Huri Whakatau: The Call for Māori Software Requirements Elicitation

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Abstract

It is essential to consider specifications and design when examining the requirements for new software for stakeholders and software engineers. The Huri Whakatau project investigates current relevant requirements and design techniques to understand the Māori (Indigenous people of Aotearoa) demographic to identify any relevant gaps for examining requirements.

The process has been tested by investigating existing internationally accepted groups and their methodologies to attempt to adapt a new methodology for Māori groups. In the context of the research, an accepted group is defined as a group which is not from a developing country or Indigenous group. The research was able to identify three untested methodologies; this involved conducting an empirical study as a part of the experiment. The decision was to transform the internationally accepted soft systems methodology (SSM) with groups in a user study. Comparing previously recorded satisfaction using the technique and the use of Māori techniques determined that SSM would be the strongest candidate. When testing SSM with participants, overall, there was a higher level of satisfaction with Māori participants using the new proposed adapted Māori approach as opposed to the internationally accepted groups.

Acknowledgments

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Contents

Glossary

Aotearoa – New Zealand

CATWOE – Customers, actors, transformation process, world view, owners, environmental constraints

Hui – Meetings

Iwi – Tribal group or groups

Kaitiakitanga – Guardianship and protection

Kanohi ki te kanohi – Face to face

Kaumātua – Elder or someone with a lot of mana

Kaupapa Māori – A Māori approach, topic, customary practice, institution, agenda, principles, ideology, a philosophical doctrine, incorporating the skills, attitudes and values of Māori society

Koha – Gift of sentimental value

Kōrero – Discussion, story, account, state, talk

Kuia – Female elder or elders

Mana – Prestige, authority, control, charisma, spiritual power

Manaakitanga – Improve each other's mana

Mātauranga – Māori knowledge

Mihi – A greeting, an acknowledgment

Oranga – Wellbeing, health, living

Pākehā – New Zealand of European descent

Pepeha – Introduction

Te ao mārama – Wisdom and understanding/Natural world of life and light, kaupapa Māori methods

Te reo – The (Māori) language

Tikanga – Correct procedure, traditional values, custom or body, especially in a Māori context.

Vision mātauranga – A policy-driven mission to "Unlock the innovation potential of Māori knowledge, resources and people to assist New Zealanders to create a better future".

Wānanga – Education in a Māori cultural context/environment

Whakatauki – Speech or expression

Whakawhanaungatanga – Process of getting to know each other

Chapter 1

Introduction

The most essential step in the creation of new software entails the problem specification and design by relevant stakeholders and software engineers. According to Braz et al. [1], “Software Engineering leads to the use of approaches, models, processes, and methods to design and build technological solutions for a specific group of people”. However, accepted software engineering (SE) methods do not take into consideration the needs of Indigenous peoples who are underrepresented in science and engineering. For instance, minority speakers of Indigenous languages tend to be segregated by the majority group, which precludes the development of fit-for-purpose SE methods for the minority group [2]. While software development companies may incorporate Māori engineers and develop software for Māori, there is no systematic codification of kaupapa Māori (a Māori approach, topic, ideology attitudes and values of Māori society, see Glossary) software practices for them to use. Further, even though Indigenous/Māori rights have gained momentum, resulting in an increased demand for Māori SE researchers, there are as yet not enough researchers to carry the field forward [3].

To understand these gaps, one needs to study the country’s past: According to Ranginui Walker [4] “New Zealand was founded in the year 800CE and was the last of the Polynesian settlements”. In 1769, Captain James Cook met the Polynesian tribes of New Zealand. Both the voyagers and the New Zealand settlers were able to establish a European–Māori agreement in 1840 eventually known as the *Treaty of Waitangi* after several encounters. The European voyagers established a settling governing force leading to the colonisation of New Zealand land. With the regression of Māori speakers and population due to land wars, land alienation, and imported diseases, the European population flourished and became dominant. Over the years, with a lack of resources due to a significant proportion of their land being confiscated by the Europeans, many Māori people began moving from their traditional homelands to integrate into cities for work. The European culture that

thrived was oblivious to Māori customs, Māori language, and Māori systems of knowledge and engineering.

Essentially, this thesis investigates the importance of Māori tikanga (cultural values), such as the process of whakawhanaungatanga (getting to know each other), kanohi ki te kanohi (face to face), to manaakitanga (to improve each other's mana), to ascertain the effect on the quality of requirements generated if these aspects are absent (this will be explained in more detail in Chapter 4). To determine whether these two main points are possible, an empirical user study involving Māori participants will need to be conducted (this will also be explained in more detail in Chapter 5).

It is suggested that this thesis is the first to highlight the need for Māori-specific software elicitation, and hence contributes to the broader field of Māori SE. Overall, this thesis makes the following key contributions; it

- Identifies and highlights the gap in Māori software requirements elicitation;
- Conducts a systematic literature review (SLR) to survey academic publications on the topic;
- Classifies accepted and Māori methods discovered based on their similarity and rate of usage;
- Generates an interface between accepted and Māori methods by mapping the similarities of processes between them;
- Proposes a research roadmap to push the field of Māori SE forward, focusing on the development and evaluation of fit-for-purpose elicitation methods.

There were three main criteria for deciding which technique would be incorporated. The first criterion was finding a technique that seemed to be untested by Māori rōpū, which began the next phase that covered the two other crucial criteria. In the second phase, the two important criteria were: satisfaction and similar application of existing Māori techniques, as these are the main aspects valued by Māori groups. To determine satisfaction when reviewing the results of existing accepted literature, and the participants' level of satisfaction with the methodology and overall result, we needed to understand the

application of Māori techniques and whether there was a similarity between the application technique and similar existing techniques that had been conducted in previous Māori studies alongside the application of kaupapa Māori philosophies and mātauranga Māori (Māori knowledge) concepts. Once each technique had been analysed individually, a comparison analysis was conducted of the level of satisfaction recorded by existing literature and the application of Māori techniques determining the soft systems methodology (SSM) to create a new Māori technique for creating software which incorporates kaupapa Māori philosophies and the process of whakawhanaungatanga.

Kaupapa Māori philosophies are the practice of Māori cultural values and philosophies. A brief overview of the Kaupapa Māori key concepts are: First, “doing something for Māori reasons and not self-benefit” means when the decision-making process is occurring, all perspectives are taken into account and the best result is provided once every perspective has been provided. An example of this is a piece of Māori software that has been created with the contribution of the Māori people. Second, “doing things for Māori people” means ensuring the reason the action has been completed is to the benefit of the Māori community as a whole. Third, “doing things in a Māori way” means ensuring the practice incorporates practices that are deemed acceptable by the Māori community. This includes several practices, but one example is saying a Māori karakia (prayer) before and after a formal meeting. Fourth, whakawhanaungatanga is the building and maintenance of relationships; an example is the concept of reconnecting with people after an extended period with no communication; whakawhanaungatanga involves multiple subcultural values that are explained further in Chapter 3: Systematic Literature Review.

Finally, using the SSM determined the changes needed to allow for people to perform whakawhanaungatanga with the other participants, both strengthening relationships and creating a positive and productive environment when performing the Māori SSM, alongside a change of the concept prototyping with feasible and desirable changes combined in one stage to create a collaborative process creating a six-stage SSM process. The main process involved a pre-interview phase, asking participants questions regarding

their background, experiences, and expertise with whakawhanaungatanga and software; this is discussed in Chapter 5 (the interview questions can be found in Appendix A). Once the interview phase was completed, the study commenced, first testing the accepted methodology, and, once completed, moving on to the proposed Māori methodology with surveys to understand how participants rated each methodology. Once the conclusion was reached, the participants were thanked for their participation and asked if they had any questions regarding the research or the user study that was conducted. Before testing whether the process would be successful in a full user study, a pilot test was conducted with three participants to identify any changes that would need to be incorporated. The pilot user study was successful, allowing a transition into the full user study where participants were given an ethics consent form to sign before joining the study (see Appendix B); once signed, everybody was assigned to a group consisting of four participants. The main study repeated the successful pilot-user process with the two techniques followed by a survey (see Appendix C), and concluded by allowing participants to ask questions.

