from the conceptual framework. This shows how the conceptual framework derived from the theory can be utilised by museum professionals. The venue of the workshop was deliberately prepared. The background of the participants was considered in order to keep balancing from both scientific and cultural side. There were eight participants that divided into two groups. The whole workshop comprised of five activities that consumed three hours and twenty-five minutes long. It began with the introduction to the research objectives and the purpose of the workshop that spent 15 minutes. Follow by the first activity “The important things for Thai rice farming” that aimed to encourage the participants to think about the important things that support the success of rice farming (in general) and categorised the things that support the success of Thai rice farming. This activity was thirty-five minutes long. The second activity, lasting forty-five minutes, was “Science and cultural practices behind the success” which had the purpose of allowing the participants to identify knowledge about science and cultural practices existing in Thai rice farming. The third activity was “Finding the connections between the knowledge in cultural heritage and science”, which encouraged the participants to look for the relationship between the knowledge of science and the knowledge existing in cultural

heritage about rice farming. The fourth activity was "Developing the concept for telling the story about success factors in rice farming", that aimed to encourage participants to design a concept for telling the story related to the connection between the knowledge of science and the traditional knowledge about rice farming. The last activity was forty minutes long, and was "Design a prototype for science museum". The activity allowed the participants to design_a prototype to communicate the connection between cultural heritage and Western science about rice farming with the derived information from the workshop. At the last session, both groups presented the proposals of the designed exhibitions that proposed for science museum Thailand. One month after the workshop, all the participants were approached individually for the post-workshop interview in order to receive their feedback and recommendations regarding the process and the outcome of the workshop.

The workshop participants' exhibition proposals reflect the theoretical framework developed in chapters 2 to 5 of this thesis. They can, to some extent, be used to develop one way of presenting an interpretation of traditional rice farming practices from a scientific perspective in the science museum. They show how traditional ceremonies and other types of intangible cultural heritage can be analysed by looking into the sub-processes and activities of the traditional rice farming practice, followed by an analysis and interpretation of the social context in order to identify the links between Western scientific and traditional knowledge. Participants in this workshop started by looking at the overall picture of rice farming rather than any specific ceremony or traditional knowledge in rice farming, as anticipated by the theoretical framework. That is because the main theme was rice culture (i.e. the culture of rice farming) in Thailand, which comprises a number of cultural and agricultural processes and activities. Therefore, they tried to look at the overall picture and examined constituent processes within the social and environmental context before trying to explore the body of knowledge that intangible cultural heritage encompasses. This was done subsequently, while the local knowledge that underpins intangible cultural heritage was mapped onto Western scientific knowledge in order to establish the relationships which could reciprocally and reasonably explain each other. As seen from the groups' presentations in the last workshop activity, rice farming methods were analysed from process to context, ranging from environmental management to traditional beliefs.

Both groups considered the main and standard processes of rice farming, i.e. sowing, caring, harvesting, and storage. After that, they analysed the context and the particular elements of those processes thoroughly. For example, regarding sowing, they considered the selection of a suitable rice variety for each region, the selection of the land area to sow it in, the preparation of the area, and water preparation. From this step, they began to look further into each of these to identify beliefs, ceremonies and practices involved and dug deeper to find the reasons for and meanings of those beliefs and practices in order to define the key body of knowledge in the traditional practices. After the analysis, the two groups took the same approach to create links between the two types of knowledge: by comparing and using science to explain the traditional practices. It was interesting to note that some parts of the traditional practice could be easily related to Western science while others took more time to analyse.

The collaborative interpretation activities of the workshop were very effective in enabling participants to take into consideration both traditional and modern knowledge. Notably, the experts from the science museum were able to discuss traditional knowledge and, similarly, the culture experts were able to discuss modern rice farming science and technology. This shows that the participants were well aware of the knowledge from 'the other side', albeit not in-depth. As seen in the brainstorming activity, the participants brought up issues related to both types of knowledge. But in order to explain important or specific details, it still required an expert in the field to clarify and add the details, especially regarding the actual practice of rice farming. Many participants suggested that the local rice farming Sage be invited as an advisor and that the workshop take place in an actual rice field, in order to obtain more insights.

The workshop enabled the two groups to make connections between Western scientific knowledge and intangible cultural heritage and to interpret the meaning of traditional practices, ceremonies and beliefs using scientific explanations. Moreover, they explored techniques for developing these connections into science museum exhibitions. The participants in both groups were careful in their approach to elaborating these connections without confuting or discrediting the 'other side'. Both groups maintained a balance by creating a plot for their exhibition story that allowed both bodies of knowledge to shine equally. Their presentations were based on facts and narrated with deep respect for the sociocultural context. It is safe to say that the issues that these two groups presented

represented the worldviews of Thai farmers respectfully. For example, the *All Rice* exhibition presented the contradicting ideas of the grandfather and the grandson, contrasting traditional beliefs with the modern worldview. On the other hand, the *Telling a Story through Ghost Spirits* exhibition told a story of ghosts and spirits that resonates with Thai worldviews. Belief in ghosts has been deeply rooted in Thai culture for centuries. Basing the museum narrative on Thai farmers' worldviews can give a balanced juxtaposition of cultural views and beliefs with Western science. Science communicators are often required to present a balanced argument between two very different perspectives on the same issue, taking an approach that is fact-based, accurate and balanced. The post-workshop interview provided positive feedback and valuable recommendations to the research.

This research aimed to explore and understand the approach of science communication through Thai local context in a science museum. It also aimed to address the disconnection between the ICH that surrounds rice farming knowledge and practices in Thailand, and the communication of Western science about rice farming in Thailand's science museum. The design workshop, therefore, was created to be a research tool. This research applied a ScienceICH workshop to be a method for studying how professionals across disciplines work together to combine ICH and science. As this research focused on the process of combining and interpretating ICH with science, the workshop offers a space for the researcher to explore what happened during the workshop. In this research, both design workshop and interviews provide rich and thick data sufficient to answer the research question.

CHAPTER 7 CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

This study aimed to explore and understand the connections between the local knowledge that is woven into intangible cultural heritage and Western scientific knowledge. Moreover, it aimed to explore how science museum exhibits and programs can integrate traditional Thai knowledge and culture with Western science and also explore the potential impacts of combining the two forms of knowledge. The conceptual framework was developed in accordance with the literature research on the relationship between worldviews, traditional knowledge, ICH, and Western science. This conceptual framework was put into practice using a design workshop format. The resulting design workshop, ScienceICH, was a place for multi-disciplinary collaboration. The outcome from the workshop was a series of design representations developed by combining ICH and Western science in the form of an exhibition prototype. The participants were able to trace relationships between traditional knowledge, ICH and Western science and collectively produce these design representations during the workshop. The ScienceICH design workshop is proposed by this thesis as a fundamental part of the design process as the outcomes of this workshop, the design representations and ideas, are essential in informing subsequent stages of the design process. This chapter presents an examination of the design workshop as a potential platform for supporting cross-disciplinary collaboration and producing the design ideas that connect science and ICH. Moreover, the workshop also illustrates how museum professionals can connect the knowledge of ICH and Western science. This chapter is divided into two parts. The first part analyses and discusses the findings from the workshop presented in chapter 6. It discusses the appropriateness of the workshop format to implement the conceptual framework for museum professionals and also explores the process of combining knowledge from ICH and Western science for the purposes of science interpretation and communication in non-Western contexts. The second part presents the conclusions from the research and the contributions provided to museum professionals. This part also presents the limitations and benefits of this research and makes suggestions for further study. The results of this research can provide an alternative lens for museum professionals to apply when

designing their museum communications. Importantly, it is clearly seen that ICH has the potential to be developed into a tool for communicating science in Thai science museums.

7.2 Analysis and discussion of the findings from the workshop.

In chapter 6, the results indicated that the design workshop format has the potential on the one hand to support the investigation and combining the traditional knowledge that is woven into ICH with the Western science and on the other hand to facilitate the participants to produce a representation of design concepts for Thai science museum exhibitions. This section explores the role of the design workshop as an approach to putting a conceptual framework into practice and discusses the multi-disciplinary collaboration that is facilitated by the design workshop.

7.2.1 The role of a design workshop as an approach for putting a conceptual framework into practice.

This research aims to explore and understand the connection between intangible cultural heritage and modern scientific knowledge, and to investigate how science museum exhibits and programs integrate traditional Thai knowledge and culture with Western science. A workshop format was selected as a possible approach to putting the conceptual framework into practice. As shown by the successful result, the design workshop format has the potential for practical application by museum professionals, fulfilling the research aim. This design workshop provided opportunities for all participants to discuss the sessions' topic. A series of steps of thinking and re-thinking was created in line with previous researches that a workshop can be an appropriate format for achieving reliable results derived from a series of steps of thinking and design (Erlandson et al., 1993; Lain, 2017; Lee & Cassidy, 2007; Ørngreen & Levinsen, 2017; Pandey, 2014; Vavoula & Sharples, 2007). In this regard, the design workshop provides an appropriate context for working across disciplines.

The literature research, Chapters 2 to 4, showed the relationship among worldviews, intangible cultural heritage, traditional knowledge, and Western science. The literature review also found that Thai rice farming was an appropriate case study as there are many cultural events (Anuman Rajadhon, 1963; Department of Agriculture, 2002; Department of Foreign Trade, Ministry of Commerce, Thailand, 2016; Gomes, 2001; Gomes et al., 2001; Museum Siam, 2011; Rice Department, 2009; Satsanguan, 2002; Thai Rice Foundation under Royal Patronage, 2006a, 2006b; Yoo-In, 2011). In this regard, this research related the Thai rice farming as a case study topic that falls within the scope and definition of ICH (UNESCO 2003), although Thai rice cultures have not been officially registered as ICH. In addition, museums are appropriate institutions and have great potential to communicate the connections between cultural heritage and Western science to the public. The research shows that it is not just the mission of the museum to educate the public in many areas of knowledge, but museums are credible institutions comprised of experts, knowledge, artefacts, information, and connections (Boyle, 2009; ECSITE, 2008; Falk & Dierking, 2000, 2013; Falk & Storksdieck, 2005; Hein, 1999; Hooper-Greenhill & Moussouri, 2002; ICOM, n.d.; Kelly, 2007; UNESCO, 2004, 2017). These features make museums appropriate places to convey knowledge. The research has shown that museums can achieve this purpose through the ScienceICH design workshop. This study found that the design workshop is one of the appropriate approaches that can be developed and used for designing science communication.

In this study, the design workshop had three main parts which contain five activities, and each activity concluded with the participants' presentation of their outcomes. The first part, to identify the body of traditional knowledge in rice ICH, aimed to encourage participants from different disciplinary backgrounds to identify knowledge of ICH through the activity *"the important thing for Thai rice farming"*. The second part, exploring the connection between ICH and Western science related to rice farming, consisted of two activities: "*science and cultural practices behind the success"* and *"finding the connections between the knowledge in cultural heritage and modern science"*. This part was designed to stimulate all participants to explore the relationship between ICH and Western science related to rice farming. The aim of these two parts was to encourage participants to express ideas about ICH. These parts also encourage participants to share viewpoints and look for possibilities for making a connection

between the different types of knowledge. The activities were developed from the concept of the relationships among worldviews, traditional knowledge, ICH, and Western science about Thai rice farming. The understanding of those relationships allowed me to design the sessions in the workshop appropriately. However, the feedback from the participants suggests that sessions two and three could be combined so that the activities could be continued. This is because when they thought about the science and the cultural practices behind rice farming in activity two, they already had ideas for linking them together, as an example from one of the ethnographic professionals (C3) stated:

"After we finished the discussion of the second activity, we knew that science and ICH, traditional knowledge, and practices, are related at one point…".

They are aware that both sets of knowledge can be connected in some way. However, the participants could not specify physical things or other evidence that play a role in connecting the different types of knowledge.

The result from the workshop and the recommendations from the participants reflects that the design workshop format is appropriate as an approach to support museum professionals in making and interpreting the connections between traditional knowledge and practices and Western science. However, based on the interviews, there was a problem with the terminology of ICH and Western science. Some participants with a scientific background who were not familiar with the cultural background had to spend significant time to develop an understanding of the meaning of ICH while the participants with cultural backgrounds did not need much exposure to understand scientific terminology. This contrast implies that as a group, the participants were more familiar with science concepts and ideas than with aspects of ICH. Many scientific terms and concepts are used in schools and everyday life, e.g. gravity, pH, genetic engineering, and the principles of light; this common usage of such concepts made the participants a bit more familiar with science than with the meaning of ICH. This finding supports Mahamontri's (2014) observation that science and technology have become more influential in Thai society and affect the Thai worldview. The traditional worldview which relies on nature, traditional beliefs, practices, and religion is fading and being replaced by a modern Thai worldview which is influenced by the economic system, the political system, the expansion of formal education, and advances in science and technology (Hathayatham, 2005; Hongladarom, 2002, 2004; InfoQuest, 2020;

Mahamontri, 2014; Noonin & Phuangprayong, 2019; Pongsapich, 1998; Tinnaluck, 2005; Yuthawong, 2011, 2017). This means that it is not only science and technology that are taught in the classroom but also political issues, economic issues, and many modern practices so that Thai people are now more familiar with the modern world than with their traditional cultures.

The researcher prepared many examples related to the terms ICH and Western science to support the participants during the workshop. However, some of the participants with scientific backgrounds reported that it may have been more effective if they had been able to do fieldwork, travelling to see the actual practices, providing information before the workshop, and having access to the internet to retrieve more information. This feedback may be the result of insufficient information provided to participants before the workshop or that the participants did not have enough time to review the information provided to them. However, these suggestions need to be also considered in determining the time frame for the workshop as this design workshop was only half a day, leaving little time to participants for such preparatory work. The participants also reported that they would like to continue the next stage of the design process as they would like to progress their design idea as much as possible. In conclusion, this design workshop shows that it is possible for museum professionals to put a conceptual framework into practice using the ScienceICH workshop approach. Design workshops can be an alternative approach for museums to implement as tools in the process of exhibition design.

7.2.2 Multi-disciplinary collaboration: The bridge between ICH and Western science

The combination of knowledge across disciplines is necessary and fascinating, particularly in groups from different socio-cultural backgrounds (Akkerman & Bakker, 2011; Carr et al., 2012; Collins & Evans, 2007; Engeström, Engeström & Kärkkäinen, 1995; Star & Griesemer, 1989; Suchman, 1993; Tsui & Law, 2007; Vavoula & Mason, 2017; Venkat & Winter, 2015). It is worth trying to understand the boundary-crossing process that occurred at the ScienceICH workshop, as this concept provides an understanding of how people can go further to acknowledge, appreciate, and understand areas of knowledge other than their own comfort areas. This was manifested by how professionals with different backgrounds successfully combined their expertise and made connections between ICH and Western science in this design workshop.

The workshop allowed participants' different backgrounds to create the boundaries that affected their collaboration in the design process, as suggested by Vavoula and Mason (2017). This discussion emphasises boundary-crossing and its role in the success in combining ICH and Western science in the design workshop. The discussion also analyses the events of the workshop and how they facilitated the connection between ICH and Western science. The analysis considers the boundaries, the boundary objects, and the intermediary design 'deliverables' as the essential elements of the boundary-crossing process. The results of the analysis increase our understanding of how museum professionals from different domains can combine ICH and Western science successfully.

The boundaries

For the purpose of making a connection between ICH and Western science, the ScienceICH design workshop provides a place for developing design ideas. To serve the purpose of this research, the workshop required professionals with both ethnographic and science backgrounds and with museum experience. The collaboration among different socio-cultural backgrounds and different disciplines can make the design process discontinuous and fragmented (Akkerman and Bakker 2011), but this can also be fascinating. The ultimate goal of this design workshop was multi-disciplinary collaboration. The outcome was derived from a variety of ideas that needed orchestration

with competent vision and viewpoints. The participants' collaboration occurs within the context of each participant's prior experiences, which define the individual's boundaries. In the workshop, all of the participants were experts in their areas and were familiar with the exhibition design process. The participants with scientific backgrounds had experience in designing science communication tools for the museum but had little experience with the design of cultural and ethnographic exhibitions. In the same way, professionals with ethnographic backgrounds had experience in designing ethnographic exhibitions, but they were not involved in science exhibitions or science communication. The ethnographers had only had limited opportunities to use some science concepts as part of their exhibitions. It emerged from the workshop analysis that some participants had difficulties at the beginning in understanding ICH terminology. The science museum professionals needed more explanations about the scope of ICH in Thai rice farming. They were hesitant, sceptical, and not confident to present their opinions to the group during the first discussion about ICH. They asked many questions of the ethnographic museum professionals for a clearer understanding of the scope of ICH. Considering that scientific knowledge and method are the strengths of these participants, knowledge of culture and ICH are far from their comfort zones and the boundaries was noticeable. A design is a result of the social process (Cross and Cross, 1995) of working together. The best way to achieve the goal of design is to cross the boundaries and think together. Thailand has farmed rice for thousands of years and there are still many cultural events related to rice farming today. Rice farming has also had a close relationship with Thai worldviews for a long time. I had therefore anticipated that even the scientists among the participants would have felt more comfortable about discussing rice ICH than they actually were. It is interesting that these professionals hesitated in giving their opinions on ICH related to rice farming; could this have been because they are in fact further away from traditional Thai worldviews than I thought they would be?