The main contribution of the Huri Whakatau project is to incorporate kaupapa philosophies into internationally accepted methods to improve SE practices globally. Incorporating kaupapa Māori philosophies is vital for Māori-specific requirement elicitation methods and processes. These methods and processes can be used to address issues within the engineering field to generate high-quality results when interacting with stakeholders or customers.

The thesis is arranged as follows. Chapter 2 will investigate the related work of other researchers to provide background on the attempted works of Māori culture both within and outside of software, alongside the non-Indigenous (I reference this as the *accepted group* within the thesis) research for a relevant gap. Chapter 3 will explain the process of conducting the SLR to identify the key similarities between Māori and accepted groups. Chapter 4 will examine three accepted techniques (founded on the results of Chapter 3) that have not been applied to Māori people, alongside a comparison of the intended

audience and how the techniques would apply to kaupapa philosophies and mātauranga concepts to determine the best overall technique for a user study to test the research findings. Chapter 5 will apply the approach found in Chapter 4 to create a pilot study which becomes a full user study to gauge participant satisfaction to determine improvements for the technique alongside the success of the technique. Finally, Chapter 6 will conclude with the overall stages taken in the research and the overall outcomes of the research.

Chapter 2

Related Work

Requirements elicitation constitutes a rich and fast-developing field of research that has attracted a lot of research in recent years [2]; there have been contributions made in improving requirements elicitation for users who are members of developing countries or part of *underrepresented* groups, which have aided in creating a higher demand for research. This thesis defines underrepresented groups as groups of people who do not fully follow internationally accepted knowledge methods, such as people from developing countries or Indigenous groups. Even though the research discovered a large number of research papers on improving requirements elicitation concerning underrepresented groups, there is comparatively minimal work done in this area for citizens of developing countries or members of Indigenous groups. Nevertheless, one needs to remember that Māori knowledge is not generally expected—yet—to be codified in standard academic venues; thus, a lack of papers on the field does not imply a lack of content.

Keegan and Mato [5] investigated a smartphone created by 2 Degrees Mobile Limited, which attempted to incorporate a Māori language interface. They decided to create a study to understand Māori community members' perspectives on the product. Throughout the study, they realised a common issue for participants was the unfriendly interface which caused frustration alongside the lack of familiarity with the words being translated. Another example is Wagner's [6] paper on the Status Quo in Requirements Elicitation which covered performing empirical and valid foundations regarding requirements elicitation; the paper also mentions the "underlying theory" and their results with participants through empirical studies and compares the difference in each country. After the study, Wagner realised there was no significant difference between any of the countries, with interviews, facilitated meetings, and prototyping being the common techniques believed to be a strong starting point for detailed investigations. However, these papers did not conduct a formal literature review.

Only one paper, by Crow and Parsons [7], followed a formal literature review protocol. Their research investigated the development and evaluation of mobile learning tools in the Māori language. They reported multimedia sources have created multimedia to aid in rejuvenating the language. Applying game mechanics to other areas, known as "gamification", is a technique used to improve the experience for people when learning, in this case the Māori language. Crow and Parsons's main investigation used the design research process where the product was tested with prototypes to determine the success of implementing techniques related to Māori language learning. After testing the development cycle, they reported their classroom observations that the product was "engaging and effective for vocabulary learning". No formal research questions were created but an investigation into various disciplines of mobile research was conducted. After investigating the disciplines, an overall finding was reported on the benefits of gamification for mobile devices; they then proceeded to create their methodology from the results of the literature review.

There was significantly more literature relating to accepted groups on Google Scholar, and with the more extensive research done by the accepted group, there was a significant contrast in how a literature review was conducted. Three main forms of literature reviews include:

- Systematic literature review [1]
- Literature review [8] [2]
- Existing literature [9] [10]

Requirements elicitation is how software engineers gather, analyse and formulate information to create specifications to present before beginning the development phase. The field of visual design has an adapted concept similar to requirements elicitation called: design thinking (DT). DT can be defined as "a human-centered approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success" [11]. Both requirements elicitation and DT investigate the needs of people using technology.

Braz et al. [1] incorporated DT into agile development, specifically in the requirements elicitation phase, through an exploratory study. They conducted an SLR using three main databases: ACM's Digital Library, IEEE's Digital Library, and DBLP-Computer Science Bibliography via a manual search analysis. Braz et al. generated a few search strings for their SLR and selection criteria, with inclusion and exclusion criteria alongside quality criteria. When going through the identification phase, they called it "selection of primary studies" which then led to them generating their results and future work.

Visual design finds the information provided by the target audience vital as it provides key information to provide a visual vocabulary [12] "Finding information", which includes "analysing/synthesizing", and "using information classified as communicating", are a few of the subcategories visual designers use to elicit requirements [13]. Eliciting requirements in visual design seems to be a key process that is used in the design process. The design process involves five aspects as displayed in Table 2.1 [14]:

Table 2.1: The five main design process techniques

Number	Design Process Technique
1	State of the design
2	Goal of the design process
3	Design decisions and rationale
4	Control of the design process
5	General knowledge of the design

Recruiting participants is a crucial process for requirements elicitation as the technique can be empirically tested to determine any unforeseen issues or improvements that need to occur. Social linguistics leverages such methods for underrepresented groups, including Māori. The field of social linguistics has a similar technique called the *friend-of-a-friend approach*; this approach is similar to how Indigenous groups elicit requirements, this involves people going through their social network to get participants for their study [15] and through their network to elicit requirements, as displayed in Figure 2.1. Bishop [16]

mentioned a similar technique to the friend-of-a-friend approach Māori groups have elicited, called *whakawhanaungatanga,* which is the process where people understand the information in regard to each other and any relations they may have; another meaning for the term is to understand each other between extended periods of lost communication. The concepts of mātauranga Māori, kaupapa Māori, and whakawhanaungatanga are discussed more in the Māori elicitation section. The work of both Bishop and the friend-of-a-friend approach help to create an understanding of how the process works for both groups. Figure 2.1 below shows the relationship between the methods which can be beneficial for both groups in understanding how to find a relationship for the upcoming research.

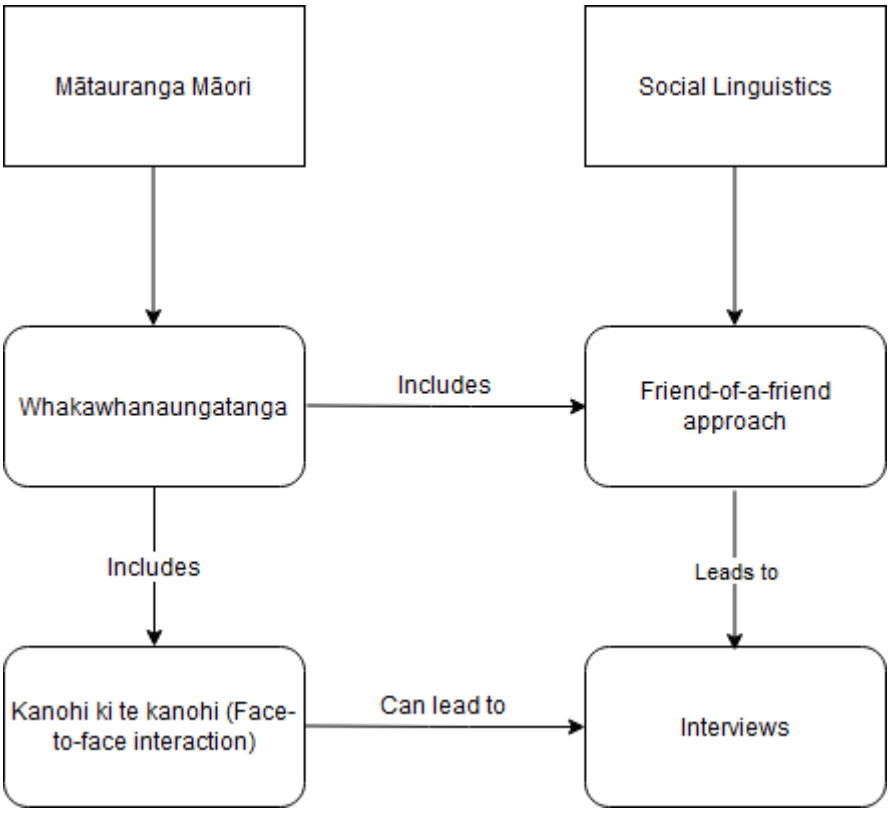

Figure 2.1: A mapped diagram for the relationship between mātauranga Māori and social linguistics