It is possible that the scientist participants may have developed modern Thai worldviews similar to those observed by many researchers (Hathayatham, 2005; Hongladarom, 2002, 2004; Mahamontri, 2014; Noonin & Phuangprayong, 2019; Pongsapich, 1998; Tinnaluck, 2005; Yuthawong, 2011, 2017). As one example from the literature research of Mahamontri in 2014 points out that Thai worldviews have been changing from traditional worldviews to modern worldviews and the Thai people are moving from

nature- and religion-based worldviews to economic-, political-, and science and technology-based worldviews. This can make traditional cultural heritage alien to them. However, the cultural context has not been removed from participants' lives. The scientist participants tried to present ideas and examples related to ICH as they understood it to the group, indicating that some of the traditional rice culture stories persist in modern Thai culture.

During the design workshop, it was noticed that there was a boundary between the expertise of the two groups of participants. The boundary arises due to the difference in areas of expertise (Figure 7.1). Crossing the boundary results in the synthesis of a unique product derived from the combination of the different sets of knowledge.

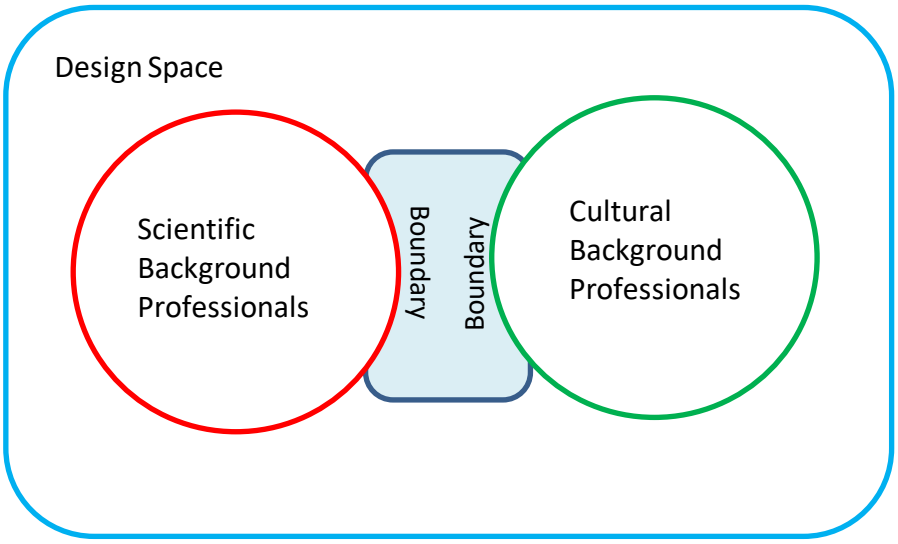

Figure 7.1 The boundary between the different the areas of expertise in ScienceICH design workshop.

The opportunity for creating consent across disciplines

The design workshop was a fundamental part of the design process, helping to generate important outcomes and design ideas that could be used in the rest of the design process (Akkerman & Bakker, 2011; Bertron, Schwarz & Frey, 2012; Carr et al., 2012; Collins & Evans, 2007; Engeström, Engeström & Kärkkäinen, 1995; Hughes, 2015; Lord &

Piacente, 2014; Star & Griesemer, 1989; Suchman, 1993; Tsui & Law, 2007; Vavoula & Sharples, 2007; Vavoula & Mason, 2017; Venkat & Winter, 2015; Whitworth & Ahmad, 2014). In this research, the design workshop was designed to contain three main parts. The first two parts were created for finding and understanding the connections between ICH and Western science and the last part was for interpreting this understanding to create a design for use in the Thai science museum. In the collaboration process through which the different experts worked together, many approaches were used during the workshop such as discussions, sharing viewpoints, raising examples, giving presentations, and negotiating. This cross-disciplinary collaboration revealed a boundary resulting from the different contexts of the participants' specialities. This boundary played an important role in formulating, generating, and creating the outcome of the design workshop. The boundary is one of the most important elements for the integration of traditional knowledge and Western science in this study. Boundary objects as discussed in chapter 5 were created throughout the workshop and were developed as intermediary design objects that encapsulated negotiated and agreed meanings and understandings from both sides.

The first part of the design workshop was an important time for participants to notice and acknowledge the boundaries and to find an appropriate path to cross them. The quest for this part was challenging for all participants. Everyone began with their own idea about how to achieve this. Akkerman and Bakker (2011) suggest that there are four mechanisms that constitute the learning potential of boundary-crossing: identification, coordination, reflection, and transformation. The participants in this workshop were defining something that they were not familiar with by trying to offer ideas and examples to the working group. The explanations of the objects that participants were asked to bring to the workshop were used as the media through which to express their viewpoints. For example, a small bag of fertiliser brought by one of the scientists; she explained that it is one of the necessary elements for modern rice farming as it contains nutrients for the growing rice. She also suggested that fertiliser is one of the most crucial factors for success in rice farming. One ethnographer presented a bag made of animal feed sacs. She told of her recollection of farmers at a small village near the Thai border, for whom optimism and a positive mentality are their most crucial defences in the modern age, as they need to persevere and overcome obstacles arising from changes in modern agriculture. These two objects were presented by participants from two different domains. They pointed out two different viewpoints driven by priorities dictated by their domains:

the scientist paid attention to necessary nutrients for rice growth while the ethnographer focused on moral support for farmers. While each may have meant that the object they brought would act as a boundary object, in practice these objects contained meanings, visions and explanations that were clear to them but not necessarily to others in the group. But as the session went on, the objects acted as props for them to communicate their personal understandings to the group and to open a dialogue with others to negotiate their viewpoints. By the end of the session, the objects had acquired new meanings owing to this negotiation and could now act as true boundary objects.

Figure 7.2 An example of a boundary object at the first session.

Other props cum boundary objects that participants brought included a booklet about an exhibition on rice culture, a leaflet from the Royal ploughing ceremony, an international documentary book related to rice farming in Thailand, and banknotes and coins. Thai rice farming stories were told through these objects, along with the impression and viewpoints of the participants as related to their specialities.

During the workshop, many boundary objects were also created. Interestingly, participants were creating more objects through collaboration. They wrote down their ideas and presented their examples to the group. The boundary objects in this view were more than physical objects and included words, examples, visions, and viewpoints

presented in different forms such as on scrap paper, with pictures on a smartphone, drawings on paper, and spoken words. These objects presented phenomena such as the ritual of the Royal ploughing ceremony with personal explanations from the viewpoint of participants' areas of expertise. Interestingly, there was more than one object shown by one person for the same event. It seemed that the participants were trying to identify meanings by testing each other's interpretations of the objects, indicating that they were using objects to communicate their worldviews. To extend, when participants were asked to think about the factors that may contribute to success in Thai rice farming, they offered many ideas through post-it notes related to their areas of expertise and familiarity (Figure 7.3). There were many ideas on the wall at the end of the session. A discussion emerged when they felt confused by the objects as many of them were not familiar to some participants and seemed unrelated to the purposes of the session.

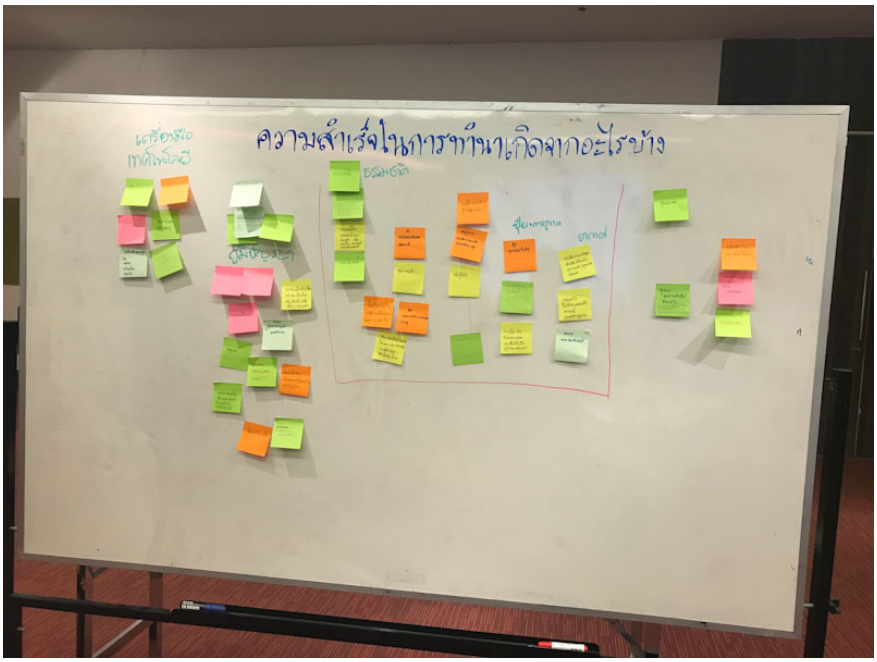

Figure 7.3 Many objects presented by the participants in one event.

The solution to this situation is fascinating. The participants tried to examine every object to look for objects that shared a common meaning for all participants: they were actively looking for boundary objects. It looked like a task to "fill in the blank with a suitable word". This coordination mechanism (Akkerman and Bakker 2011) involved all participants collaborating through efforts to translate and interpret together. In this

exercise, the participants produced words and conferred to find a suitable word (Figure 7.4). For example, they agreed that the objects offered represented the necessary resources for rice farming: knowledge, experience, expertise, farming skills, knowledge and understanding of nature, knowledge transfer, preference and proficiency of farmers in different localities, and ways of raising morale. The participants agreed that these requirements could be narrowed down to the word "wisdom". From their viewpoints, wisdom provided an understanding for both sides about the knowledge in both traditional and Western knowledge that is necessary for rice farming in Thailand. Wisdom became a new perspective for the diverse participants that enabled them to get a common understanding using the reflection mechanism proposed by Akkerman and Bakker (2011).

Figure 7.4 The participants were finding a suitable word for a representation

Another example that was also fascinating was when the participants could not agree on what object or word should be used as a collective term for labour-saving devices, e.g. rotary tillers, rice harvesting machines, yield-enhancing technology used in rice farming, and modern digital equipment. In this case, they developed a new common phrase that provided the meaning and understanding and covered all objects: "equipment and technology". Both "wisdom" and "equipment and technology" are examples of using the

objects to produce (lexical) intermediary objects that encapsulate shared understandings. This resulted from negotiation, and reaching the understanding led to agreement on the meaning. The intermediary object held a common meaning for participants from both specialisms and they used it to continue the design process.

The boundary objects that represented personal expertise created credibility as intermediaries and were used to mediate the same topic for all participants. Therefore, the intermediary can bring all participants to shared knowledge and experiences and drive the collaboration process. This situation supports Vavoula and Mason (2017), who suggested the importance of the role of intermediary objects. At this point, the boundary crossing was noticeable. The results from all parts of the workshop and the design representation at the end of this workshop show clear empirical evidence of boundary-crossing and made a significant impact not only on this research but also for the participants. It can be claimed that the transformation mechanism that is one of the mechanisms that constitute the learning potential of boundary-crossing proposed by Akkerman and Bakker (2011) had been emerging as found in the result of the working across disciplines which was the effect of the interventions that lead to changes in practices that can create new things from the combining of the practices.

The discussion above shows that all of the participants brought objects to the group during the collaboration and learned from and with each other. This shows that the ideas and viewpoints related to both scientific and cultural backgrounds were blended. The participants used an intermediary for finding solutions, leading to consent. Therefore, the intermediary in this workshop can refer to a range of words or objects that share similar meanings and understandings. Moreover, the workshop indicated that participants would work together to reach consent about these objects. These objects determine the area in which both sides feel comfortable with the concurrence of viewpoints. I call this area '*a consent zone'*; the area that contains resources for both sides to use and reach consent without difficulty. Science communication production must consider the level of communication as there are many contexts and educational backgrounds in the same society (Bultitude, 2011; Burns, O'Connor & Stocklmayer, 2003; Falk & Dierking, 2000, 2013; Fenichel & Schweingruber, 2010; Godec, S., King, H. & Archer, L., 2017;

Hathayatham, 2005; Hilgartner, 1990; Rennie, 2013; Stocklmayer, Gore & Bryant, 2012; Suriyakul Na Ayudhya, 2017). The spectrum of the contexts of the audience's model from Hilgartner (1990) provides an idea of the degree of communication ranging from upstream for specialised audiences such as specialists, researchers, and lecturers in science disciplines to downstream for students and non-technical audiences. The context of the audience and the degree of communication are powerful factors that have to be considered when designing science communication to suit a target audience. This design workshop created a place for participants with scientific backgrounds, science specialists, participants with cultural backgrounds, non-science specialists, and professionals to work together. In this workshop, the various participants had to find a method of communication that could smoothly facilitate the collaboration across disciplines and would lead to a successful outcome. The offering of boundary objects to the group worked like tuning radio frequencies searching a music style that all participants would enjoy listening to. The ending point was a common language, contained in the package for both sides. Participants then used objects from the package for seamless collaboration. The intermediary objects in the workshop can represent the appropriate degree of communication that can promote common understanding. The participants felt comfortable in collaborating with this level of language and moved together to a consent zone. Figure 7.5 shows what happened during the design workshop.

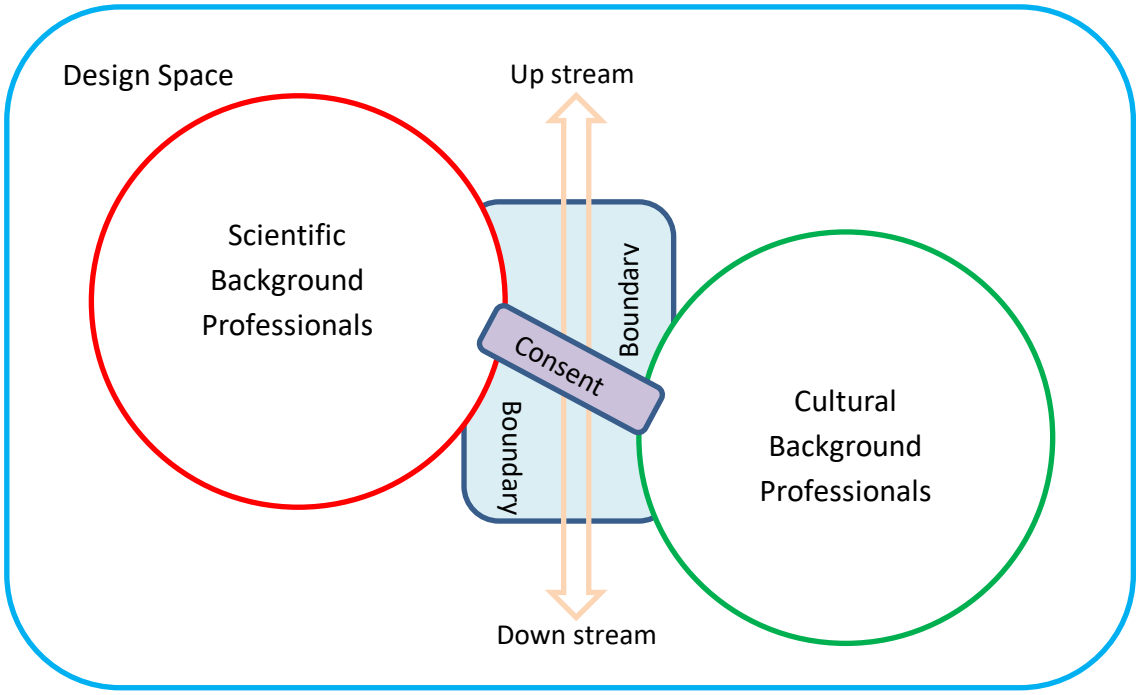

Figure 7.5 Schema of the design workshop for boundary-crossing.

The design workshop created for this study is a part of the design process, and it provides the design space. When the sessions of the design workshop began, professionals with both scientific and cultural backgrounds were in their separate spaces. When one of them presented an object to the group, the boundary was noticed. Presentation led to discussion, and negotiation, and agreements – and transformed the ordinary objects into boundary objects. These boundary objects were further manipulated by participants through further discussion, negotiation and agreement, giving rise to intermediary (lexical) objects that facilitated the rest of the workshop. Consents were produced in the consent zone, a bridge that allowed both sides to move across the boundary and then back to their zone easily. The consent zone requires an appropriate level of communication that allows participants with different specialisms to work across the disciplines successfully.

The critical role of the intermediary object goes beyond agreeing common meanings and understandings (Akkerman & Bakker, 2011; Vavoula & Mason, 2017). The intermediary object has the potential to lead to a connection between Western science and ICH. Although not all of the participants could clearly identify a physical thing or things that

link Western science and ICH, they were aware that ICH and Western science are related. Participants gave the following responses to the question "What do you think is the link between them?"

"It could be said that everything is related to everything else and the knowledge about science and cultural heritage is unexceptional….. there are stories related to both science and culture everywhere"

"When we looked into the reasons, I understood that they are linked to science, but I may not be able to explain how it is linked."

Some of this feedback is derived from interviews that took place after the design workshop. The responses imply that the participants understood that the connection is derived from the process of consent in the design workshop rather than by the products or the information brought to the workshop. To extend, they did not mention the results or any examples from the workshop as the critical thing linking ICH and Western science, but they remarked that they were aware of the relationship between the two after the workshop. The discussion above and the feedback indicate that boundary objects and intermediary objects play an important role in collaboration to provide the opportunity to use the processes of consent. These lead to the conclusion that design workshops have the potential to provide awareness of the connection between ICH and Western science.

A different lens for viewing ICH

The design workshop supported a new way to view ICH. The ScienceICH format allowed participants to share and develop the relationship between ICH and Western science to establish a new way to interpret ICH with science. In addition, workshops can provide a new lens through which to look at ICH. During the design workshop, this research captured some ways in which participants made connections between ICH and Western science that have the potential to support a new way to view ICH through science.

Compare

It was found that almost every participant compared knowledge with practice in various stages of Thai rice farming. They divided rice farming into stages and discussed the practices within each stage. The modern and traditional practices were compared and cultural events were presented and matched with each stage. For example, in the stage of preparation, they discussed the Royal ploughing ceremony, comparing the traditional styles with the modern style of ploughing the rice field. Participants identified the similarities and the differences in terms of purpose, process, and equipment and then further discussed the reasons why the traditional styles were so special. The analysis from the discussions in both groups found that there are three concepts that are useful for making comparisons: people, places, and time.

These concepts are related to the ideas, examples, and visions expressed by participants about the connection between ICH and Western science. The concept of people as an important factor was derived from a discussion about people in different communities. There were discussions, explanations, and examples showing that people in different communities are the owners of the local knowledge, and this is different for each community. As local knowledge is intimately related to worldview, the discussions, explanations, and examples of the participants correspond with Horner and Vandersluis (1981) and Ibrahim (1991) who suggest that each community has its own identity that emphasises the differences between communities. This can imply that the identity of each community, including local knowledge and cultural events, is different and depends on the community's members. People in the community create knowledge and pass this on to future generations. Some participants mentioned that people in each community reacted differently to the world and created knowledge and practices with their own style. Participants compared the traditional practices of rice farming across the regions of Thailand. All participants agreed that there were different practices resulting from different cultures and local beliefs. This indicates that workshop participants thought that people created the knowledge and practices to suit their cultural context.

The concept of place derived from the participants usually mentioned limitations related to the geography and the environment of the community and they considered that both

geography and the surrounding environment of the community significantly influenced the creativity of people in each community. There were suggested that worldview has a significant impact on peoples' thinking and the design of their strategies for living and is related to the surrounding environment (Aikenhead, 1996; Cobern, 1991, 2000, 2005; Costa, 1995; Du Toit, 2007; George & Glasgow, 1999; Hart, 2010; Ibrahim, 1991; Irzik & Nola, 2009; Kearney, 1975, 1984; Koltko-Rivera, 2004; Phelan, Davidson & Cao, 1991). The consent of the participants agreed with this argument. The different locations of communities can create different practices and knowledge. One of the examples from the workshop is that one participant from an ethnographic background pointed out the different styles of land preparation for rice farming between the highland and the lowland. The science museum specialists agreed and provided the explanation that it was a limitation related to the slope of the areas that influenced the highlanders to create rice terraces instead of the adopting the typical shape of rice fields. The geography and environment of communities was a major topic of discussion in both groups throughout the design workshop.

The comparison of the concept of time between traditional and modern cultures was also discussed during the workshop. Whenever the participants discussed traditional practices, some participants mentioned the new style and examined the differences between the two, modern and old. Many of the discussions concluded that "it is because of the time change, everything is changed, so they are not different, just changing with time". The traditional knowledge and practices may be replaced by new knowledge and practices that are discovered. Moreover, some of the participants mentioned that "when the changes arrived, people needed to adapt their daily lives; which is why different styles of farming have emerged". One of the participants suggested that "much of the modern knowledge and practices are influenced by traditional knowledge and practices such as the winnowing machine".

Discuss and simplify together

Another noticeable theme from the design workshop is '*discuss and simplify together*'. The discussion was ongoing throughout the workshop with personal language. A difference in specialism sometimes makes it difficult to find a solution together. This study found that when there was a problem with things such as terminologies, jargon,

definitions, and specific context, a simple explanation would be given by the relevant expertise to support the group conversation. This is an essential characteristic of competent participants. One example is the confusion and the difficulty some participants had in identifying the tacit versus the explicit knowledge of Thai rice farming. The scientific background team had difficulty distinguishing the tacit and explicit knowledge until the ethnographers explained and gave some examples of the knowledge transfer. Thus, examples and explanations were useful techniques for this workshop.

Goals and objectives

This research also found that the participants often referred to '*goals and objectives'*. The goal was not only related to rice farming but also aimed to develop comparisons of the processes and objectives of the cultural events. This indicates that the common goal and objective allowed these different professionals to discuss common topics.

In conclusion, this research found some techniques that the participants used to examine ICH using Western science and also to look at science from the viewpoint of ICH. This amounts to a comparison using the context of people, place and time, leading to discussion and simplification, explaining with examples, and focusing on the goals and objectives of comparing knowledge, practices, and cultural events. These various ways to look at ICH and Western science are useful not only for museum professionals who can adopt these techniques for museum communication but also for all people to appreciate the benefits of cultural heritage.

The design idea created for the Thai science museum

The purpose of the workshop was to encourage the participants to work together to design a prototype exhibition that communicates the relationship between cultural heritage and Western science in the Thai science museum. The last part of the ScienceICH workshop '*design a prototype for a science museum'* aimed to encourage the participants to work together to do this. The result shows that through a series of activities in the workshop, participants were able to develop a representation of their design concept. This part of the discussion explores the development of this design representation or prototype by analysing what and how the participants contributed to the design.

After the connection between ICH and Western science was acknowledged by the participants at the end of part two of the workshop, activity four in part three allowed them to design a communication style for connecting ICH and Western science. During the session, participants provided the boundary objects and created intermediary objects. The intermediary objects played an important role leading to consent in a similar way to the previous three activities of parts one and two. Interestingly, participants offered many methods to support the processes of consent in this session. They suggested communication styles to the group for consideration together. Through this activity, they were producing boundary objects for museum communication. The participants created ten stories as their communication styles for explaining the connections between science and ICH. Interestingly, the participants agreed that storytelling is one of the powerful and robust techniques to communicate these connections to the public. There was a suggestion from the interviews that *"many of the social contexts can be used to create the story, and it will reduce the alienation between the public and science"*. This corresponds with Rennie (2013), who suggests that in terms of communicating science to the public in museums, storytelling is an effective communication tool. Storytelling has the potential to motivate audiences to engage with science at the exhibition (Rennie, 2013). Participants in this workshop considered the balance of the content because of a series of discussions among the representatives of both subject areas. They were careful not to glorify one side more than the other. The participants created stories for presenting rather than only explaining the knowledge and practices of both modern and traditional style of rice farming. At the end of activity four, there were two stories told by two groups. Each story attempted to communicate the value of both traditional knowledge and Western science. Not all of the story details had been figured out, but all of the participants suggested that these would be considered in another stage of design. The outcome of this design workshop was a design concept for museum communication. Considering the balance of the two kinds of knowledge, scientific and traditional, is essential. As a science communication tool, the presentation should be balanced and provide an opportunity for the audience to appraise the information (Bultitude, 2011; Burns, O'Connor & Stocklmayer, 2003; Hilgartner, 1990; Rennie, 2013; Stocklmayer, Gore & Bryant, 2012). The presentation should not contend that one side is better than the other. Keeping a balance can avoid conflict and impact on the confidence of audiences in their daily lives.

In activity five, participants were asked to develop their stories for any type of programme at the science museum, including exhibitions but also, for example, educational or outreach programmes, a science show, or a documentary. Both groups decided to develop exhibition prototypes. It is possible that the form of the exhibition was more familiar to them, as they all had prior experience with exhibition design and development. Interestingly, the design prototypes were not the final form of the design process.

In reality, prototypes such as these produced at the workshop are 'throwaway' (Davis, 1992; Davis & Bersoff, 1991) in the sense that they are not the final product and often are replaced with subsequent versions that either correct design errors or advance the design concept further. In this sense, even the choice of an exhibition over other types of programme is one that can change and be 'thrown away'. The final decision depends on the conditions and limitations of the design process for application in the real world. However, the most important thing is the design idea. Even if the prototype is eventually discarded, the design idea may still survive and make it into the final product. During prototype designing, participants were concerned about target audiences, balance, accuracy, time spent in development, budget, collaboration, and the artefacts to be displayed. Moreover, they expected that the exhibition should provoke a sense of respect, pride, harmony, and fun. The effectiveness of the multi-disciplinary collaboration in this workshop is demonstrated by the solutions the participants came up with. The ScienceICH workshop was indeed an appropriate method for seeking solutions to expressing complex ideas and demonstrated the competence of all the professionals involved (Akkerman & Bakker, 2011; Carr et al., 2012; Collins & Evans, 2007; Engeström, Engeström & Kärkkäinen, 1995; Isaksen, Dorval & Treffinger, 1994; Star & Griesemer, 1989; Suchman, 1993; Tsui & Law, 2007; Vavoula & Mason, 2017; Venkat & Winter, 2015). They crossed their disciplinary and institutional boundaries by appreciating and understanding each other's areas of expertise, supported by the boundary objects, the intermediary objects, and the processes of consent. The results of all the workshop sessions show that ScienceICH provided an opportunity to bring together professionals with different backgrounds to find a way to make a connection between ICH and Western science and to develop a design idea for science museum communication successfully.

The basic principle of creating the design idea derived from this study.

The findings and the discussion allow us to accept that boundary crossing played a key role in understanding the connection between ICH and Western science. Therefore, combining the two different areas of knowledge should begin with a conceptual framework for the design workshop and preparation of the boundary by bringing competent professionals from both areas of expertise to the design space. It is important to consider the boundary-crossing and to prepare the appropriate design workshop and the relevant boundary. The workshop should provide an environment that facilitates the opportunity to produce intermediary objects and the processes of consent. The boundary can be prepared by using cross-disciplinary collaboration. Competent professionals should participate. Vavoula and Mason (2017) suggest that the success of the design depends on participants who have individual competencies. One reason for the success of the design workshop in this research was the competencies of the participants. Scientists and ethnographers met at the boundary and this stimulated new ideas and encouraged their creation and sharing through boundary objects.

7.3 Conclusion

This research highlighted the approach of combining ICH in the form of traditional knowledge and practices with Western science to develop design ideas for a science museum. Below I review how the results and discussion from the study address the research questions.

1. **What theoretical framework should underpin the design of exhibitions that integrate local Intangible Cultural Heritage within modern science museums in non-Western contexts?**

The literature review provided a background for answering this research question. The review provided an understanding of the relationship between ICH and science. In this research, worldview was defined as a perspective and comprehension of the world, nature, and the universe that influences how people live within their perceived world. Worldviews are one of the crucial foundations for developing knowledge about the world. This knowledge is transmitted to future generations through various means. This worldview forms a culture that has been carefully developed and maintains people's identity, values, and knowledge. Much of this knowledge is conveyed in the form of

prayers, drawings, oral traditions, performing arts, rituals, traditions, practices, costumes etc. These things reflect the people's efforts to live with nature and the world around them harmoniously. The ways in which they embed their essential knowledge in various forms of culture is the art of transferring knowledge to their descendants, an essential act of pedagogy. The limitations in creating the forms or patterns of knowledge transfer depend on social and environmental contexts. The literature review allowed us to understand how traditional beliefs, practices, and knowledge are woven into our cultural heritage. The understanding that the knowledge which exists in the cultural heritage arises from context allows this study to portray the importance of culture as a collection of information, knowledge, know-how, and identity of each community. Moreover, the understanding that worldviews are related to the formation of culture helps this research to connect local knowledge to its related contexts and develop a relationship between ICH and Western science. The review also explored scientific worldviews and how Western science is communicated and how it influences people's worldviews. This part of the review points out the differences and the problems when the traditional and the modern worldviews come in contact. The differences in worldviews are related to the way people are shaped by and shape their worlds.

The review of Thai worldviews as a non-Western context provided important information about the Thai culture and how Thai people perceive the world. The study found that traditional Thai worldviews are related to nature, beliefs, and religions, especially Buddhism, Brahmanism, and Hinduism. This worldview has been a part of the Thai way of life for thousands of years. This worldview is mainly related to the concepts of reincarnation, karma, merit, and sin. It is found that Thai worldviews are gradually changing from the traditional worldviews which rely on nature and religions to modern worldviews that result from the development of economic, political, and educational systems and science and technology. These advances have greatly changed the traditional way of life, particularly in large urban cities.

The advances that have taken place in the world in the last five hundred years have significantly affected cultural heritage throughout the world. The review of the development of ICH has pointed out that the awareness of cultural conservation at the international level began to be widely discussed after World War II. It was important to establish the values and benefits of cultural conservation. The cultural conservation

movement allows us to see the efforts to clarify and define both tangible and intangible cultural heritage. This helps in understanding the meaning and scope of ICH. The efforts to raise awareness of cultural conservation were widespread and encouraged for every country by at least two major world organisations: ICOMOS and UNESCO. UNESCO played an important role in creating guidelines concerning ICH. The Convention for Safeguarding of the Intangible Cultural Heritage announced by UNESCO in 2003 produced the guidelines by which countries and communities look at their daily lifestyles and begin to identify and conserve their ICHs in appropriate ways. Considering the culture according to the scope and meaning of ICH given in the UNESCO guidelines helps us to see the large picture of the local culture in the community. This view allows us to classify the traditional cultural events and the scope and meaning of ICH and helps this research find an appropriate representative ICH in the Thai context for considering the knowledge and practices of ICH. Rice farming in Thailand was thus identified as an appropriate case study as it is a significant resource for Thai culture and there are many cultural events related to Thai rice farming that have been a part of Thai society for centuries. Thai rice farming was examined from the viewpoints of ICH and Western science. The review on the development of Thai rice farming allowed this study to distinguish between traditional and modern practices related to ICH and the imported Western science. The literature provided information with which to investigate the relationships among worldviews, cultural knowledge, intangible cultural heritage, Western modern science, and Thai rice farming.

ICH and Western science can be integrated and communicated to the public for educational purposes. The review showed that museums, particularly science museums, have the potential to combine these two areas of knowledge and communicate to the public effectively with the use of artefacts, information, and specialists. The level of communication, upstream and downstream, and the concept of communicating science appropriately to the public were a concern. Any design of communication on the connection between the different worldviews must be sensitive to the society's needs and find a balance in the information included and the style of presentation. There are many forms of science communication that have the potential to convey this message and can be used in science museums such as exhibitions, educational programs, science shows, science camps, science documentaries, books, and media. However, the form needs to

ensure a balance and an appropriate style that will suit the target group. The literature research provided information with which to formulate a conceptual framework of the relationship between ICH and Western science that can underpin the design of exhibitions that integrate local Intangible Cultural Heritage with Western science in museums in non-Western contexts.