When investigating the literature, there were a few gaps evident; I was able to identify the following gaps in the papers below:

- What are the DT techniques used? What are the challenges faced in the

requirements elicitation of agile software development projects? [1]

- Are there ambiguities identified during the interview review to be used to ask useful questions in future interviews? [17]
- What existing software tools exist for Māori language learning and Indigenous language learning on mobile devices? [7]
- How can changing the viewpoint in developing countries to improve success rates of requirements elicitation of a research paper that could apply to Indigenous groups? [2].

Overall, the analysis of existing literature has presented a large gap where requirements elicitation for mātauranga Māori groups has not been explored. Although empirical testing has been conducted for developing countries, there has been no recording of the efficacy of requirements elicitation techniques and best practices for Māori groups. The next chapter will explain the process of the SLR alongside the differences and common techniques and methods Māori and accepted groups use to elicit requirements in research.

Chapter 3

Systematic Literature Review

After investigating the methodologies other exploratory studies incorporated, it was apparent the specific areas of both mātauranga Māori and requirements elicitation were not being investigated; this led to the decision to begin finding a gap in the research. There were three main literature research questions (LRQ) that aided the research in the best approach to creating the SLR; the three questions were:

- LRQ1: What mātauranga Māori techniques are used to elicit requirements? What impact do these techniques have on generating specifications?
- LRQ2: What "accepted" techniques are used to perform requirements elicitation? What impact did these techniques have on generating specifications? How do these techniques compare to Māori techniques?
- LRQ3: Are there any Māori software engineering requirement design methods that currently exist? If so, what are they?

An SLR was conducted; there were two main phases to consider when the SLR was conducted. First, planning the SLR, where the search strings used when investigating three different types of databases were determined, helped me to narrow down the field-generating search strings and create inclusion and exclusion criteria for the research. Second, the identification phase was an investigation of the title and abstracts of all literature; if they were within the scope of the inclusion criteria, and didn't meet the exclusion criteria, they advanced to the Introduction and Conclusion analysis. The same process was conducted for the Introduction and Conclusion analysis to the full-text analysis and the same for the full-text analysis to accepting the paper in our decision-making process. The papers we allowed past the full-text analysis were referred to as "accepted papers" alongside the snowballed papers. The results of the flow diagram in Figure 3.1 show the number of papers in each stage of the process.

3.1 Search Terms and Techniques

To begin understanding the correct search term techniques for the SLR, there were four main items to consider, these were: *Western* or *accepted* requirement elicitation techniques, *mātauranga Māori* requirement elicitation techniques, developed software by Mātauranga Māori and their process to generate the requirements, and, finally, current or traditional methods to elicit these requirements. After determining all these factors, alongside doing ad hoc manual search analysis, I decided to use these as the main search terms when conducting database searches:

- "Elicitation technique" OR "elicitation techniques"
- Technique OR techniques
- Modern OR current
- Traditional OR tradition OR previous
- "Māori" OR "matauranga Māori"
- Western
- Indigenous
- Specifications OR requirements
- "Software engineering"
- "Design methods"

3.1.1 Databases

The databases used came from three different sources: online resources, library resources, and external resources. All databases contain different forms of information; an example is Google Scholar, which provides a large database that contains a high volume of accepted papers that have been peer-reviewed.

3.1.1.1 Online Resources

These databases were found by investigating online resources where potential relevant research had been conducted. All databases have vital information in the field of requirements elicitation, which is why the five online databases in Table 3.1 were investigated.

Table 3.1: Suitable databases for SLR

Number	Search
1	Google Scholar
2	Institute of Electrical and Electronics Engineers (IEEE)
3	Scopus
4	Science Direct
5	ACM Digital Library

3.1.1.2 Library Resources

Building on a local community is essential since one of the main focus areas is Māori techniques and practices, which is why investigating the University of Waikato Library for information is vital when conducting an SLR as this will contain a large selection of resources to aid in providing local community work.

3.1.1.3 External Resources

When looking for software created by Māori, it was apparent there were few papers with relevant information, therefore a decision was made to investigate the work of two Māori researchers at the University of Waikato: Te Taka Keegan and Paora Mato, as they have a number of Māori software contributions, including an investigation of a telepresence system for Māori communities [18], and research around the success of Māori smartphone interfaces [5].

3.1.2 Search Strings

Table 3.2: Search string table rules

Number	Search String
1	(Māori OR mātauranga Māori) AND "*software*" and ("*needs*" or "*interview*")
2	(Māori OR "mātauranga Māori") AND (specifications OR requirements)
3	Western AND (specifications OR requirements)
4	(Western) AND ("elicitation technique" OR "elicitation techniques")
5	"*Māori*" AND "*software*" AND "*design*"
6	"*Māori software*" AND "*decision making*"
7	"*Software*" AND "*requirements elicitation*"

Deciding the correct search strings is important as the research needs to contain both relevant and a large number of sources. An example of the importance of source abundance is due to one of the search strings being removed (Māori OR Mātauranga Māori) AND ("*elicitation techniques*" or "*elicitation technique*") due to only yielding seven search results on Google Scholar (see Table 3.2) alongside only nine results on "*Māori software*" which resulted in the search strings needing to be refined.

3.1.3 Criteria for Study Selection

With the search strings aiding in providing the key information, when investigating the relevant resource, both the exclusion and inclusion criteria need to be taken into account. The subsections below will explain the inclusion and exclusion criteria for the research and how they aided in finding the correct results.

3.1.3.1 Inclusion Criteria

The inclusion criteria are the terms and techniques which were chosen to be included. Five main inclusion criteria were identified in aiding the results (see Table 3.3).

Table 3.3: Inclusion Criteria in SLR

Number	Inclusion Criteria
1	Modern OR traditional
2	Mātauranga Māori OR Māori OR Western
3	Māori OR Indigenous OR Western
4	"*Elicitation technique*" OR "*elicitation techniques*" OR specifications OR requirements
5	Produced from software

3.1.3.2 Exclusion Criteria

The exclusion criteria are the terms and techniques which were chosen to be excluded; these are important to prevent irrelevant results from appearing in the review. Four main exclusion criteria were identified, these are shown in Table 3.4.

Table 3.4: Exclusion Criteria for SLR

Number	Exclusion Criteria
1	NOT modern OR traditional
2	Modern AND traditional
3	NOT an "*elicitation technique*" OR "*elicitation techniques*" OR specifications OR requirements
4	Not Māori OR Indigenous OR Western

3.1.4 Identification Phase

The identification of the papers selected for the SLR is as follows: the four main phases were title and abstract screening, introduction and conclusion analysis, full-text screening, and snowball analysis. Title and abstract screening is the first phase, to filter out any irrelevant papers from external fields such as health science. After successfully filtering out the incorrect fields, the second phase, introduction and conclusion analysis, is used to further investigate the selected papers to determine if they still meet the inclusion and exclusion criteria; if successful, the paper moves onto the full-text analysis, then snowball analysis to gather information to generate research questions. The results and numbers of each stage are displayed in Figure 3.1 below.