2. **How can science museum exhibits and programmes integrate traditional Thai knowledge with Western science to enhance science communication in Thailand?**

To answer this question, the research has transformed the conceptual framework into a course of action for Thai science museums. The ScienceICH design workshop format was developed as it was considered an effective format for finding a solution through multi-disciplinary collaboration. The workshop was designed to consist of three parts. The first part aims to identify the body of knowledge in ICH and consists of one activity: ***the important thing for Thai rice farming***. The second part is designed for exploring the connections between ICH and Western science as they relate to rice farming. This part contains two activities: activity two is ***science and cultural practices behind the success*** and activity three is ***finding the connections between the knowledge in cultural heritage and Western science***. The third part aims to encourage museum professionals to produce a design representation for a science museum with two activities: activity four is ***communicate the connection*** and activity five is ***design a prototype for a science museum***. There were two prototypes for science exhibitions developed from the design workshop. The result of the design workshop indicates that museum professionals can combine the knowledge in ICH with Western science and can design an example of science museum communication in the form of an exhibition. The discussion in this study also suggests that the competence of participants, a multi-disciplinary group, boundary-crossing, and consent zone play important roles in combining ICH with Western science. It is found that boundary-crossing in the multi-disciplinary workshop is essential for creating the connectivity between science and culture. The result of the boundary-crossing in the design workshop and the use of boundary objects can lead to consent. The process of consent is essential for establishing an understanding of the connection between ICH and Western science. The prototypes of the science exhibition as the output of the design workshop represent the design ideas of the producers. Those design ideas resulted from boundary-crossing and represented the conceptualisation process of

working across disciplines. The success of the design workshop is a crucial confirmation showing the ability of this strategy to support the science museum in integrating traditional Thai knowledge with Western science to enhance science communication in Thailand.

3. What are the perceived potential impacts of combining traditional knowledge with modern science in Thai science museums?

One of the important impacts of this research is that science museums and museum professionals can use ICH and Western science to support museum communication. The science museum can use ICH to communicate science within the cultural context and might reduce the alienation between local people and science content. Other museums can use science as a different lens through which to present innovative views of other types of museum communication. The connection between ICH and Western science can be an alternative idea for museum professionals to use in their spaces and can be used with many forms of communication.

This study also provided a new approach to designing science communication in science museums through the value of ICH. In addition, this new approach can be used in the other direction; to design communication of ICH through science. With the perception that ICH is an important resource of traditional knowledge that has a relationship to Western science, each can be used to interpret the other with the development of new museum communication. Both science and non-science museums have the potential to connect and present this relationship effectively.

Moreover, this study is an integration of the knowledge of both science and culture. Science is a representation of rationality and systematicity, and culture is a representation of beliefs, traditions, and practices related to faith and ways of life. Museums can be a potential place for the integration of the two. Specialists from both sides work across disciplines and agree on the appropriate topic, concept, design, level of language, and detail of the content. This integration is considered a fascinating approach to science communication and to museums in Thailand. The integration helps emphasise the

important values of people's lives that rely on information, reasoning, the stability of mind, encouragement, and inspiration. This approach can promote a knowledge-based society that respects cultural values, leading to sustainable social development appropriate for the Thai context.

7.3.1 Implications and benefits of the research

This study was conducted in the National Science Museum in Thailand. However, the results of this research are applicable to developing new exhibitions and educational programs for other kinds of museums, such as historical and cultural museums that aim to connect different areas of knowledge or topics.

The implications of crossing the boundary between Western science and ICH in museums not only illuminates the value of science in culture and the value of culture in science but also presents one of the appropriate ways to safeguard cultural heritage. These efforts could help minimise the gaps between Western science and local culture and between the former and new generations, which are critical for sustainable development in the future. For example, bridging the generation gap provides positive and valuable social engagement in the ageing society by encouraging elderly people to interact with the public by telling stories about the traditional practices that were important parts of the daily life in the past. Moreover, exhibitions or educational programs in museums that represent the traditional knowledge in local communities could generate a sense of pride and acknowledgement of the local wisdom of the cultural heritage both locally and internationally. Additionally, a workshop design with multi-disciplinary experts can provide an alternative approach for museum professionals to develop new and innovative exhibitions and programs. For example, the science museum might apply this concept of working and brainstorming of the exhibition contents and museum media such as a documentary film or special talk and series of events in the topic area of science that related to local wisdom such as a traditional house, the local fishing equipment and instruments, traditional knowledge about local medicine or homoeopathy, food preservation and production in the countryside, etc.

These exhibitions and programs are also a resource for future innovators as the exhibitions or programs about traditional knowledge and local wisdom can play an important role in inspiring and supporting the public and scientists to learn about local culture and may lead to further innovation.

7.3.2 Limitations of the study and recommendations for further work,

There are two major limitations that emerged from this study which are 1) the time frame for arranging the participants and the workshop and 2) the dynamic of the designed workshop.

To begin with the arrangement of the workshop, it is important to identify proficient experts to join in the workshop as competent participants. In this study, there were eight participants with expertise in either ethnography or science. The researcher had begun to contact them and arranged a time for introducing information about the research project before the workshop took place. It was difficult to find a time in which all participants were available. Hence, there were two potential participants who were not able to attend the workshop, and other potential participants were contacted. It was challenging to set a workshop date that fit every participant's calendar due to their full-time jobs. After identifying the participants, it took almost three months to find a mutually agreeable schedule. To apply this methodology for further research, it is recommended that researchers should secure the time and participants in advance and contact them very early to allow additional time to arrange the schedule for the workshop.

Another limitation of this research is the dynamic of the designed workshop process. In this study, the design workshop is the main activity in which all participants are liberally allowed to share, discuss and exchange their ideas and information. The group was very diverse, which comprising a wide range of people with museum expertise both in science and cultural heritage, such as people from creative industries (exhibition designer or developer), academia (researcher and scholar). In order to observe and facilitate correspondents from different backgrounds and with different perspectives on the topic, it is important for the researcher to be open-minded and be able to deal with potentially unexpected outcomes. The moderator should be well prepared not only to handle and manage all activities, but also be capable in dealing with balancing all answers to find a solution that connects the ideas of all the participants. In this study, the researcher

beneficially applied his science communication skills in communicating and moderating the workshop successfully. This maintained the dynamic of the design workshop, which was thus boosted both by the diversity of participants and the proficiency of the moderator in managing the workshop. In this regard, there is room for further research to explore the role and responsibility of the researcher/moderator in the delivery of a dynamic design workshop. Further research is also needed to follow up on the design process. The design representation or prototype of an exhibition or program from the workshop should be continued through the next stage of the design process to get a final form of the design. The question of whether this kind of design product, a result of combining ICH with Western science, has the ability to enhance visitors' learning of science and culture. Future studies should evaluate what and how visitors learn from the final form of the design representation. Such research could establish a better understanding of the impact of developing exhibitions or programs that use the results of this study. The National Science Museum were enthused by the outcomes of this workshop and will likely implement some of the ideas that came out of ScienceICH in the future; it will be interesting (and rewarding for me) to see an actual science communication product emerge based on this framework.

One recommendation mentioned in the workshop was the use of a real farmer in the group of participants. This could be done by implementing the citizen curator concept (Proctor, 2010; Rebecca, 2014) to support the prototype design or the design representation. There are four major benefits to including a farmer as one of the participants. Firstly, the discussion and brainstorming in the workshop could represent the stories, situations, and specific needs of the owners of the culture itself. Secondly, as a skillful practitioner and the owner of the cultural content, the farmer as a participant could succeed in conveying the information, techniques, experiences, and knowledge about rice farming for the discussion during the workshop, reflecting the real world of the farmer's community. Thirdly, as the powerful stakeholder in the process of developing exhibitions or educational programs of the museum, the real farmer and people in the local community would be strong supporters of the museum's content and could act as artefact providers. Local people could also provide support and services when the related exhibition is set up in the local community. Lastly, the overall advantages of including a farmer or local philosopher in the workshop process are not only to generate a sense of belonging and to

encourage people in the community to support and sustain the museum but also to promote sustainable cultural conservations.

Similar to storytelling in the museums, cultural or traditional stories have the potential to continuously inspire people in different cultures across the world; such stories can help generate further authentic art, songs, and rituals and enrich many activities in real life. I strongly believe that the synergies between science and culture can drive fruitful innovation in science as well.

Appendices

Appendix 1 Ethics Review Document

14/05/2018

Ethics Reference: 16055-csna1-ss:museumstudies,schoolof

TO:

Name of Researcher Applicant: Chanin Suriyakul Na Ayudhya

Department: Museum Studies

Research Project Title: Science Museum Interpretation through Thai Intangible Cultural Heritage

Dear Chanin Suriyakul Na Ayudhya,

RE: Ethics review of Research Study application

The University Ethics Sub-Committee for Science and Engineering and Arts Humanities has reviewed and discussed the above application.

1. Ethical opinion

The Sub-Committee grants ethical approval to the above research project on the basis described in the application form and supporting documentation, subject to the conditions specified below.

2. Summary of ethics review discussion

The Committee noted the following issues:

The amendment only relates to the of the research and I am happy to approve this change. Best wishes, Martin

3. General conditions of the ethical approval

The ethics approval is subject to the following general conditions being met prior to the start of the project:

As the Principal Investigator, you are expected to deliver the research project in accordance with the University's policies and procedures, which includes the University's Research Code of Conduct and the University's Research Ethics Policy.

If relevant, management permission or approval (gate keeper role) must be obtained from host organisation prior to the start of the study at the site concerned.

4. Reporting requirements after ethical approval

You are expected to notify the Sub-Committee about:

- Significant amendments to the project
- Serious breaches of the protocol
- Annual progress reports
- Notifying the end of the study

5. Use of application information

Details from your ethics application will be stored on the University Ethics Online System. With your permission, the Sub-Committee may wish to use parts of the application in an anonymised format for training or sharing best practice. Please let me know if you do not want the application details to be used in this manner.

Best wishes for the success of this research project.

Yours sincerely,

Dr. Martin Phillips

Chair

Appendix 2 Information sheet for participants

Signature: _____

Model Information Sheet for Participants

Project Title: Science Museum Interpretation through Thai Intangible Cultural Heritage

Contact Address:

Mr.Chanin Suriyakul Na Ayudhya

26/345 Warangkul Village, Ladsawai

Lumlookka
Patumthani, 12150
Thailand
Phone number: 66863757990
Email: csna1@leicester.ac.uk

Date: 20-25 May 2018

I would like to tell you more about the nature of the project, who I am and why I am undertaking this research, and how you were selected for the project. I would also like to inform you about how your data will be used and the protections of your privacy and confidentiality that are in place.

Who is doing the research

My name is Mr.Chanin Suriyakul Na Ayudhya, a postgraduate student in the School of Museum Studies, University of Leicester, United Kingdom.

What is the research for

This research aims to explore and understand how Intangible Cultural Heritage can support science interpretation and communication at Thailand's National Science Museum. In particular, the project addresses the disconnection between the Intangible Cultural Heritage (ICH) that surrounds rice farming knowledge and practices in Thailand; and the communication of modern science about rice farming in Thailand's science museums. This research has the potential to offer a theoretical basis that can open up

the debates surrounding the merits of bringing them together and lead to new practices in the science museum.

The research therefore addresses the following three research questions:

Question 1: What theoretical framework should underpin the design of exhibitions and other museum programming that integrates local Intangible Cultural Heritage in modern science museums in non-Western contexts?

Question 2: How can science museum exhibits and programmes integrate traditional Thai knowledge and culture with western modern science to enhance science communication in Thailand?

Question 3: What are the perceived potential impacts of combining traditional knowledge with modern science in Thai science museums?

Your role in completing the research

You are invited to take part in a design workshop, which will take place on 20-25 May 2018 at National Science Museum, Thailand. The workshop will last approximately half of a day and will involve participants joining a series of design activities such as brainstorming, prototyping, and focus and plenary group discussions. The workshop will be conducted in Thai and you will work with colleagues across science / ethnographic museums.

If you agree to participate, you will receive a detailed workshop schedule and you will be asked if you can bring with you material (objects, catalogues, guides, etc.) relevant to rice farming that can act as prompts for the design activities.

To facilitate data analysis, the workshop will be audio and video recorded and I will also be taking notes by hand.

How you were selected

The workshop is for museum professionals from Science and Ethnographic museums in Thailand which hold collections related to rice farming. You were selected because you are affiliated with one such museum and have expertise in this topic.

Your rights

Your participation in this research is entirely voluntary and you are free to withdraw from the project at any time before the **31st August 2018**. If you are uncertain or uncomfortable about any aspect of your participation please contact the researcher listed at the top of this letter to discuss your concerns or request clarification on any aspect of the research.

Protecting your confidentiality

Any information you supply will be treated confidentially.

Any information you supply will be treated confidentially. After the workshop, data will be digitized and encrypted by the researcher. The recording, transcript and resulting data will be securely stored on University of Leicester servers, which are password protected. The data will be anonymised before it is analysed and published and care will be taken so as no workshop participants can be identified in the written reports unless they explicitly request so. The workshop data will be retained for at least six years from the date of thesis submission in accordance with the University of Leicester's Research Code of Conduct, which can be viewed at: https: / / www2. le. ac. uk/ offices/ researchsupport/ integrity/ code- of- conduct/ 5- after-research/ 5- 5- retaining- records- and- research- data. All material and information collected will be kept safe, according to the UK Data Protection Act 1998 (see http://www.legislation.gov.uk/ukpga/1998/29/contents).

If you have any questions about the ethical conduct of the research please contact the Research Ethics Officer, Dr Jennifer Walklate, on jaw72@le.ac.uk.

Thank you,

<SIGN HERE>

<PRINT YOUR NAME HERE>

Appendix 3 Model Research Consent form

Model Research Consent form

I agree to take part in the "*Science Museum Interpretation through Thai Intangible Cultural Heritage*" study which is research towards Chanin Suriyakul Na Ayudhya's PhD at the University of Leicester, UK.

I have had the research project explained to me and I have read the Information sheet about the project which I may keep for my records.

I understand that this study will be carried out in accordance with the University of Leicester's Code of Research Ethics.

Material I provide as part of this study will be treated as confidential and securely stored in accordance with the General Data Protection Regulation (GDPR) as well as the UK Data Protection Act 1998 (see http://www.legislation.gov.uk/ukpga/1998/ 29/contents).

I have read and I understand the information sheet	Yes	❑	No	❑
I have been given the opportunity to ask questions about the project and they were answered to my satisfaction	Yes	❑	No	❑
I understand that I can withdraw from the study at any time	Yes	❑	No	❑
I agree to the workshop being recorded and my words being used in a PhD thesis	Yes	❑	No	❑
I agree to my words being used in related academic publications, including on the Internet	Yes	❑	No	❑
I give permission for the following personal details to be used in connection with any words I have said or information I have passed on:				
My real name	Yes	❑	No	❑
The title of my position	Yes	❑	No	❑
My institutional affiliation	Yes	❑	No	❑
I request that my real name is acknowledged in any publications that references the comments that I have made	Yes	❑	No	❑

RESEARCHER **PARTICIPANT**

Name [PRINT] ……Name [PRINT] …….

Signature ……..Signature ……..……

Date……..Date ……..……

Appendix 4

Thai rice farming, one of the most significant sources of Thai culture and traditional knowledge

Thailand is located in the middle of the mainland Southeast Asia and is influenced by tropical monsoon climate. The climate and location offer appropriate weather conditions and environment for agriculture. The most commonly consumed agricultural product of Thailand is rice because of not only the yield of this product, but also the high-quality standard on an international scale. Thai people have been associated with rice farming for millenniums. Thus, rice farming is a significant source of cultural heritage in Thailand.

As rice farming has been a key career for many Thai people for thousands of years, it is of cultural and social significance. Thai farmers contribute not only labour but also skills, ability, and time in order to maintain and enhance their product. For this reason, it can be seen that Thai people's lifestyles are associated with rice and rice farming. Farmers in each region share their different beliefs and practices, which are influenced by their worldviews. Therefore, rice farming in each community has its own particular culture that may vary significantly from that of other regions. Therefore, rice farming is one of the significant sources of cultural heritage in Thailand. Rice cultivation has provided many important rituals, performances, and traditions related to rice farming from various regions around the country. For example, there is a traditional rocket festival in the northeast of Thailand that does not exist in other regions. This tradition is organised by north-eastern people to worship and ask for rain and prosperity for their farm every season. This ritual may be a result of the geography of the region, which is characterised with a high plateau and drought area. People in this region look for rain. As farmers cannot control the climate, they believe that only extraordinary power or gods can provide rain. This belief leads to rituals and activities that those people rely on. This section explores the history of rice and rice farming in order to understand how can this agricultural product has generated forms of culture in the community related to ICH and examines the current situation related to knowledge that is applied to rice farming from the past to the present.

The background of rice in Thailand

Rice is one of the most frequently consumed cereals in the world. There are more than 50,000 edible rice plants in the world, though three of them account for sixty per cent of the world's food energy intake, namely rice, maize, and wheat. Rice is the staple for over half of the world's population. This significant energy source is mainly produced in Asia (90 %) (CIRAD, 2009). The largest proportion of rice consumers are in Asia, followed by Africa and America. The demand for rice increases annually. As a result, rice has become more than food; it provides work and income for millions of people in rice-producing countries.

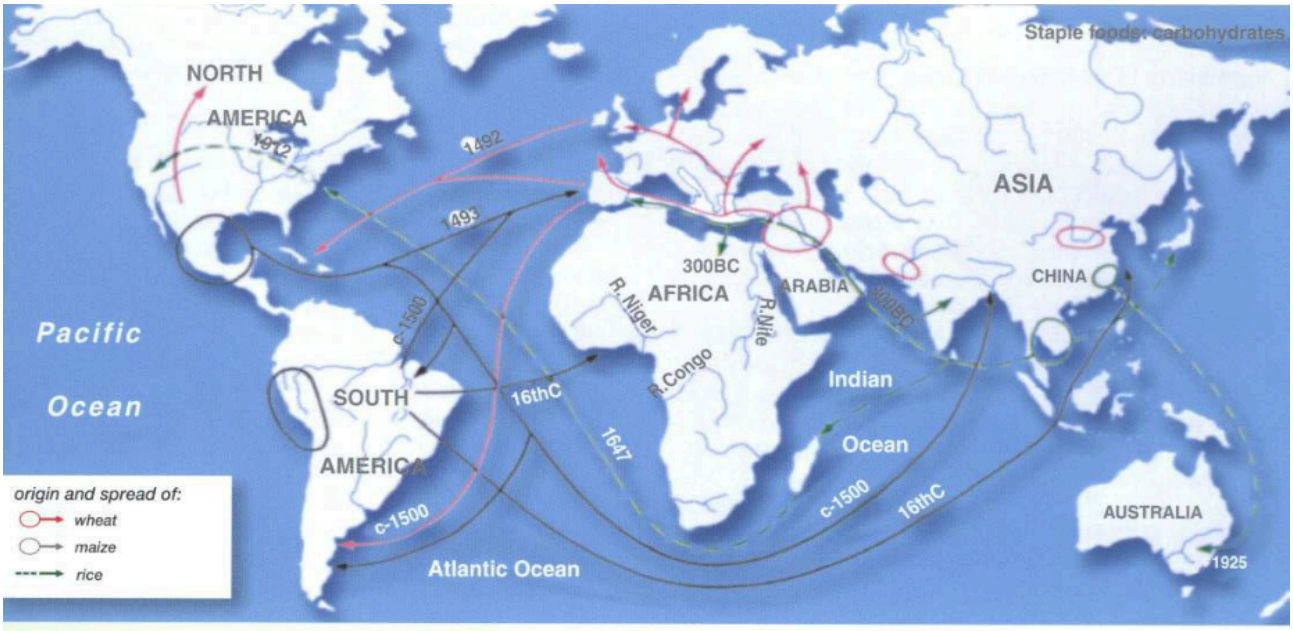

Figure 1. Map of the origin and spread of wheat, maize, and rice

Rice in Thai history

The origins of rice can be traced back to approximately 10,000 years ago, though the first rice farms date back to approximately 5,000 years ago in the river valleys of South and Southeast Asia and China. Thailand is one of the largest producers and exporters of rice to the world's market. Rice has been the major staple food for Thai people for centuries.

The Thai population's lifestyle has been related to rice and its cultivation since ancient times (Srisuchat et al., 2005).

Rice has a long history in Thailand and has been inextricably linked to Thai society and people since the early stages of rice farming 5,000 years ago. The oldest archaeological evidence of rice farming is an ancient rice chaff found in the mixture of an ancient clay pot in the North-Eastern region of Thailand, which suggests that early Thai agricultural societies had begun to grow (glutinous) rice (add reference). A 3,000-year-old cliff painting at Pha Taem in the North-Eastern part of Thailand shows pictures of men, buffaloes, and rice fields, offering further evidence of rice farming. The glutinous rice that was farmed in Thailand in the early stages originated in the far north of Thailand, China, and Vietnam. The cultivation of this type of rice continued until the time of Suvannabhumi (1,500 years ago).

Figure 2. 3,000-year-old cliff paintings discovered at Pha Taem, Ubon Ratchathani, depicting a rice field with men and buffaloes

Source: http://www.thairiceforlife.com

The long, slender grains of rice were taken by the monks and traders traveling from the Indian subcontinent to Thailand. Subsequent cultivation in Thailand proved that crops grew successfully, meaning that they became a popular choice. Long-grain rice, which was grown in Thailand at that time, proved to be popular, particularly among the high society, who called it *Khao Kong Jao* or *Khao Jao*, which translates as "the rice of the royal family". Rice farming continued with the two types of rice, namely glutinous rice from the north and long-grain rice from the west (Department of Internal Trade of Thailand, 2016).

During the Sukhothai kingdom (1237-1438 AD.), rice farmers had developed a successful indigenous irrigation system. This system allowed farmers to divert water from the river outside of the city to the centre and keep it in a special kind of large reservoirs called *Sarithphong* for agriculture, mostly for rice farming. The close relationship between rice and Thai people during this period has been expressed shown on pottery patterns depicting the way of life of those living in the city and how close it is to rice farming and agriculture.

Figure 3. Chinese designs with unique patterns of paddy ears, fish, flowers, and cattle designs

Source: http://www.thairiceforlife.com

In the Ayudhya Kingdom (1350-1767 AD), Thailand experienced significant economic growth. Many traders from East Asia, India, Persia, and Western Europe came to trade minerals and agricultural products, one of which was rice. At that time, the paddy field became a mark of nobility as it was instrumental in the organisation of the social system known as *Sakdina* (feudalism). This system represented a social order that emphasised landholding rights as a frame that was used to categorise people into social classes. Each social class had different rights in terms of ownership of paddy fields, with higher classes being provided access to larger fields than lower classes, and only the king being allowed to provide land ownership rights to people.

The Rattanakosin era (1782 to present), has seen the country grow. With this growth, demand for rice has also grown. This growing demand has resulted in changes in approaches and methods of cultivation. Machines and chemical fertilisers are now used to enhance rice crop yields and reduce cultivation time. These techniques were imported from abroad and replaced human and animal power in the fields. This transformation of cultivation methods has led to higher crop yields and, consequently, higher incomes for farmers. Major Thai rice farmers now rely on machines and chemicals. The introduction of these technologies, however, has diminished the usefulness of traditional Thai practices in rice cultivation.

Rice and beliefs in Thai life: the significant influencer for Thai cultural heritage

Rice in Thailand represents more than food, and instead creates culture and traditions. Rice links Thai people with the communities, cities, and the nation, and many Thai cultures and traditions originate in rice.

Thai people believe in Buddhism, Hinduism, and Animism. Thai farmers usually pray or offer things to gods or ghosts when there is an unfortunate event, such as when there is insufficient water to cultivate rice. Thai rice farmers, because rice is an important product for many communities, believe that there is the ghost named *Phaya Thaen*, who is considered the controller of natural elements such as water, wind, and fire. Thai farmers therefore developed one of the most important Thai rituals, *Bun Bang Fai* (which is the

name of a traditional rocket). The purpose of this ritual is to ask *Phaya Thaen* to produce rain for the Thai people. This ritual has become one of the most famous Thai traditions of the northeast region of Thailand. This ritual is an example of the relationship between Thai people and the importance of rice. This ritual is important in terms of building respect for unity and common morale in Thai society.

Figure 4 and 5 The "Bun Bang Fai" ritual

Thai people, particularly farmers, believe that there is a spirit-an angel named *Mae Phosop*. This angel is a guardian angel of rice that has the power to protect and take care of all rice farms and farmers. Thai farmers have a profound respect for *Mae Phosop* and offer to care for the rice crop as much as possible. This ritual has been passed from ancestors as cultural heritage. The ritual, which gives respect and worship to gods, mirrors Thai farmers' worldviews. Because of the importance of these figures, rice has been an important agricultural product for centuries. Thai farmers contribute all of their life to this business. As Thailand is located in a tropical zone that is rich in biodiversity and influenced by monsoon winds, pests and flooding may cause significant damage in rice farming. In order to address climate and environmental conditions that farmers cannot control easily, these rituals and worship were created in order to ask for someone who has more power than ordinary people to control the climate. This "someone" may represent gods, ghost, and angels that farmers believe they can help. At this point, the rituals and activities that emerged from the worldviews of farmers in each community become the cultural heritage of the community. These figures also represent examples of cultural heritage associated with rice farming and worldviews in Thailand.

The history of rice cultivation reflects the development of Thai society. The practices that were used in rice farming also developed along with the growth of Thai society. The knowledge was developed and passed from generation to generation. The purpose of rice farming in its early stages was to consume within families and trade within communities. Ancient Thai farmers learned and lived with nature, and the processes of rice farming were developed with care. Ancient farmers build up knowledge from observing and practicing with the environment. These farmers found that rice cultivation in each environment had specific conditions for growth that depended on many factors, including location. The methods of rice farming in the lowlands of central Thailand cannot be used effectively with highland rice farming techniques in the north. The varied contexts also provide a variety of practices.

Figure 6. The ritual to show respect to Posop

Source: www.banmuang.co.th

Rice cultivation in Thailand

Rice production in Thailand can be classified into four ecosystems that depend on geography, namely irrigated, rain-fed lowland, deep water, and upland. Thailand's geography is also divided into four main regions, namely central, north, northeast, and south. The rice cultivation in each region varies in terms of management and techniques. The specific natural environment in each region can result in different ways of thinking, worldviews, and culture. These differences lead to different practices in cultivation, even when the plant is the same. The specific character of practices, knowledge, and techniques are created in each community and are passed on to future generations to present as the community's valuable cultural heritage. However, much of the rice farming across the country relies on rain, though large yields of rice are produced in well-irrigated areas such as the central region.

The central region, which is an alluvial area, there are numerous rivers and canals that are characterised by high-quality irrigational systems. This area is therefore suitable for rice

farming and has been so for centuries. Farmers in the central region may have more than one rice crop per year.

The north of Thailand is covered by fertile mountainous areas. There is a mixture of upland and lowland rice distributed across this region. The most common strain of rice cultivated in the north is glutinous rice. In mountainous areas, land is usually transformed to be a terrace field for rice farming.

The northeast region is the largest rice farming area of Thailand. This area of plantation is combined with fertile and dry highland. Despite the arid characteristics of this area, the Northeast region is the source of some of the most commonly known rice strains, such as *Hom Mali* rice from Thung Kula Ronghai.

The rice fields in the south of Thailand are located between two oceans due to the shape of the land. Much of the rice production in this area relies on delayed rain from other regions of the country. Southern rice farmers have chosen the most appropriate strains of rice suitable for high salinity and acidity in the common soil of the south (Department of Internal Trade of Thailand, 2016).

Figure 7 Map of Thailand illustrating its boundaries and geography

The process of rice farming

In Thailand, there are many rice strains that may be farmed. There also exist a number of subtle processes in rice farming that rely on geography, climate, irrigation, and specific

strains (www.ricethailand.go.th). Furthermore, rice farming has three main stages, namely preparation, planting and maintaining, and harvest and post-harvest.

Preparation

This stage involves preparing the field and nursing selected rice grains. In this stage, the soil will be prepared to make the land ready for planting. The selected rice seeds will be nursed (germination) and prepared for transplanting to the field.

Planting and maintaining

After rice seeds are prepared, they will be transplanted to the field. This process is usually carried out manually. The transplantation will ensure that the seeds are evenly spaced to ensure that there is enough space to add fertiliser and pull weeds around the rice while the rice seedling is growing. This process involves caring for and guarding the rice. Farmers must be cautious in terms of conditions such as a suitable level of water in the field, pest prevention, and rice disease monitoring. Monitoring these elements requires significant experience, skills and expertise to achieve.

Harvest and post-harvest

When rice ripens, farmers will harvest their product and keep it for trading. Traditional Thai farmers usually use sickle as a tool for harvesting rice in fields. The harvest has a limited time- frame and must be performed at the earliest possible availability in order to ensure that the rice is not over ripe. The process of post-harvesting is also important for farmers as they must have the expertise to keep their product safe from moisture, pests, animals, and mould that will destroy their product.

Culture and traditional knowledge in rice farming can be found in almost every stage of the cultivation and influence Thai people's lifestyle. In Thailand, rice is more important than just as a staple food. Rice drives society, provides work, cultivates traditions and morale, creates knowledge and wisdom, and generates a general sense of pride and dignity to all Thai people.

The traditional practices and the modern style of rice cultivation in Thailand.

Agriculture has been a profession for large numbers of the Thai population for centuries because the climate and natural resources are ideal to grow many kinds of plants, including rice. Ancient Thai farmers learned to cultivate rice through direct experiences associated with their natural environment and transferred their knowledge by working with the following generations as a form of transformation knowledge for indigenous people. When a grandfather brought a father to the rice farm, the father would learn how to cultivate rice and how to respond to rice from observing and practicing with his father. The father would perform the same procedures with his children. This kind of the knowledge transformation is one of the appropriate channels of transferring knowledge and is a basic pattern of learning in Thai farming from the past to the present (Traimongkolkul et al., 2001).

The traditional style of rice cultivation in Thailand is similar to that of other plants. Traimongkonkul et.al. (2001) studied the transformation of rice cultivation styles in the central region of Thailand and discusses the traditional and modern styles, particularly in terms of the use of technologies for rice farming in Thailand. This study focused on two different areas. The first area was the old and traditional style of rice farming, and the second area focused on the new and modern technologies and the ways in which they support rice cultivation. The first area used the Maharacha field located in the Ayudhya province. This area has been used for rice farming very long time in history. The field has provided a high rice yield for communities in the past. The farmers in this area are familiar with the traditional style of rice cultivation that has developed and transferred from generation to generation. These farmers still use the traditional style of cultivation despite the existence of modern, high-quality technologies, or new styles of cultivation utilised in many other rice farms in other regions of Thailand (Traimongkolkul et al., 2001). However, the farmers at Maharacha have faced difficulties. These farmers' rice fields are losing the essential elements and have been affected by changing environmental and social factors. These changes have led to the financial crisis in terms of farmers' cost. Traimongkolkul et.al (2001) argues that the traditional style of rice farming in this area is similar to that of the past and those of other farms that have attempted to conserve their traditional practices. Maharacha's farmers grow, maintain, harvest, and transform their product by themselves, mostly by man and animal power. These farmers accurately understand the whole system of rice farming and control every stage using their own

skills. Only one or two farmers were able to manag4e a huge farm. Furthermore, when the farm grow to a size that they were no longer able to manage, they would conduct co-operation from neighbour farmers or community members without offering them compensation. Traimongkolkul et.al (2001) further discusses traditional styles of rice cultivation and how each has the ability to manage almost every process of farming with limited use of technology. Rice farming tools have been created, formulated, and produced using farmers' traditional knowledge and practices. Farmers at the Maharacha field still use a traditional farming style.

In another area, Traimongkolkul et.al (2001) studied the Banglain field in the Suphanbury province. This area has been promoted and supported by the government as a land for the modern rice cultivation style. Banglain's geographical structure is a delta and similar to that of the Maharacha field. The government has established an exemplary irrigation system to supply sufficient water to Banglain's farmers in order to produce rice for the entire year. Differently from the Maharacha field, the new systems and technologies have introduced to this area, whereas Maharach's farmers still use traditional tools and grow local strains of rice such as Khao Loi (floating rice), which is a special rice strain that has the ability to extend its nodes above the water level when the Maharacha field is in flooding. The modern style at the Banglain field includes efficient irrigation systems, the use of machinery in almost every stage of cultivation, the using of chemical fertiliser, pesticides, high-quality technology tools, and specialists (Traimongkolkul et al., 2001). The main purpose of rice farming in this area is to generate large-scale production for the global market. Farmers can grow their rice whenever they want due to the sufficiency of resources and tools, whereas the farmers in Maharach field rely on climate and usually encounter flooding every year. The farmers at Banglain incur high costs and rely on machinery more than man and animal power, meaning that cultivation is an intensive and mechanised form of rice farming (Traimongkolkul et al., 2001). Farmer at this location seemed to serve more as managers on duty more than a farmer as they tend to hire specialists from machinery companies or private sectors for almost every stage of the cultivation.

These cases studies offer an understanding of the differences between traditional and modern styles of rice farming in terms of results, problems, and management. The high demand for rice in the present has led to changes in the management structures. Some of the farmers prefer traditional farming styles, though they often some of the serious

problems encountered by Maharacha's farmers. This study also suggests that the modern farmers' behaviour is changed by modern technology and management compared to that of the past. These changes can lead to the loss of traditional beliefs, practices, and knowledge in Thai rice farming.