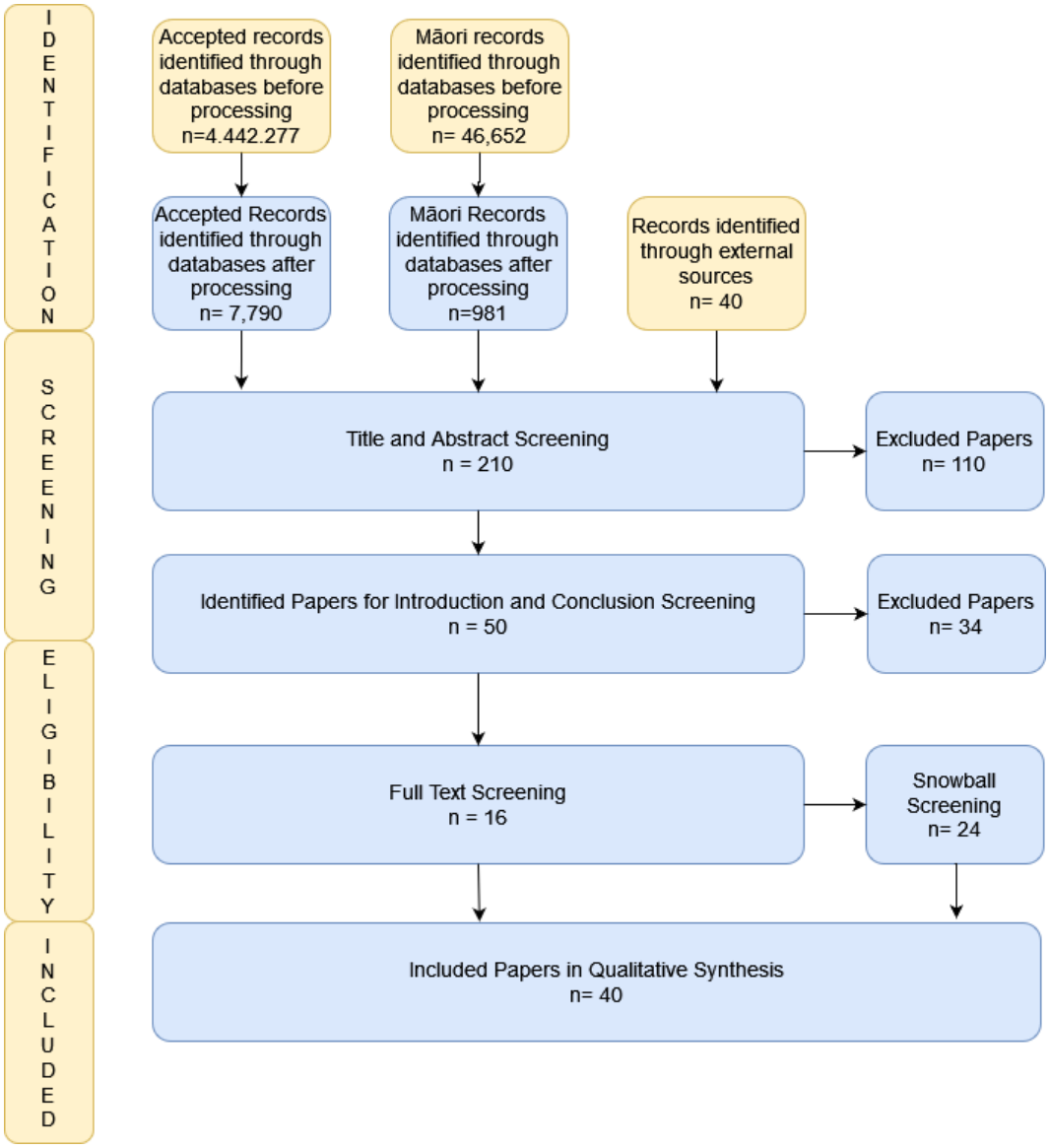

Figure 3.1: Flow diagram for systematic literature review

The Māori and accepted techniques have different criteria but has been categorised as the same, due to the accepted fields containing more papers and having international engineering papers.

3.1.4.1 Title and Abstract Screening

A total of 210 papers were selected for analysis. One of three issues leads to papers being ignored: incorrect field, incorrect topic, or incorrect population. These were identified by comparing the inclusion and exclusion criteria against the papers.