Although there are differences in some of the traditional and modern styles of rice farming, in general, the basic processes and principles of rice cultivation have not been completely changed and have many factors in common. The knowledge and practices in almost all of the processes seen in both traditional modern farming are similar. Rice seeds still need significant care to be able to grow and offer a significant quantity of rice. The traditional tools and practices have been replaced by high-quality tools and machinery. In most Asian countries, the manual methods of cultivating and harvesting rice are still practiced in some areas of Thailand. The comparison samples to illustrate the differences between traditional and modern practice in rice farming on Thailand are as follows:

How Thai rice farmers learn to become rice farmers

The knowledge and practices that have been collected and transferred from past generations could be learned and tested by receivers in contemporary generations before implementation. The knowledge that had been tested would be passed to the following generation successfully if they found that it was important and necessary for living. However, as time passes, and many technologies have emerged to support people's living, it is worth determining whether Thai farmers in Thailand still transform their knowledge of rice cultivation by directly observing and practicing with their families.

In the case of Maharacha, which uses a traditional cultivation style, farmers learn how to be rice farmers through direct observations and experiences. These farmers learns from nature in order to develop the rice cultivation appropriately and offer it to the next generation by working together. In this system, children work and learn from their parents. In the case of Banglain, which uses a modern cultivation style, farmers learn from specialists who are sent by the government. The government provide specialists to educate leaders or farmers with the potential to take on a modern style and use it for their field to distribute their knowledge to their communities. The government prepares

channels for farmers to gain valuable information, news, and exchange their knowledge and experiences with other communities to their benefit. Present learning of the modern style of rice cultivation includes learning from other farmers (Traimongkolkul et al., 2001).

The turning point of rice cultivation from the traditional style to the modern style in Thailand began in the 1960s. After World War II, people were concerned with population growth rate, food shortages, and poverty. These concerns led to a revolution of food production. The success of improved strains of cereals that can be cultivated in diverse climates, well design irrigation, and machinery brought the world to the Green Revolution. The Green Revolution had begun many years from the outbreak of World War II. This revolution started in Western countries and distributed it thought the world respectively. The Green Revolution brought modern science and technology to Asia's agriculture in order to improve cereal varieties, fertilisers, irrigation systems, and modern pest control methods (Hazell, 2009). The main purpose of the Green Revolution was to increase the amount of food provided to people all around the world. The Green Revolution brought massive changes in technology used for rice cultivation, which was a significant stage that changed the farming style in Thailand (Srisuchat et al., 2005). The arrival machinery, chemical fertilisers, pesticides, and newer rice strains meant that Thai farmers lost their confidence because they had to change and felt that their traditional knowledge and practices were obsolete. Thai farmers at that time had to adapt and seek new knowledge from outside of the country. The Green Revolution, on one hand, affected the reduction of traditional knowledge and practices in rice cultivation. However, on the other hand, this revolution provided opportunities, new knowledge, and techniques for Thai farmers. The government and Thai farmers have received updated knowledge from the West and combined it with the traditional knowledge and practices developed to be a new style of rice cultivation in the present (Traimongkolkul et al., 2001). One of the examples of this process is when chemical fertiliser was introduced to Thai farmers in 1953, at which point it was found that chemical fertiliser could enhance the scale of rice production more than the traditional organic fertiliser. However, due to the higher costs and negative impacts for soil, farmers reduced the amount of chemical fertiliser and searched for the suitable ratio of the natural fertiliser in their community (the traditional style) to be mixed for increased benefits. The traditional knowledge and practices passed

from the previous farmers arise from the observation, trial, and test. These practices are the ingeniousness and valuable heritage for each local community. Local farmers can combine new knowledge and technology with traditional knowledge and practices to be able to have their own style and appropriate to their local community and develop their sustainable agricultural community successfully (Warren, 1991).

It appears that Thai people have associated with rice farming for centuries because it connects their worldviews with rice farming and daily lifestyles. Rice farmers and other members of local communities formulated their own practices, approaches, and activities using the worldviews that are a result of their collective cultural heritage. Cultural heritage reflects these community members' worldviews, and these worldviews are influenced by beliefs and the environment. Rice farming is a valuable source of income for Thai culture development, particularly in terms of ICH. As rice farming has developed and transferred knowledge and practices for many generations, it is clear that rice farmers have their own forms of knowledge. This knowledge allows them to pass obstacles and allows them to live well with the perceived world. Moreover, it is noticeable that the original concepts of many types of machinery and modern styles of farming replacing the old style of practices are derived from traditional knowledge and practices. These concepts are fulfilled with the use of modern Western scientific knowledge and technology. The combination of scientific, more technological and traditional knowledge is powerful for community development. For this reason, even if community members live in different part of the world, it is essential to determine how these areas of knowledge are beneficial to all members of the community.

Appendix 5

Thai rice farming :traditional knowledge and modern science

In Thai rice farming, there are rituals, traditions, and festivals as the cultural event in the cultural heritage that are significant events in every stage of rice farming. While experiencing cultural heritage in every stage of Thai rice farming, there is also knowledge in those steps as well. The success of Thai rice farming has prospered for thousands of years through both cultural events and knowledge. The rice farming practices derived from knowledge have transformed due to the development of science and technology. The traditional knowledge and practices are gradually replaced by modern forms of practice, which resulted from science and technology globally. Cultural practices, traditional knowledge and modern science, are the essential things that support and fulfil farmers' confidence and success in Thai rice farming. They provide an important role in all stages of rice farming, preparation, maintaining, and harvest and post-harvest. This part will look for the relationship between traditional knowledge and modern science in farming practices. It will present some of the examples of traditional practices and modern practices in three stages of Thai rice farming and look at two forms of knowledge :explicit knowledge that manifests in rice farming practice) for example, the modern style of seed preparation that the knowledge and practices are resulted from analyzing information and transmitted through structured forms such as training and instructions from scholars or experts(, and tacit knowledge that manifests in the ICH and traditional knowledge of the practice) for example, the rituals and the traditional knowledge related to seed preparation that transmitted without the structured forms .(It will examine these concerning modern science, with the aim to highlight the parallels :where traditional knowledge, both explicit and tacit, presents a view of the scientific phenomena and processes that are involved in rice farming –a view that is alternative to that presented by modern science. In doing so, this section highlights the richness of the scientific knowledge that lies within ICH . Importantly, the section also highlights the parallels between traditional Thai knowledge and modern science .

The study on the development of Thai rice farming can show a vivid picture of what the traditional practices and modern practices look like and when the modern style of rice farming is imported to Thai society. This can help this research identify traditional and

modern Thai rice farming practices and knowledge appropriately. The study found that the modern style of Thai rice farming emerged in the reign of King Rama V, 1869 to 1910. Noticeably, the coming of the modern style in each stage is developed at a different time. Some of which are examined below in both traditional, modern practices and scientific knowledge in three stages of Thai rice farming.

The traditional and modern practices in the preparation stage of rice farming.

The examples raised in the stage are seed preparation and field preparation. Both seed and field are essential as they are necessary raw materials for rice farming. The farmers consider these preparations to be an essential aspect of starting their success in rice farming. The preparation processes are done along with the rituals such as Royal ploughing, Bun Bung Fai, and Blessing to Mae Phosop.

Seed preparation

Rice strain is one of the most important things in rice farming. High-quality seed can guarantee rice quality and productivity. Preparing and supplying high-quality seed that is suited to the condition of each rice field and the ability of the farmers themselves is essential to consider at the beginning level.

Rice consumption in ancient times, humans will gather ripening wild rice from the forest. They noticed that rice seeds that fall to the ground could germinate in the next rainy season. They learn to gather the grain of rice by tied several stems together to make a cavity for supporting the ripening seeds. When the rice was ripened it will fall on the area around the made cavity and easy to collect. Later, they found that rice seeds can be cultivated to grow in a remote area from the place where it was born. Which may be caused by coincidences when migrating, the grain may fall in any part during the journey and then grow up, thus resulting in the idea to collect rice seed for planting in their field. It is the beginning of the development of the collection and preparation of rice seed (Department of Agriculture, 2002).

The preparation of the rice seeds in the past time looks simply. They divide a part of the rice that is collected in that season to cultivate for the next crop. Sometimes, they do

explore other neighbours fields to request good rice seeds for using in their crop. Farmers keep observing their rice field for good characteristics of rice seed. When the rice begins to conceive, they seek for good characteristics as they confident and continue monitoring growth until the harvest period. Farmers will start harvesting rice that considered as good characteristics first. Then the rice will be dried and blessing for Mae Phosop before threshing and securing separated from other seeds. The farmers will keep their seeds separately, in a safe place away from destroying by birds and rats. The traditional seed preparation in the past time, therefore, is the finding good varieties of rice derived from their own rice fields or a request from the field of neighbours, using their own experiences.

Seed preparation in a new style begins in the year 1921 by The Rice Experiment Station (RES), a part of a Department of Agriculture (DOA) in present (Department of Agriculture, 2002). By using the Cooperation from the experts within the country and imported, RES launched a project to collect rice variety across the country during the years 1921 to 1922. It is the first time in Thailand to adopt internationally accepted methods to classify Thai rice strains in the country. They collected 4,764 samples of rice varieties from all over Thailand. They planted and selected good varieties using Pure Cultivation Methods according to the technical principles.
Later, rice varieties were developed using modern knowledge in genetics and genetic engineering for higher quality than native species and become favourable for Thai farmers to grow in their farm instead of the native strain.

Scientific knowledge or modern knowledge that used to classify and opt high quality of rice seed is the knowledge that comes from a variety of field. The knowledge of botany helps to distinguish and understand the physiology of rice, knowing what the nature of rice will be, and how the productive rice will be. Knowledge of genetics causes an understanding of the nature of rice that have adapted naturally and can be transmitted to generations.

The seeds farmers have chosen need to be planted repeatedly to achieve the stable characteristics that result from more stable genes. The different characteristics of rice are caused by the breeding of male and female pollen in the sexual reproduction process, which is natural. In the process of sex-based mating, there is always an overlapping

exchange of the chromosome parts, called crossing over, and thus the genetic code that controls specific characteristics often change into a new characteristic. Sometimes it results in an excellent characteristic that benefits for farmers. Experienced farmers know what characteristics are suitable for their climatic conditions and geography. This allows native farmer continues cultivating good native rice strains for their farm. Preparing seeds in traditional style is important in helping to conserve native varieties. However, the difficulty and complexity of the traditional style seem the burden for farmers, as the market requires higher quantities of rice in the present. The traditional preparation of seed is gradually fading from Thai agricultural society. The new farming method is that farmers prefer to buy seeds from stores or ask for rice varieties from government agencies. Those seeds have been carefully selected and examined by modern scientific processes. They, therefore, help reduce difficulties in preparing and reduce the risk to the quality of the seeds. Considering the fundamental knowledge that those scientists use to select rice varieties are relying on the knowledge of botany and genetics, as well as statistics that work along with the new standard and advanced tools and methods derived from Western modern science. These supported by the government, and it provides certainty and reliability for farmers. While the traditional method uses observation, recognition, and the understanding of the surrounding nature that farmers perceived before beginning experiments themselves in their fields. It provides unstable characteristics result from the uncontrollable environment and unstructured methodology while they do experiments in their field. This result in the farmers do not have the best rice variety in terms of the quality of the product, but it allows them to get the rice varieties that are appropriate for their areas. The new or modern seed preparation method began to appear formally in Thailand in 1940, when the government had a policy for farmers to use high quality of seed with the government standards and need to have the appropriate methods to nourish the soil and nourish farms according to academic principles Then the traditional seed preparation process began to disappear.

Soil preparation

Traditional soil preparation usually uses human resources, animals, and simple equipment. The equipment is made of the materials that can be found in the local area and built with simple methods. There is evidence that farmers in ancient time had melted metal and formed to be the shape that meets the needs of various tools suitable for use in

each community. The tools have been designed and created, suit to the surrounding environment and the condition of their rice fields. The traditional methods still rely on human and animal labour to transform the ground. In the early days, farmers dig holes for sowing rice with their own. Later, he began to develop tools such as rake and plough and used the animal power to drag rakes and ploughs for adjusting the ground surface, preparing their field for farming. There is evidence since the Sukhothai period, 19th century (Department of Agriculture, 2002).

The ploughing and raking are the turnings of the soil. This method has the ability to reduce some diseases and insects that can cause problems with the rice field. It is also a mixing of plant debris to become a fertiliser for rice plants when it grows in the field. When considering accordance with modern science, the knowledge in the field of Physic about force, balance, friction have to be used to design and use the tools appropriately. Farmers should concerning the use of force and balance to control their cattle to pull a plough with appropriately speed and directions to flip the soil in the field successfully. The friction derived from the diversity of soil quality will be concerned through tools creating's process in order to have the appropriated tools for their field.

Modern soil preparation methods began in 1953 by the Rice Department. They started using tractors machines for ploughing and raking the field. It began in the rice experiment station and service to farmers who were in the problem with lacking labour at low cost. No longer from the time, the private sectors came to this business. During that time, Rice Department had launched a program of training for using and maintenance of machinery for soil preparation with the framers' family as the target. Later in 1958, the Department of Rice Engineering or Division of Agricultural Engineering in the present, The Department of Agriculture currently, had set up a project to develop agricultural machinery, called "the Iron Buffalo Project" lead by MR Thepparit Tewakun. Agricultural Engineering Division had developed the first driving tractor in Thailand, which was a three-wheeled tractor. Later in the year 1960, a 4-wheeled tractor was built and named the Iron Buffalo model. In the following year, King Rama 9 brought this tractor to experiments in the experimental rice fields at the Royal Palace in the heart of Bangkok. This created high confidence for the developers and farmers. The efficiency of tractors and preparation machines was developed consecutively. It became an important labour saving tools for farmers and reduced the time to prepare the field,

compared with human resources or animal power using in the traditional style. It well supported the expansion of the rice-growing that dramatically raised at that time. This led to the changing of soil preparation approaches from manual labour to mechanisation, such as the use of tractors and ploughing machines instead of manpower. The government played an important role in promoting and supporting this new style of soil preparation regarded economic growth.

Planting and maintenance stage

This stage is important as farmers have to pay attention to and monitor the growth of rice deliberately for maintaining the quantity and quality of rice. The human agricultural society began in the range of 6 thousand to ten thousand years ago (Department of Agriculture, 2002). Humans brought plants to grow and feed animals near the habitat for food and garment. The early period of agriculture, the land was prepared by deforesting and burning. The ancient farmers were always shifting cultivation on the highland areas. Later, they found that the lowland areas between the valleys or the low areas were fertile, and the soil was rich with nutrients suit to cultivation. With both plants and abundant water, humans then moved to the plains area and expanded the plantation area to make enough food to meet their needs.

Planting

Rice cultivation in the early days of Thailand found evidence at Ban Non-Nok Tha, Khon Kaen province, 6 thousand years ago(Department of Agriculture, 2002). There is evidence of paintings at Pha Taem showing the cultivation of rice in waterlogged areas and water control in the fields. Traditional rice farming in Thailand is often done in the area near natural water sources along with water management with simple tools and methods such as ridges, manual water transportation system, and using cattle for labour-saving. Most of the tools were developed by themselves from wood and iron and used to smooth the areas. They designed their space and selected their rice variety themselves that suitable for the natural conditions. One of the earliest rice farming methods, farmers grew rice by putting rice seeds into the holes, which are still being made in some of the highlands of northern Thailand. Farmers put rice into prepared holes before the planting season and waiting for the first rains fall. They left rice sprout and grew up. This

way, the root system of rice has the ability to resist to flash flooding and drought periods. This traditional method, often used in sandy loam or loamy soil because of easy in soil preparation and weed control. For the lowland, farmers would use sowing, which had different sowing approaches depending on weather conditions and geography.

Another traditional method is the transplanting rice cultivation, which rice seeds will be planted in the nursery and then transferred to plant in the main field. This method has many steps and much detail. Farmers need to make a constant adjustment of the distance of the young rice plant to make it easier to deal with weeds and harvesting. This traditional style obtains high yields but is suitable for areas with much water. It requires many steps, skills, and experiences, including labour and time. However, this method still relies on necessary labour such as man and cattle and simple equipment such as plough, spade, and rake.

Traditional rice sprout preparation needs to do in a flat surface and controllable water level. Experienced farmers will design their filed in accordance with the seasonal wind direction so that it is well ventilated, preventing seedlings from causing disease. Rice sprout applied to the nursery filed need to control quality by selecting good characteristics, healthy and free from diseases and pests. They need to be the rice sprout that has the appropriate age. This requires the expertise and experience of the farmer. Young rice plant removal from the nursery field is important and need to be concerned as the young plants should be in perfect and healthy condition. This also relies on the skills, experience and expertise of the farmers to reduce damage on the young plants as much as possible.

The young plant preparation also needs to use farmers' skills on fertilising and maintaining the water level to get a good quality of rice.