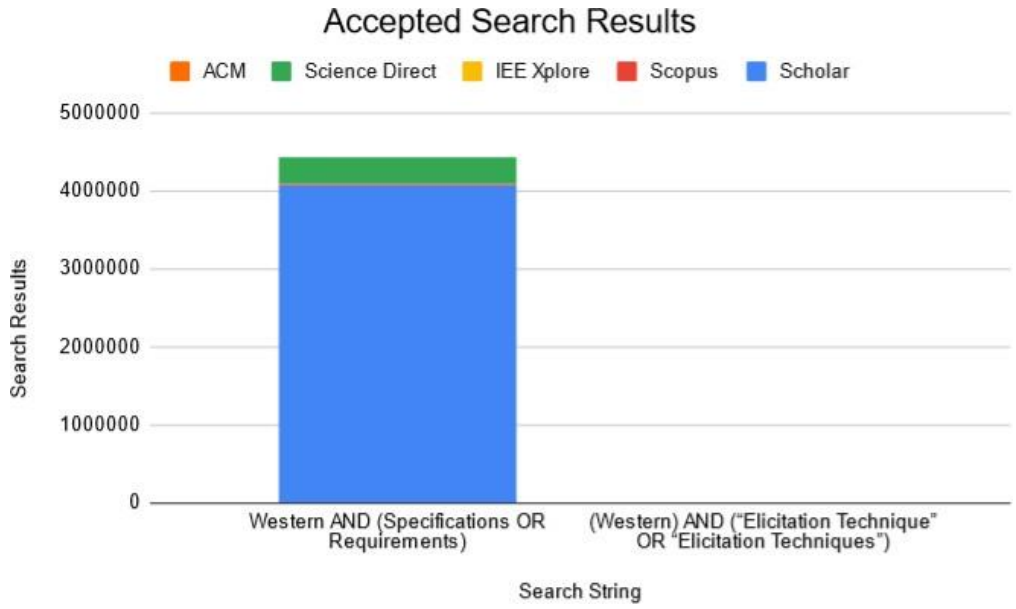

Figure 3.2: Accepted elicitation techniques search results

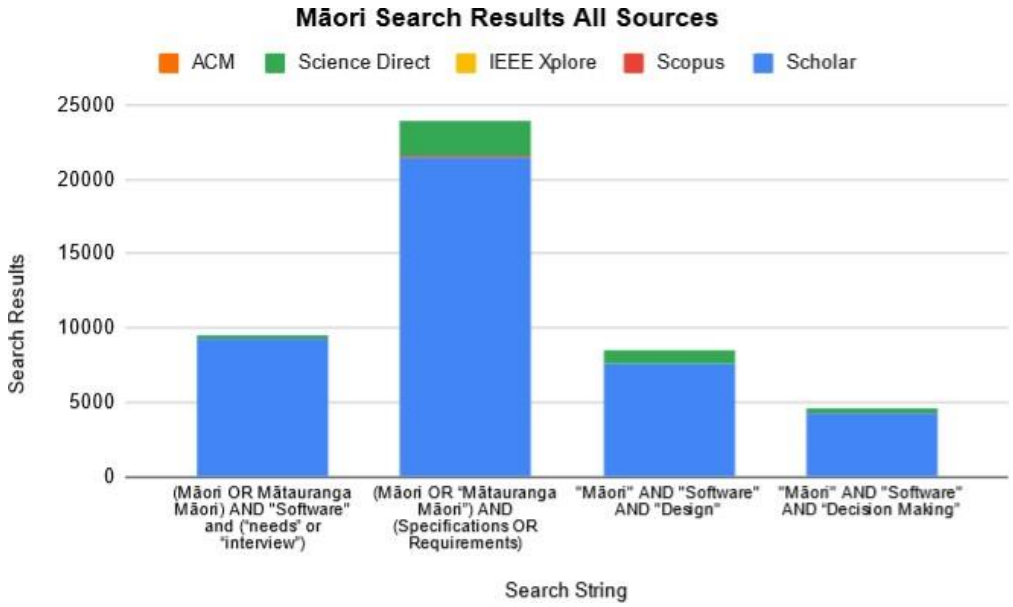

Figure 3.3: Māori elicitation techniques search results

When performing a search string analysis on the Māori topics, I discovered a large number of papers that were completely unrelated and could be categorised as either teaching, cultural preservation, or education. Thus a different approach was taken to meet the quota for the introduction and conclusion phase for identified Māori researchers in the field with relevant publications. When reading through both Keegan and Mato's [5] [18] papers, I identified the gaps and current existing literature regarding the field to determine the

number of focus areas for the software mātauranga part of the SLR (as displayed in Figure 3.3 above).

There was a large amount of existing state-of-the-art literature with around four million results on Google Scholar (see Figure 3.2) compared to Māori literature that had around twenty-five thousand results (see Figure 3.3) which enabled specific search strings to define the specific gap identified. A significant number of papers creates parameters to comprehend current gaps by reviewing papers published after 2017. A large portion of these papers was found via the Google Scholar database. When reviewing existing literature, although the SE field was relevant, a large number of papers were not identified for the requirements engineering subfield which was an “incorrect field”.

3.1.5 Introduction and Conclusion Analysis

After concluding the introduction and conclusion phase and identifying which papers held relevance for further analysis, the introduction and conclusion of 50 papers were screened to determine which papers were still within the inclusion and exclusion criteria for a full-text analysis. Reasons for excluding papers in this area included having a single elicitation requirement, cultural focus, being a non-empirical study, and being unable to access the source.

3.1.5.1 Full-Text Analysis

For the full-text analysis, only sixteen full papers were analysed to identify the specific research methods and techniques used, and the results from their research to determine a gap for our upcoming user study. To do so, all papers needed to be rigorously investigated to ensure they were both relevant for the purposes of the research and could benefit Māori groups.

3.1.5.2 Snowball Analysis

After analysing all papers, key citations which appeared a large number of times were investigated for snowball analysis which was important to ensure we did not miss a relevant gap that could change how the research was conducted.

3.2 Requirements Engineering

Requirements engineering for software is the first step in the software development process [19]; it aims to elicit, analyse and verify the requirements software needs to meet, such that effective specifications are generated.

3.2.1 Requirements Elicitation Techniques

3.2.1.1 Information Gathering

The first phase is to gather information from the stakeholders. Apart from extracting what the software needs to do, this phase also decides on fit-for-purpose approaches for the specific use case to generate software requirements. The research identifies the following accepted techniques being used by requirements engineering researchers:

- Interviews [20]
- Structured interviews [9]
- Use of domain and architectural models [21]
- Surveys [2]
- Observation [22]

3.2.1.2 Requirements Expression and Analysis

Once the requirements conductor finishes gathering information, they need to analyse the quality of the elicited requirements. The second phase, requirements expression and analysis, uses scenarios and simulations to assess the software's expected performance in a realistic situation, identifying the following requirements expression and analysis techniques:

- Controlled requirements elicitation (CORE)
- Soft Systems Methodology (SSM) [9]
- Profile distance method (PDM) [9]
- Role-playing scenarios
- Fault tree analysis [23]
- Agile [24]

3.2.1.3 Validation

The final stage ensures that elicited requirements are presented to the stakeholders, which will determine whether the results generated are correct to ensure high-quality requirements are generated; the validation techniques found were:

- Quality function deployment (QFD) [25]
- Concept prototyping [2]
- Iterative process of elicitation techniques [9]
- Flowcharts [2]
- Decision trees [26]
- Repertory grid [27]

Although those techniques are beneficial, the SLR brought out some papers that mentioned the techniques found; the main papers are mentioned in Table 3.5.

Table 3.5: Accepted techniques in papers

Number	Paper	Author	Techniques
1	Requirements Elicitation	Myers	Focus groups, repertory grid, card sort (ranking), hierarchical task analysis and interface analysis [27]
2	Issues in Requirements Elicitation	Christel	Interviews, team approach, use of domain, architectural models, CORE, SSM, PDM, QFD, concept prototyping, iterative process of elicitation techniques [9]
3	Teaching Requirements Elicitation Interviews: An Empirical Study of Learning From Mistakes	Bano et al.	Interviews [28]

3.2.2 Gaps and Limitations of Accepted Techniques

Although these techniques are accepted internationally, they are less effective for Indigenous groups, due to differences in recruitment and engagement processes. Sadig and Sahraoui [2] mentioned when testing with African groups that local needs were created for a specific goal so the techniques were “special”. The same applies for Māori groups where

face-to-face trust building is required before gathering information on the approach when creating software.

3.2.3 Requirement Analysis Conclusions

Three stages of requirements elicitation were identified from the accepted techniques; they were: information gathering, requirements expression and analysis, and validation. Each phase served a different purpose to ensure high-quality requirements were generated. Although this field has worked for an international audience, reports of countries following a direction for "local needs" [2] would struggle to use the accepted techniques. Mātauranga Māori groups require specific processes to gather the information to generate requirements, so specific processes need to be created.

3.3 Background

According to Walker [4] "New Zealand was founded in the year 800CE and was the last of the Polynesian settlements". Māori groups take their names from the *waka* (canoe) that brought them to New Zealand [29]. In 1642, Abel Tasman was the first European visitor to New Zealand. Captain James Cook was the next European to visit New Zealand, in 1769. Cook's visit later led to European–Māori agreement in 1840 with the signing of the Treaty of Waitangi [29]. Through the treaty, Māori groups became the minority people and moved from traditional homelands to urban areas which were dominated by the European colonisation [30]. Despite Māori groups becoming a minority, they were able to hold onto their key values, two of which are whakawhanaungatanga (see Chapter 2) and manaakitanga (see 3.3.1.1 Cultural Values).

3.3.1 Evolution of Māori Culture

Māori groups were able to hold onto their cultural values, but, as time progressed, the Māori population became more of a minority. In the year 1900, it was reported that the Māori population was at its lowest [30]. In 2002, it was reported that only fifteen percent of the 3.6 million New Zealand population identified as Māori [31]. Māori also did not have a traditional written language, making a stronger reliance on verbal and visual communication making kanohi ki te kanohi (face-to-face) interaction more valuable.

3.3.1.1 Cultural Values

Throughout the evolution of Māori culture, key values have been adhered to; an important aspect is *mana*, which is where a person's respect from the community is determined. A person with high mana is respected by the community, but a person with little mana is not highly respected, which in turn leads to no acknowledgment from the community. An example of why mana matters is in formal kanohi-ki-te-kanohi *hui* (meetings) where the group will ask the person with the most mana for guidance but ignore people with little mana. The second term is whakawhanaungatanga (see Chapter 2); this is the most essential term as Māori groups find relationship building essential [32]; it is the first process before being able to gather requirements and has been defined as a requirements elicitation process. Many subvalues are honoured in Māori culture, for example, *koha*, the process of gift giving to start building a good relationship; but the main one to discuss is the third value manaakitanga, which is also a subcategory of whakawhanaungatanga. Manaakitanga is the process of building another person's mana; this is essential to Māori groups as mana is something they value highly as it is a form of respect from the community and earns their trust to be able to elicit requirements.

3.3.1.2 Mātauranga Māori

Mātauranga Māori is the knowledge created by Māori to assist Māori with a te ao mārama (wisdom and understanding) viewpoint [33]. The creation of information by Māori is vital as they follow a 200-year viewpoint which involves a strong Māori understanding. Several movements follow the mātauranga Māori concept, examples include: Vision Mātauranga and wānanga (education in a Māori cultural context).

3.3.2 Requirements Elicitation

Requirements elicitation is the process by which a person gathers information and develops a prototype to start developing a product or software. Māori groups follow similar techniques to the accepted methods but the person eliciting the requirements must undertake a different process.

3.3.2.1 Culturally Specific Techniques

Māori groups heavily emphasise the concept of whakawhanaungatanga and building relationships before allowing people to begin discussing topics that involve Māori values or ideals, this is referred to as a *process*, hence the name: requirement elicitation processes. The elicitation processes are as follows:

3.3.2.2 Information-Gathering Techniques

Following key Māori cultural values, there are five main information-gathering elicitation techniques found in the information-gathering phase of requirements elicitation. These are listed in Table 3.6:

Table 3.6: Māori information-gathering techniques

Information-Gathering Technique	Description
Interviews	Passed down information, face-to-face discussions (open or closed)
Identifying key stakeholders	
Empirical studies	Tweeting on public forums, conversing
Historical research	Collections
Inclusion of Māori developers/ engineers	A Māori engineer vs an engineer who happens to be Māori

3.3.2.3 Requirements Expression and Analysis Techniques

After the information has been gathered, Māori groups also undertake the requirements expression and analysis phase with the three main techniques found in Table 3.7.

Table 3.7: SLR analysis techniques

Number	Analysis Technique
1	Scenarios of a specific project
2	Statistical analysis
3	User testing

3.3.2.4 Validation Techniques

When investigating the literature, there was only one form of validating whether the information that was gathered and analysed was conducted correctly for Māori groups; this was the concept commonly known as *concept prototyping* [18].

3.3.3 Māori Interfaces

Over the years, a few Māori interfaces have been created, and this has led to varying results; although trying to adhere to culturally specific techniques, the unsuccessful interfaces have tried interface rules and have followed international standards which have led to complicated and difficult-to-follow interfaces. Successful interfaces have been reported with children, which has led to successful results, but the interfaces were created in a much simpler manner. The reason these interfaces are important is they outline the issue of successful and unsuccessful applications for Māori groups and the reason behind the results to understand the importance.

3.3.3.1 Successful Interface

An example of a successful interface using te reo Māori is an application called Math Tutor, the target audience is both students and teachers. The aim is to teach young children simple addition and subtraction using aids such as images. A bright colourful graphical user interface was created to attract children to use the application while making it educational. Positive results were generated and the researcher mentioned a good foundation for more sophisticated learning tools [7].

3.3.3.2 Unsuccessful Interface

Language loss is gradual and generally an issue of attrition. Mato et al. [5] mentioned that “mass communication” has caused the process of language extinction to increase rapidly due to pressure to speak a dominant language to communicate with a larger audience. Lack of promotion has made it important for Māori to become aware of te reo as a language to continue their survival. Increased awareness is the key to ensuring language survival, especially with an Indigenous language such as te reo Māori. Users had difficulty navigating the te reo Māori interface that 2 Degrees created; Mato et al. mentioned possible reasons, these were: reverting to processes and methods created in a dominant language’s interface, which is similar to the process of language switching.

3.3.4 Limitations

Three key issues were found when following the Māori processes and techniques: outside the Māori and Indigenous communities, their world view is not shared; as explained in Chapter 4, the processes used to gather requirements are different to mātauranga Māori techniques. Second, this has led to a division between Indigenous techniques and accepted techniques due to the Indigenous methods being unrecognised. Finally, there has been no recording of scientific notation for Māori techniques which makes mapping them to accepted techniques difficult.

3.3.4.1 Specific World Viewpoint

Although Māori culture is beneficial for gaining techniques for Māori groups, the processes do not work in regard to international groups, which makes it difficult to transfer the processes. This needs to be considered when generating requirements as different groups have different needs.

3.3.4.2 Unrecognised Elicitation Techniques

Processes such as whakawhanaungatanga are not recognised internationally, meaning they will not be incorporated and so need to be considered. This makes it difficult for non-Māori groups to elicit requirements when speaking with Māori groups.

3.3.4.3 Māori Scientific Resources

Although no Māori-specific scientific notation has been reported, there has been an online platform created by the Ministry of Education called *Paekupu* [34] which is a digital collection of terms translated to Māori; this is especially important as it assists in determining the translations of English scientific terms.

3.3.5 Vision Mātauranga

Vision Mātauranga is a government policy to increase the engagement of Māori-led methodologies in the research, science and innovation sectors [35]. One foundation idea Vision Mātauranga holds is to demonstrate what Māori can present that is not able to be sourced in other areas. One way Vision Mātauranga suggests doing this is with what they call an *interface*. Mason Durie [36] defined an interface as: “Two bodies of knowledge

coming together". The interface visually displays the differences through a Venn diagram of both the requirement elicitation techniques and requirement elicitation methodologies, comparing the similarities and differences between mātauranga Māori and accepted groups.

Māori research methodologies that are driven through Māori philosophy to create research that is defined as "rich mātauranga Māori" research is what Vision Mātauranga defines as *kaupapa Māori*. Performing kaupapa Māori techniques by adhering to both Māori methodologies and philosophies, alongside having Māori researchers, ensures the process is conducted correctly. Community involvement is one of the values Vision Mātauranga holds as important. To ensure community involvement, Vision Mātauranga has a plan to conduct empirical studies involving Māori participants who have a background in the philosophies and methodologies conducted by Māori groups, to assess where techniques can be improved.

3.3.6 Common Requirement Elicitation Techniques

Requirement elicitation techniques common to both groups are those used when conducting research, for example, interviews. Understanding the techniques common to each group allows us to understand how developed and effective each technique is. Table 3.8 was generated to demonstrate the number of papers that used each technique.

3.3.7 Requirement Elicitation Techniques Diagram

Mātauranga Māori and accepted groups have similarities and differences (see Figure 3.4); there are seven similar techniques in both groups, three in the information-gathering phase, three in the requirements expression and analysis phase, and one in the validation phase. The similarities are identified in Table 3.8 below.

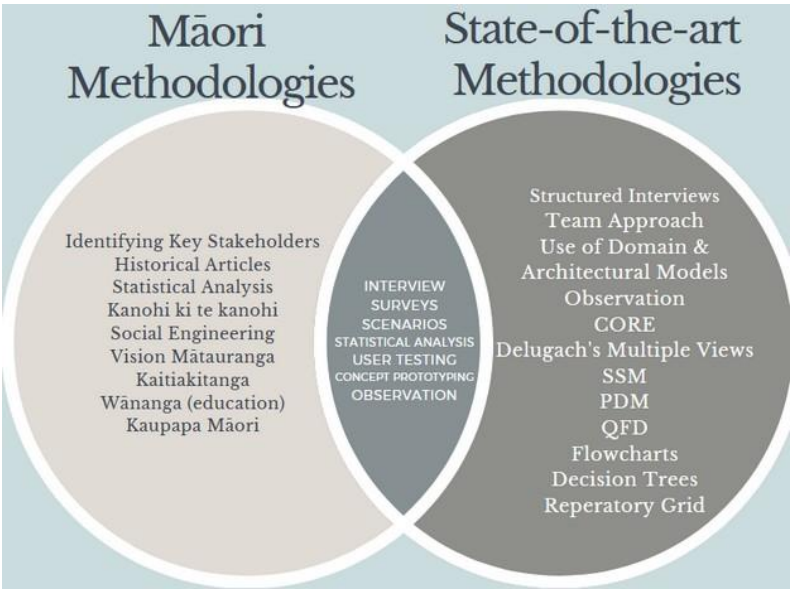

Figure 3.4: A Venn diagram showing the relationship between mātauranga Māori and accepted techniques

Table 3.8: Techniques involved in Māori and accepted requirement elicitation techniques

Technique	Information gathering	Requirements analysis	Verificiation and Validation
Interviews	✓		
Observational techniques	✓		
Surveys	✓		
Scenarios		✓	
Statistical analysis		✓	
User testing		✓	
Concept prototyping			✓

Knowledge of the similarities between mātauranga Māori methodologies and accepted methodologies allows us to compare the differences in how they conduct the same technique, to generate different techniques in the other discipline. Although largely the same number of techniques are performed by both groups, the key difference is the process both groups perform before eliciting these techniques, which are defined as a *requirement elicitation process*.