The traditional transplant rice cultivation requires much expertise, even though the seedlings are planted at only 3-4 trees per point, but the farmer will have to use the experience to analyse how long the rice leaves must be cut or not cut in order to be consistent with the amount of water trapped in the rice field. This to avoid causing the whole rice to sink or fall in the water during planting. The experienced farmers can evaluate the number of minerals and fertility in their field by themselves and plan for

distances of the rice plant appropriately. In the view of scientific knowledge, these kinds of method need to concern about many fields of science. The biology of plants or botany is one of the fields that should be concerned as it refers to the stages and functions of plants' organs. This can help farmers make their own decision to manage their transplant appropriately. The shape of the effectiveness of space and the distance of Rice in the fields had to be designed. Mathematics and Physics can make them happen. Before the modern style of rice cultivation, Thai rice farming, mostly rely on natural water resources such as raining, river, waterfall, canals, and swamps. They developed water transportation by simple methods such as water wheel, ridges and water conduit. They also use the gravity force to control and transport water from the resources. These practices are inevitably related to some Physics' principles such as gravity force for moving water from the waterfall, gear for producing a water wheel to transfer water from lower to the upper levels, and the momentum that play an important role to drive the water wheel.

The modern style of rice farming began in the reign of King Rama V (1869-1910) (Department of Agriculture, 2002). King Rama V had the policy to transform Siam, the name of Thailand at that time, to modernisation. There was a policy to allow governments and the private sector to work together on a modern irrigation system. This project provided more than enough water for farmers to use in the agriculture sector in the central area of Siam. This first irrigation system in Thailand started in the year 1888 and completed in 1915. Farmers began to use water from the canals and expanded the rice fields extensively, especially in Suphanburi and Nakhon Nayok, as well as Pathum Thani. This allowed farmers to grow rice all year round without having to wait for the rain.

During the years 1953 to 1954, the government initiated the idea to enhance rice yield by having 2 times rice cultivation a year, which led to the study and development of rice varieties and appropriate production methods. They had been tested and demonstrated before promoted to the farmers in areas that have the potential to perform successfully. The government later announced a policy for farmers to cultivate the second crop in various areas since 1965. This was the beginning of modern farming methods that rely on irrigation systems and allows farmers to be able to make rice all year round without waiting for natural raining.

Rice maintenance

When the rice germinating and growing, farmers need to take very well care and maintain their crop for keeping the high quality of their rice. Water and soil are essential elements. They support and help to maintain the growing and quality of rice. In the past, water management in the rice fields was vital because it needed water from natural sources or rainwater. Farmers relied on gravity and basic tools to push the water into and drain the water from the fields. Mostly done by manpower and cattle with simple and basic equipment. At present, the irrigation system is developed together with the use of machinery that can pump and push water more powerful. This can facilitate and reduce the time spend on water management. Farmers today rely on water from irrigation systems and pumping machines rather than traditional management systems.

Soil maintenance

There are 16 essential elements for rice growing, and all are in the soil. Those elements are derived from decaying and decomposition of minerals and organic matter in the soil. In general, the soil in the forest will have abundant accumulation and nutrient circulation. When the forest area is opened for farming, the soil is still rich with nutrients. The fields in the lowlands are abundant of nutrients from sediments that were blown from various places. This allows the rice to gain enough essential elements for growing and fruiting without adding any fertiliser (Department of Agriculture, 2002). The rice will absorb enough nutrients in those soil to create it stems, leaves, and seeds. However, when farming for many years, various nutrients were removed from the soil along with rice harvested from the fields. Nutrients in the rice field, therefore gradually reduced from the beginning level. Farmers need to add fertiliser to their rice fields to maintain and increase soil nutrients that support rice growing as much as possible.

There is evidence from inscriptions and historical that presented in the Development of Thai rice production by the Department of Agriculture (2002) that the farmers, the traditional rice farming before World War 2, preferred to grow rice in the lowland areas which rich in nutrients. The fertiliser is not necessary to add to their farm. Moreover, farming in the past did not require much productivity to feed a large number

of population as there are in the present. The traditional farmers preferred raising cattle in their rice field and manure from cattle that will become fertiliser naturally.

There is another way to increase soil nutrients in traditional farming. The farmers will put organic fertilisers such as compost or manure or green manure obtained from the fermentation of plant debris and manure that allows the process to decompose into nutrients by microbial activity in nature. In this way, farmers will deliberately select types of raw materials, duration of the fermentation, period and amount of use in rice fields. They transfer their knowledge and skills of making the organic fertilisation to other farmers without recording. The modern science that imported to this practice would be chemistry and microbiology to support the production and use of fertilisation.

The modern soil maintenance began in 1916 when there were experiments for adding fertilisers and chemicals to maintain soil conditions in the rice fields of the central region of Thailand. By putting manure, manure from seeds, and special chemical fertilisers along with the addition of lime to neutralise the PH of the soil which very acid. The experiments were acknowledgement. Then, the proportion of raw materials was developed for a better formula by studying the actual requirement of rice's essential elements following scientific information. Fertilising for soil maintenance in the rice fields began to be supported widely during the year 1948 onwards. The government provided knowledge about the using and making of modern fertilisation, both organic and chemical fertilisation, to the farmers and their networks. Based on scientifically approaches, fertiliser adding policy allows farmers to acknowledge and increase the yield of rice from fertiliser adding in rice fields. From then on, fertilising in rice fields was widely popular, along with the improvement of fertiliser and rice varieties. The government focused on the development of chemical fertilisers for the proportion of nitrogen, phosphorus, and potassium suitable for the soil in various areas of Thailand.
They are considered that Thailand has nourished the soil with a new method by adding chemical fertilisers, increasing soil fertility since 1948. The government paid attention to the development of fertiliser formulations by using scientific methods and knowledge to design experiments so that the result is suitable for the area and rice varieties of Thailand. The government supported farmers to know about making chemical fertilisers for their use in order to reduce the cost of buying chemical fertilisers from private companies and making the use of chemical fertilisers viral today.

During the years 1978 to 1985, Thailand was supported by the European Economic Community in order to develop more effective chemical fertilisers. Until now, the conventional fertilisers that the government support for farmers to use is chemical fertilisers and organic fertilisers, which include manure, compost, and green manure.

Weeds control

The emergence of weeds in rice fields is a common occurrence. Weeds in rice fields affect the growth of rice plants and may also cause diseases and insects to damage rice in the field. Weeds survival depends on many factors of rice production, ranging from rice varieties, location of the field, the cultivation methods, water management, nutrients in the soil, and chemicals used in rice fields. It can be said that all factors in rice production affect both direct and indirect on weeds.

In the past, there was a selection of rice varieties that are easy to grow and strong in order to beat the weeds naturally. The traditional farming usually used five methods to protect their rice from weeds as:

1 The development of rice varieties to be able to grow against weeds. Finding the appropriate rice varieties has become one of the important goals in rice cultivation development in the past. Farmers often observed and searched for the excellent characteristics of rice that need to be used for planting.

2 Land use design and preparation for rice cultivation. Farmers would adjust the ground level smoothly for water management and moisture control. The controlling water levels throughout the field was another way to control the number of weeds during planting.

3 Cultivation methods. Rice cultivation with the water trapped can support rice to grow well, and the high level of water can be a problem for weeds. Farmers, therefore, tend to grow rice in conditions that water has been trapped in the field since ancient times.

4 Water management. Determining water levels and soil moisture is an essential factor in the management of various types of weeds. Farmers know what kind of weeds can be destroyed by how high water in the fields.

5 Soil preparation. Farmers use the ploughing method to turn the part of lower soil to the upper. This can control the common weeds in the field before cultivation. The weeds that are growing on the soil surface will be flipped and die naturally. Moreover, it will be transformed to be green manure for rice when the cultivation starts. When the demand for rice increases, the management model must be changed from manual labour to modern style. Farmers gradually change their methods from using traditional practices to use chemicals and fertilisers for weeds control as vastly found currently.

The problems from weeds in ancient times is not a significant obstacle. It is because of the soil still rich in nutrients, and the cultivation is for household use, not large crops and no complicated soil preparation. This result in weeding can be done by manual labour. The use of a method to select areas that are lowland, create water barriers, make ridges, manage water level and design land use can effectively control weeds. Moreover, the native rice variety is high potential in competition with weeds (Department of Agriculture, 2002).

The modern style of weeding took place after 1957 when the Thai government brought new rice strain that has the ability to be grown all year round and provide to Thai farmer after breeding with native strain. This hybrid strain supported farmers cultivate rice two times a year. However, the strain is not high quality enough to compete with weeds comparing to the native strains. Thus, the government had to find a solution to this problem. They use the machines to turn up the dry soil without having to wait for the rain and wait for the germination of weeds to eliminate weeds as early as possible. They also used irrigation and water management to control the weeds. However, it is still a problem in many areas of heavy infestations. Therefore, they decided to begin the experiment with herbicide in rice fields and becoming more popular among farmers consecutively.

The modern weeding method was developed after the year 1957 is to the use of chemicals along with mechanical tools. However, the machines are not as good as

using traditional tools to eliminate weeds, so farmers who do not use only the traditional practice turned to use herbicides before planting, instead of ploughing machines (Department of Agriculture, 2002).

Rice disease control

Rice disease is a significant problem for rice production. There is information indicating that rice disease can damage rice up to 15 to 20 per cent of the amount of rice produced each year. In the past, rice diseases did not often affect rice farming because farmers planted rice once a year and relied on natural rainfall. Moreover, farmers used native rice varieties with different varieties grown in the areas not far apart from other rice fields and did not require fertiliser. Once harvested, the stubbles were burned, which could destroy the pathogen. Farmers left the fields to grow nothing until the new rainy season. These conditions were not suitable for diseases to disseminate (Department of Agriculture, 2002).

The beginning of the modern rice diseases control began in 1953 onwards. That year, the government set up a rice experiment centre and encouraged farmers to use high quality of rice varieties, mostly was the hybrid strain, and nourished the soil with fertiliser according to new agricultural principle (Department of Agriculture, 2002). This caused decreasing the variety of rice strain to grow by farmers in every area. There was a similar strain cultivating in large areas throughout the year. These conditions were suitable for rice diseases to adapt, grow, and spread in large areas across the country.

The modern style used in this situation is the breeding and selection of rice varieties to resist diseases systemically. It also includes the designing of the rice fields to be able to control humidity relative to the season wind direction in accordance with the modern agricultural principle. Moreover, the chemical and antibiotic will be applied to protect and eliminate rice diseases in the field. The imported knowledge for this practice is chemistry, microbiology, and botany.

Rice pest control

Rice pests become one of the significant problems for farmers currently. They can destroy vast amounts of rice production both in the fields and after harvest. In the past, farmers

growth rice once a year and used a variety of rice varieties. These conditions were not suitable for rice pests to live in the rice field throughout the year. This can reduce rice pest infestations. When the farming methods have changed, the rice fields are enlarged, cultivated with the similar strain (cannot resist to the pests), and is grown throughout the year, causing rice pests to become a significant problem. The traditional practices for pest control mainly consist of four ways, Superstition, Mechanical methods, Traditional cultural control, and Chemical using.

1. The superstition method includes sprinkling Holly water in the field and set up the Talaw (ตาแหลว) a special shape of wooden pole with the magic spell, in the ridges.

2. The mechanical methods. Farmers collect only eggs and worms of rice pests from their rice field. The leaves with the worms will be eliminated by hand and burn the debris away. One of the traditional mechanical practices is to use a mat or a bamboo panel that is coated with oil as a trap and move over rice plant. The pest will fall out of the rice leaves and stick to the trap. Then the trap will be destroyed in order to eliminate the pest effectively. Another mechanical method, farmers will tie grass and place along the ridge and waiting for the worms to come in the daytime then collect the worms to destroy in the evening. Farmers in the past also applied the light trap to reduce the number of pests in the fields. They will light a lantern above an oil bath in order to lure insects into the light and fall into the oil bath. Moreover, farmers will bring straw and fresh grass place on the ridge alongside the rice fields in accordance with wind direction. They will place the sulfur powder on straw and set fire. The resulting smoke can expel insects from the fields. Farmers usually raise ducks in the fields to catch insects and worms in their rice fields. Another mechanical method is to dig deep holes alongside the area where there is facing pest problem in order to lure the worms into the hole and collect them to destroy. One of the interesting mechanical methods to eliminate rice pest from the filed is that the farmers will flood water over the field after harvesting then plough to destroy the larvae of pests in the soil before draining.

3. The traditional cultural control. The cultural control is the design, planning, and set up the cultivation system by concerning conditions and environment that are not suitable for outbreaks of diseases and pests. The examples of this method are the determining time period and location for cultivation accordance with natural conditions, adjusting the shade affected to the fields, the designing of the field related to the season wind direction, crop rotation, and growing plants to lure or repel insects. In the past time, farmers use these methods in a simple way and basic tools. However, some of the traditional cultural control are still using currently such as the trapped water over rice field when planting and draining. This will create an inappropriate condition for worms that living in rice leaves. They will fall out of the leaves and flow with the draining water out of the field.

4. Chemical-using. The using of chemicals in the past is the use of natural chemicals such as medicinal plants and plants with a pungent odour. Other natural chemicals using are sulfur and lime.

The modern rice pests control began after World War II by the introduction of synthetic chemicals for removal and protection rice from pest (Department of Agriculture, 2002). The first synthetic chemicals used are DDT and Phosphorus derivatives. Although they work well with many kinds of plants and insects, there are many side effects such as chemicals, toxic, residues that are harmful to consumers. The development of insect resistance Rice strains is one of the modern methods to handle pests infestations. However, the government found that the use of two method, chemicals and resistant rice strains, is more effective than using one method. One of the important things is the appropriate use of chemicals. It should not destroy the beneficial insects for rice fields. The government therefore launched a project to transfer knowledge and modern practices by using an integrated approach to farmers including using pest resistance rice varieties, surveying of actual quantity rice pests in the fields, destruction level of the pests in the fields, using insects that are hostile to rice pests, and using pesticides in the appropriate levels. These practices can be supported by many fields of scientific knowledge including microbiology, chemistry, biology and physics.

Animals control

Thailand is located in the monsoon area with tropical and rainy conditions in the rainy season. There are plenty of forests and wildlife. This area is therefore abundant of biodiversity. Naturally, animals, wildlife, and plants were balanced, in the past. They always controlled the amount of each other. Animals that were causing problems for agriculture were not a significant problem. Until the Thai agriculture developed rapidly after the year 1892, the invasion and destroying of the crops by animals became one of the critical problems. The forests were destroyed in order to transform into cultivated areas. The expansion of cultivation areas, irrigation system, transportation system, and reservoirs resulted in a large number of wildlife habitat and plants to be reduced. This dramatical growth affected the ecological balance and the natural environment. The necessary food resources of wild animal had been destroyed along with the forests. Many wild animals needed to search for new resources and the agricultural area had become an appropriate target for them. Rat is a good example of this case. It is a small mammal that

has a lot of intelligence and ability to destroy agricultural products hundreds of millions of baht per year (Department of Agriculture, 2002). They can live all year long in rice fields and increase the population quickly. One of the reasons is that its natural enemies such as snakes, birds, and mongooses are dramatically decreased result from deforestation and expansion of cultivation areas. The traditional method for control animals in agricultural areas as rice field are mechanical methods and chemicals using. The mechanical methods include hunting with conventional weapons, digging, trapping, and blanketing (Department of Agriculture, 2002). The chemicals using include the using of medicinal plants and baits. The modern methods to control rats population in the fields took place in the year 1975. The government had present the method "Systematic Preventive Rat Control in Rice" that consisted of two essential stages. The first stage is to reduce the population of rat as much as possible during the soil preparation stage. At this stage, a variety of methods will be applied, including conserving rats' enemies in the fields, concerning the cultural control, and the using of the fast-acting chemicals. The second stage is keeping the low population of rats during planting by mechanical methods, cultural control, and slow-acting chemical using.

Some animals that are problematic in rice fields are alien species such as golden apple snails *(Pomacea canaliculate)* which imported from far east Asia, Taiwan and Japan during the year 1982-1983 (Department of Agriculture, 2002). Although the primary aim to raise for the aquarium, it was accidentally escaped to public water sources and became one of the major problems for farmers. It destroys rice sprout and spread quickly. The government and farmers use integration methods of cultural control, mechanical methods, and chemicals using, but the result is unsatisfactory.

Birds are an animal that creates problems in the rice field. Both traditional and modern practices usually use scare methods by creating sounds, including using a scarecrow. This is because there are about ten species from about 900 species of birds that are the problems for rice fields. The major of the rest of the birds are useful in pest and animals control in rice fields. The imported science that uses in animals control would related to the fields of physics, chemistry, biology, zoology, and microbiology.