3.3.8 Requirement Elicitation Process Interface Mapping

A requirement elicitation process is an avenue a person must take to be able to elicit requirements, this is especially vital in Indigenous groups [2]. Indigenous groups require a special process since conventional methods have been reported as unsuccessful [2]; in the example of Māori groups, they must first meet face to face (kanohi ki te kanohi) and understand each other to build a good relationship (whakawhanaungatanga) and improve each other's mana (manaakitanga). Once the relationship has been built then they begin gathering their specifications by using requirement elicitation techniques.

3.3.8.1 Accepted Processes

Accepted groups extract requirements via effective communication with stakeholders. The first step an accepted group takes is to build a good relationship with their stakeholders via understanding their goals for a product by using any of the techniques mentioned in the state-of-the-art information-gathering subsection. Once the researcher gathers the information, they analyse and test it via a technique mentioned in Section 3.3.2.3. Finally, when the researcher is confident the information is correct, they present their desired product to the stakeholder, via validation (see Section 3.2.1.3), and success is produced to create a final product.

3.3.8.2 Māori Elicitation Processes

Mātauranga Māori groups involve an extra process which includes the process of relationship building with the involved stakeholders before the information-gathering phase. Since both the relationship with a person and giving the appropriate amount of mana (see Section 4.4.3) is important, relationship building is essential. Once the researcher and the party have reached a good relationship status then the process mentioned in the accepted processes can occur. The process in which both parties are understanding each other is known as whakawhanaungatanga and the process of building mana is known as manaakitanga.

3.3.9 Requirement Elicitation Process Venn Diagram

Although there are key differences between how mātauranga Māori groups and accepted groups conduct requirements elicitation, the key similarity between the two groups is networking. Both parties have to identify the target audience and then approach them to begin understanding the best avenue for eliciting requirements. Figure 3.5 below shows the key differences between the groups in the approaches taken when eliciting requirements.

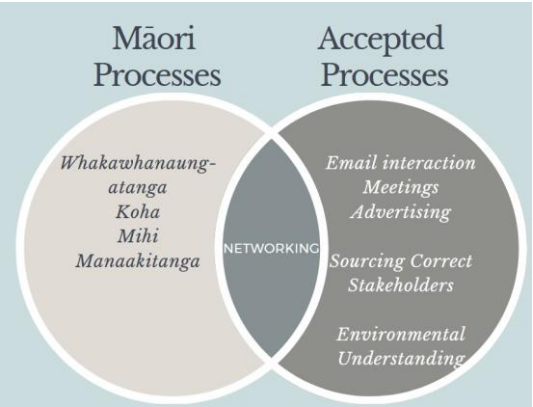

Figure 3.5: A Venn diagram showing the relationship between mātauranga Māori and accepted processes

Mātauranga Māori groups focus more on kanohi-ki-te-kanohi (face-to-face) relationship building and understanding a person before moving into the formal processes, while accepted groups begin the formal processes immediately to elicit requirements. The Venn diagram above in Figure 3.5 was essential to understanding the overlapping processes.

3.4 Research Questions Extracted

1. Would the accepted processes be more beneficial for determining a clearer outcome for elicitation techniques than the Māori processes, for Indigenous groups?

Successful requirement elicitation techniques aid Māori groups in generating stronger methodologies, Scrum (Scrum is an agile framework to manage and break work into goals), for example, would be beneficial for not overstepping the boundary of claiming this is a kaupapa Māori technique due to the cultural process incorporating non-kaupapa methods.

2. Would the accepted variation of Māori elicitation techniques on the mapped elicitation techniques be able to assist in generating stronger requirements?

The SLR revealed that each cultural group requires different elicitation methodologies (Section 3.3.9). Interviews and statistical elicitation methods have been successful for Māori groups when conducting SLRs, where the methodology was applied to thirty-eight kaupapa Māori cases with cultural variance [2] that can apply to other techniques to generate stronger requirements.

3. Could Māori groups incorporate accepted techniques into requirements elicitation to create new requirements?

Various methods, such as focus groups and SSM, have not been investigated; however, investigated methods, for example interviews, were successful.

4. With the currently existing gap between the accepted groups' methodology for developing countries and Indigenous groups, where can an adjustment of SE methodologies to generate a more robust model for all groups?

3.4.1 Proposed Empirical Studies

After analysis of all research questions, the best approach would be to conduct a study in regard to the third research question "Could Māori groups incorporate accepted techniques into requirements elicitation to create new requirements?", the approach moving forward would be to begin a three-step planning process and then empirically test this kanohi ki te kanohi with a group of participants and conduct the information-gathering phase of doing a group interview.

- Include accepted techniques that were not included in the Māori techniques and determine a process to conduct a Māori accepted variation of the elicitation technique.
- Look at the accepted methods on the left-hand side (see Figure 3.5) and consider how to convert the techniques into an accepted practice.
- Combine the techniques from the points mentioned above to create the best practices.

3.5 Conclusions

Being able to identify a SLR methodology, allowed me to determine that both the accepted terms and techniques and Māori techniques have both common terms and different procedures for how to potentially gather information from both groups.

The three identified stages of requirements elicitation from the accepted techniques were: information gathering, requirements expression and analysis, and validation, where each phase served a different purpose to ensure high-quality requirements were generated. Although this field has worked for an international audience, reports of countries following a direction for “local needs” [2] would struggle to use the accepted techniques. Mātauranga Māori groups require specific processes to gather the information to generate requirements so specific processes need to be created. Investigating Māori techniques and processes made it possible to determine the large number of similarities and differences between the Māori requirement elicitation methodologies and accepted requirement elicitation methodologies. This has allowed me to generate visual representations of how both groups interact.

Finding three main gaps could lead to researching a number of areas but this research found three main research questions that met the current needs and chose the most relevant topic “Could Māori groups incorporate accepted techniques into requirements elicitation to create new requirements?” To test whether this would be possible involved first looking at the Venn diagram in Section 3.3.9 to determine the key differences in elicitation techniques and elicitation processes between the groups. Once identified, an investigation was conducted into how to make the Māori techniques into accepted techniques by comparing them to the work found and how that would best fit after that has been completed and then testing it with Māori and accepted groups to determine what was fit for purpose.

This SLR chapter was able to find key differences and common elicitation techniques applied by Māori and accepted groups to aid in identifying three techniques suitable for Māori groups that have not been applied. The next chapter will explain the findings used

in this SLR to compare the contributions the techniques could provide to Māori groups to pick the best new technique with kaupapa philosophies and mātauranga concepts. The findings will allow for the beginning of planning a user study with a small group of participants in Chapter 5.