The harvest and post-harvest

Harvest and post-harvest are one of the most crucial stages of rice farming. Although using the high quality of seeds, proper maintenance, but when harvested and stored incorrectly, it will massively reduce the quality of rice. Although Thai agriculture development had taken place since the reign of King Rama V in 1892 onward, the modern methods of harvesting and post-harvesting had not taken place until the year 1977. At that time, the government had created guidelines to enhance rice production in three ways: expansion rice planting area, apply high technology in rice planting, and improved harvesting and post-harvest practices to reduce losses in both quality and quantity. There are six main stages for the practices of harvest and post-harvest in Thai rice farming include harvesting, dehumidification, transportation, threshing, impurity separation, and rice storage use for examples in this chapter. This part presents the traditional and modern practices in six stages of harvest and post-harvest for examples.

The harvesting

This is to separate rice seeds from stems. It is one of the essential stages of harvesting. The incorrect methods result in losing both quantity (seeds dropped during the harvest) and quality (low quality from too old rice). The appropriate time for harvesting is important. Late harvest cause reducing rice quality and becomes a good opportunity for pests to destroy rice both in the fields and in the storages. Rice harvesting in the ancient time was gathering wild rice for consumption. Then they learnt to gather the grain of rice by tied several trees together to make a cavity for supporting the ripening seeds. When the rice was ripened, it would fall on the area around the made cavity and easy to collect. In the early period of rice farming, the harvesting relied on human resources. Farmers collected fallen rice on the ground and picked rice from panicles by hands. The important evidence that shows the use of the tools for harvesting rice is the ancient stone tools that look like a blade for harvesting in Mae Hong Son province which dating back to 8,000 years ago (Department of Agriculture, 2002). The harvesting tools have evolved successively, including the use of iron as a part of the tools. There is evidence of using iron as a harvesting tool in Sakon Nakorn province, Northeast Thailand dating back to 2,500 to 3,000 year ago (Department of Agriculture, 2002). Its shape is a hook and looks similar to a sickle in the present time. Thai rice harvesting before the age of Thai agricultural development, in the reign of King Rama V (1869 to 1910), relied on

manpower and basic tools such as sickle and a wooden cart. The form of the sickle in different areas have a similar shape, but in some areas, there is a special tool of sickle different from the others. In some parts of Southern Thailand, farmers use Krae (แกระ) for the rice harvesting tool. This tool is different from sickle in shape but similar in function. It looks like a small blade rather hook. The southern farmers prefer to collect rice by cutting one panicle at one time. This purpose is different from the rest of the farmers in other regions. Other farmers use a sickle to cut at rice stems rather than a panicle. There are some reasons for the southern farmer's practising. The southern part of Thailand is a rainy and windy area and the rice fields usually flooded. Rice in the field is often felt caused by the strong wind. Using Krae collects each panicle at a time in that situation is more convenient than using sickle or machines (Rakbankerd.com). Although there is no record of the use of these harvesting devices is the traditional practice of Thailand and when they emerged in this country but can be found from traditional folk songs such as Pleng Keow Kao song. This traditional song talks about harvesting methods, device, and being careful about it. The traditional harvesting, Thai farmers ask their neighbours to help each other in order to collect all of the rice in the appropriate time, called Long Kaek tradition. This practice has become a tradition that has been practised for a long time in every region of Thailand. However, when machinery has come to replace the workforce, this tradition gradually fades away. There is still using this traditional harvesting in some rural areas of Thailand.

The agricultural machinery was first used in Thailand since 1908 but was not widespread due to the difficulty in using and costly. The rice harvesting machine was first used in Thailand during the years 1954 to 1963 by the Rice Department, Ministry of Agriculture and Cooperatives. The popularity of farmers in the use of rice harvesting machine began to increase after the government paid attention to study, research, and develop the machine seriously in 1978. The government imported the smaller machines to solve the weight and size constraints of the previous version. However, there were still problems with spare parts, repairs techniques, and after-sale services because they had to use everything from aboard. This problem had been resolved in the year 1987 when some of the Thai farmers and private sectors had produced their machine and started as the rice harvesting businesses. This new machine combined harvesting, threshing, and packaging in one machine. It provided convenience and was widely popular in Thai rice farmers.

The ripening period of rice is important for harvesting. Experienced farmers will be able to know that the appropriate harvesting period is related to the term called Plubpleaung (ระยะพลับพลึง) period which is the period that rice is not too old or too young (Department of Agriculture, 2002). It is the period that almost grains begin to turn golden yellow, but there are still some seeds at the lower part of the panicle are green. Individual varies the skill of observing the colour of rice. This result in an inaccuracy in the actual harvesting time begins. The government has introduced modern methods to rely on scientific information to help farmers determine the best appropriate timing for the harvesting. This can be done by considering the flowering date of rice as an essential criterion. It is suggested that whenever the rice in the field is about 80 % flowering, it will be marked as the starting date. Counting from the starting date of the next 28 to 30 days is the appropriate harvesting date. It can help the farmers to prepare for harvesting one month in advance. This harvesting date from the new practice will match with the Plubpleaung period in the traditional practice.

From this study found that traditional harvesting was the use of human labour with basic equipment and the modern practice is to use machines to replace manpower. In addition, the effective harvesting methods have to take into account the appropriate harvesting time. The traditional method will observe the Plubpleaung period, but the modern method currently uses the 28 to 30 days from the flooring date that helps farmers to prepare for harvesting thoroughly. The main field of the scientific knowledge involved in this stage is botany that used to analyse various stages of rice accurately and leads to determining the precise timing for harvesting.

Dehumidification of rice.

The traditional method of dehumidifying rice after harvesting was to tie rice together into bundles and sundried in the fields. There is evidence showing this method has been done since Lan Na period (13^{th} to 16^{th} centuries) (Department of Agriculture, 2002). This method has been widespread and practised among farmers until the present, due to convenience and saving. The modern methods of dehumidification of rice started in Thailand around 1992 by the government and some of the large private companies (Department of Agriculture, 2002). It was the use of machines to reduce moisture in rice before moving to store. The primary reason was to support the farmers who were able to

produce large quantities of rice, and they were not enough space to dry their rice. The problem of the insufficient space for drying rice was due to almost farmers have converted the entire area for cultivation and grow rice all year round without rest for producing the high quantity as much as possible. The farmers had to finish the harvesting as soon as possible and send to the dehumidifier machine that can work 24 hours a day instead of sun-dried in the field. This method is not only to reduce the moisture of the rice quickly but also can prevent the rice from destroying caused by animals and pests while being dried in the fields. The working principle of the dehumidifier machine is the use of hot air to remove moisture from the rice. This principle is similar to drying by the sunlight in the open air. The heat from the sun and the circulation of the air in the open air location will remove the moisture in the rice bundles, a fundamental physics. Although the humidifier machine provides more convenience and effectiveness, the majority of Thai farmers prefer to use the traditional method in the fields rather than pay costs for dehumidifier machine.

The transportation

The traditional rice farming, to transport rice, relied on human resources, cattle, and basic equipment that were created from materials and crafts of local people. The traditional basic equipment included the traditional style of the palanquin, wooden carts, and wagons. The modern transportation method had been used in the same period of the use of a ploughing machine. There was the engine truck using replaced the traditional style. In Thailand, farmers prefer to use small 4-wheeled vehicles that have modified from ploughing machine, called Rod E-Tan (รถอีแต๋น). This vehicle becomes part of Thai rice farmers' way of life today. The using of new transportation significantly reduce the time to transport rice and convenience for today's farmers, but it needs to be exchanged with costs and natural resources such as gasoline and wood from the forest.

Threshing

Threshing is the separation of the rice seeds from its panicles after harvesting. In ancient time, before the rice was cultivated for consumption, people used their hands to separate seeds. Later, rice was grown for consumption; farmers learned to bring some materials to hit rice bundles to force the grains separated from its panicles. Followed by the using of

cattle to trample on the rice bundles in order to separate seeds. The traditional threshing by manpower was to use a piece of wood firmly tied together with a rice bundle and hit the bundle to the specially built floor. This special floor is created by applying fresh cattle dung and let it air dried and hard. This will help farmers to collect the separated rice seeds on the particular ground with clean and without soil and sand particles attached to them. This method can prevent the rice from disease when they move all of them to store. In some farming communities, farmers used a mat or other special containers for supporting the falling grains instead of the built floor. Threshing by cattle was done by placing the harvested rice on the prepared floor. Then brought a strong pole set to the centre of the floor. Tie the cattle to the pole and force them to move forward and trampling on rice bundles. Rice seeds will be separated by trampling. Then farmers removed the empty panicles or hey from the floor and left the separated seeds in the floor before unmounting their cattle from the pole. Before the process is terminated, farmers need to check how much rice has fallen from the panicles. During the day time, farmers can easily check with their naked eyes, but it was difficult to notice in the night time. At night time, farmers used fire to burn at a rice panicle and listened to the fire of rice, a pop sound that similar to the sound from making popcorn. If there was a lot of pop sound, it meant that the rice bundles needed to continue threshing. These are the traditional threshing that is mentioned in many parts of rituals such as Tam Kwan Kao for a very long time. In the ritual, some messages are showing the method of threshing by using cattle and result in the farmers need to make apologies for Mae Phosop, who is a gradient of the rice. The traditional threshing by manpower and cattle can be seen in some areas of Thailand which have a small amount of rice. Similarly to many traditional methods, the old style of threshing is being replaced by a modern machine.

The modern threshing machines were imported for use on the farm in the year 1920. It was used to solve labour shortages in rice farming and the tremendously increasing of the quantity of rice product at that time (Department of Agriculture, 2002). The popularity of farmers in the use of threshing machines began to increase in 1972 when there was a need to threshing a large quantity of rice at the same time. The government has improved the efficiency of the modern machine so that farmers can use it appropriately. At present, farmers turned to use more threshing machine result from more cost-effective than manpower and cattle using. The machine currently and preferable used by farmers is

comprised of harvesting, threshing, and pre-packaging in one machine. It dramatically reduces the workload of farmers than ever.

Impurity separation

The impurity separation is a method to distinguish and remove the impurities that might contaminate to rice such as dirt, soil and sand particles, part of the unwanted plants, and debris that can cause disease and reduce the quality of rice. The traditional methods ranged from using naked eyes to distinguish the things and remove with hands. The farmers also searched for devices such as the large size of leaves in order to blow the impurities away. Some farmers used the sprinkling method by making the rice to fall while the wind blows. The unwanted impurities and abnormal rice seeds will be separated from the perfect rice grains by falling in a different location due to weight respond to the wind. However, this method cannot separate the heavy impurities such as rock fragments, pebbles, and some big soil debris. Some places used a large scoop throw the rice up in the air and use a particular fan called Vee Fan (พัดวี) blows the impurities away from rice. This special fan is made of bamboo woven in round or hexagonal shape. It is hard work and usually done by men. There is many basic equipment used in this traditional practice and mostly created and made from local resources.

Another essential equipment that was popular to separate the impurities is the winnowing machine. This traditional machine relied on manpower to rotate the turbine to create wind before winnow rice grains into the machine. The wind that produced in the machine will blow the impurities away from the perfect rice grains. In the modern method, the engine and motor are installed with the ordinary winnow making it no longer rely on manpower. Modern tools also bring high technology to enhance the efficiency for separating impurities such as electronic devices, measuring instruments, and computer along with the knowledge about gravity force, and mechanic engineering. These help to develop machines that provide more potential to separate impurities that are similar in size, shape, colour, and weight to the rice grains. However, these modern equipment are expensive, result in it is only used by private companies and agriculture trading business.

Rice storing

The harvested rice need to be well stored before being processed for various purposes. Thailand can grow rice only 1-2 times a year, but Thai people have to consume rice every day. If rice product is inappropriate stored, it may cause damage and reduce the quality that affects the demand for rice in Thailand in every age of life. The traditional method of storing rice was to move the rice into the well designed and maintenance storage such as granary and barns. Some places stored rice in some specific containers that weaved from bamboos, such as Krapom (กระพ้อม, large bow), or large basket. This storing method was often found the record in the chronicles. Farmers in the Ayutthaya period (1350 to 1767) had to pay for tax by bringing the amount of rice to be stored in a specific area such as Royal Barns for using in the time of war. The traditional Thai granary (Yoong (ยุ้ง)), and barn (Chang (ฉาง)) are specific building for storing rice. They were designed and built differently according to the type of materials, budgets, and cultures in each region. Some places used bamboos to weave as lids and then applied inside with fresh cattle dung in order to close the holes preventing rice flowing outside. Some places used some unique grass strains to weave into the lid to prevent insects from destroying rice in the granary. If the farmers did not have a granary or a barn, they used bamboos to make a specific container and used cattle dung to fill the holes of the container to store rice. These containers will be kept under the house or built a simple small house for them to protect against sun and rain. This traditional practice has been passed on since the ancestors and remains seen in many places in Thailand. This traditional method is the natural moisture and temperature control, which may cause damage to rice. Many farmers who use this method has the potential to encounter problems from pests, disease, and animals destruction. Some farmers put some materials or parts of plants at the bottom of granary, barn or containers that are believed to be able to prevent, eliminate and chase rice enemies. When rice production was increased, there is a problem with storage and storage quality. The modern method of storing rice began in the year 1972 onward (Department of Agriculture, 2002). It was a storage that had special control for the environment. Due to the high investment on instruments, the areas, and operators, it was usually found in rice trading companies and rice export companies rather than ordinary farmers. The modern rice storing uses air conditioning with the environment-controlled building to prevent moisture transfer and air exchange from outside the store. To create a controlled state, special plastic cover may be appied to prevent air and moisture transfer. Moreover,

some chemicals are used to reduce the amount of oxygen or add carbon dioxide into the system to control pests. All of these new methods have a limitation on costs which general farmers are not able to operate on their own. The current storage of rice is, therefore, using the original method combine with new equipment and tools such as using hygiene principle to storage management, using the synthetic chemicals to prevent, eliminate, and chase rice enemies. However, due to general farmers have not enough space to store their rice, it results in increasing the costs for farmers to keep their rice at rice trading companies' storages.

The traditional style of rice cultivation in Thailand is similar to that of other plants. Traimongkonkul et.al. (2001) studied the transformation of rice cultivation practices in the central region of Thailand and discusses the traditional and modern practices, particularly in terms of the use of technologies for rice farming in Thailand. Their research focused on the Maharacha field, located in the Ayudhya province, for the study of traditional practices. This area has been used for rice farming very a long time in history. The field has provided a high rice yield for communities in the past. The farmers in this area are familiar with the traditional rice cultivation practices and continue to apply them despite the existence of modern, high-quality technologies, or new styles of cultivation utilised in many other rice farms in other regions of Thailand (Traimongkolkul et al., 2001). However, the farmers at Maharacha have faced difficulties. These farmers' rice fields are losing the essential elements and have been affected by changing environmental and social factors. These changes have led farmers to a financial crisis in terms of costs. Traimongkolkul et.al (2001) argue that the traditional style of rice farming in this area is similar to that of the past and those of other farms that have attempted to conserve their traditional practices. Maharacha's farmers grow, maintain, harvest, and transform their product by themselves, using mostly man and animal power. These farmers accurately understand the whole system of rice farming and control every stage using their own skills. Only one or two farmers were able to manage a large farm. When their farm grew in size, many farmers were no longer able to manage, and would seek to co-operate with neighbour farmers or community members without offering them compensation. Traimongkolkul et.al (2001) further discuss traditional styles of rice cultivation and how each has the ability to manage almost every process of farming with

limited use of technology. Rice farming tools have been created, formed, and produced using farmers' traditional knowledge and practices.

Traimongkolkul et.al (2001) also studied the Banglain field in the Suphanbury province. This area has been promoted and supported by the government as a land for modern rice cultivation. Banglain's geographical structure is a delta and similar to that of the Maharacha field. The government has established an exemplary irrigation system to supply sufficient water to Banglain's farmers in order to produce rice throughout the year. In contrast to the Maharacha field, new systems and technologies have been introduced to this area, whereas Maharacha's farmers still use traditional tools and grow local strains of rice such as Khao Loi (floating rice), which is a special rice strain that has the ability to extend its nodes above the water level when the Maharacha field is in flooding. The modern style at the Banglain field includes efficient irrigation systems, the use of machinery in almost every stage of cultivation, the using of chemical fertilisers, pesticides, high-quality technology tools, and specialists (Traimongkolkul et al., 2001). The main purpose of rice farming in this area is large-scale rice production for the global market. Farmers can grow their rice whenever they want due to the sufficiency of resources and tools, whereas the farmers in Maharacha field rely on climate and usually encounter flooding every year. The farmers at Banglain incur high costs and rely on machinery more than man and animal power, meaning that cultivation is an intensive and mechanised form of rice farming (Traimongkolkul et al., 2001). Farmers at this location seemed to serve more as managers on duty rather than farmers, as they tend to hire specialists for almost every stage of the cultivation process.

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