Chapter 4

Study Methodology

4.1 Research Question

The first step to understanding how to create the study methodology is to extract primary research to begin development of potential approaches for the empirical user study. The research question that was decided upon for the research after conducting the SLR was: “Could Māori groups incorporate accepted techniques into requirements elicitation to create new requirements?”

4.2 Hypothesis

Understanding the efficacy of techniques is important; before we can test how well the research will be conducted, we must first create a hypothesis. There are two main hypotheses as the main focus areas that will be tested:

1. Whakawhanaungatanga (the process of getting to know each other) and kanohi ki te kanohi (face-to-face interaction) and updated techniques will generate the best results. The cultural importance for Māori groups with kanohi ki te kanohi is the ability to be able to read other people’s contributions with the combination of subtle aspects to gain a full understanding of another person’s intent. Examples of subtle aspects are body language and tone which are essential for gauging how to move forward with another person to generate high-quality results.
2. Accepted techniques and online interactions will produce the least informative results due to the absence of kanohi ki te kanohi. The mentioned aspects in the first hypothesis around kanohi ki te kanohi can be difficult to interpret in online systems and can lead to misunderstandings which can affect the quality of the requirements elicited. Another key issue is the absence of Māori tikanga (Māori culture, traditions, and values) which hinders the process Indigenous groups use to interact to yield positive results, for example, karakia at the beginning of the gathering for blessings.

4.3 Purpose

The purpose of the research is to determine the efficacy of a proposed improved methodology with Māori groups. By doing empirical tests with Māori groups who undertake kaupapa Māori practices, it will be possible to gauge the level of success and provide critical feedback in order to create a high-quality product.

4.4 Potential Approaches

The main measurement of a successful approach was satisfaction from other Māori people with an acceptable level of mana. Three methods that are successful for accepted groups have not been recorded as successful approaches for kaupapa Māori groups. Repertory grid, focus group, and SSM are three potential approaches identified that adhere to aspects of kaupapa Māori philosophies and that could be adapted.

4.4.1 Repertory Grid

First, repertory grid was identified as a successful approach due to published works applying variants of interviews to their works [37] [36], these two published works are the core resources to begin an in-depth analysis of whether this is the best-fit method for Māori groups.

4.4.1.1 Basic Overview

The origin of repertory grids is Kelly's [38] [39] personal construct theory repertory grid technique (RGT) derived from the areas of psychology and anthropology with the purpose of exploring topics that can be personalised [40]. RGT allows interviewees to express their world viewpoint without interviewer bias [27]. It is rich source of qualitative data because it allows interviewees to use their own terms or jargon. Repertory grids use rating scales which can allow the results to also be used statistically (which can lead to quantitative analysis) [41] [42].

Table 4.1: Example grid of important values in an employee

Not ideal (1)	Graduate	Less than one year experience	Ideal (5)
Not passionate	4	3	Passionate
Minimal technical knowledge	2	3	Technical knowledge
Introverted	5	4	Extroverted
No customer experience	3	3	Customer experience

A common question used to exemplify repertory grids is “What values are most important to you when hiring an employee?” If the interviewee struggles with the question, the repertory grid uses a range of different examples. Table 4.1 displays the prompted examples for the interviewee such as: not passionate and passionate, the examples are to encourage the interviewee to perform a comparison to discover unbiased answers. A scale is also provided by the repertory grid to aid the interviewee to answer without the interviewer bias. An example of this is in Table 4.1 where the scale is from one (not ideal employee trait) to five (ideal employee trait). Effective use cases for the repertory grid are brand analysis [43], consumer analysis [40], and psychological analysis [44].

4.4.1.2 Components Needed

When investigating RGT, four main components were apparent that were consistent across the works which aided the research; these components were:

Topic: What is the interview about?

Elements: First, when conducting the RGT, select a set of elements that the study will contain [45]. Examples of the topic can be selected by the interviewee or can be pre-selected [41]. The interviewee must have knowledge of all elements chosen. An example of an element would be kumara, a food that the person likes to eat.

Constructs: This is the most important component of a repertory grid. The common description used between each element is defined as a “construct”. Examples of constructs are: sweet, rich, and bitter as descriptions of how food people like to eat can taste [41].

Ratings: Grid with elements on top and constructs on the side. The interviewee rates each element vs each construct using 1 to 5. An example of is that kumara would be a 3 for sweet. This grid is powerful when comparing a matrix grid style of the interview but not beneficial when doing closed questions or answers without a common relationship [41].

4.4.1.3 Advantages and Disadvantages

To understand the best purpose for Māori groups when conducting the RGT, one first needs to identify the advantages and disadvantages. There are four identified advantages and five disadvantages of RGT, which give a high-level overview of when this technique would be beneficial for conducting an interview and what to avoid or when the technique would not be beneficial.

The four identified advantages are: First, RGT can be highly personalised for the person or people you are interviewing. Second, it is easy to administer for groups and can be created specifically for the situation provided. Third, the highly structured nature allows for ease of extraction of data for the researcher. Finally, it can be used for both qualitative analysis, due to the independent study, and quantitative analysis, due to being both able to be done with groups and highly repeatable.

The five identified disadvantages are: First, monotony can occur depending on the participant’s understanding of the topic, which can lead to people dropping out of the study. Second, the multiple repertory grids needing to be considered simultaneously can lead to high cognitive demand. Third, it is reported to be time consuming as recorded studies mention the average RGT interview can last between one to two hours which makes this not beneficial in a modern environment. Fourth, due to the nature of the RGT, it is reported to cover a limited scope. Finally, following an *as it currently is* model creates difficulty for alternative solutions.

4.4.1.4 Advantages

Highly personal: Repertory grids are designed to understand participant perspectives, this is done with the agency put completely on the participant, without the intervention of the researcher [46]. Personal experiences are derived from participants, which allows each interview to be different from the others and create a unique experience [41].

Easy to administer: Due to the personal experience aspect of repertory grids, the interviewer can extract information in a large number of contexts without a significant change to the structure of the topic they are interviewing about [46]. This gives participants a unique experience of the interview while being able to follow the structure of the repertory grid.

Structured: Since the information in the repertory grid is deemed to be highly structured, this allows for extraction and analysis using an analysis application giving the interviewer ease of use when creating mappings or diagrams [46].

Can be used in both qualitative and quantitative analysis. With the allowance of being able to conduct the study individually or with groups, repertory grids can be used for either context and gain the advantages from both qualitative and quantitative analysis. Personal constructs allow for a deep understanding of the perspective of a single participant [46].

4.4.1.5 Disadvantages

Can create monotony. Because of the repetitive nature of the task, participants are more likely to drop out of a repertory grid than most other study techniques, which can lead to inconsistency in the number of participants completing. A major factor in this is participant understanding of the topic provided by the interviewer [46].

Cognitively demanding. RGT methodology requires participants to consider multiple repertory grid elements simultaneously, which can lead to cognitive strain and overwhelm participants. The strain relates to the level of understanding the participant has on the specified topic [46].

Time consuming: The process that a repertory grid follows has been reported to take 90 minutes when creating a 9x9-inch grid. The outcome of the research can heavily dictate the length of the RGT interview process, but the average reported length is around one to two hours which is not feasible in the fast-paced modern world [46].

Limited to the scope created: Since the grid applies a preset finite range, it limits the number of responses from a participant and does not allow people to generate ideas outside of the elements and constructs, which means the number of results generated will be limited [46].

Does not create alternatives: RGT is used for exploration of already established domains and follows the *as it currently is* model which makes it ineffective for creating alternatives for participants, due to being limited by the scope of an element, construct, and rating [46].

International "*Accepted*" Publications

The first piece of work is a book written by Fay Fansella [47] in 2002 called *A Manual for Repertory Grid Technique* which explains RGT information around constructs and elements. In Chapter three Fansella discussed the varieties of grids in use at the time. She reported on the grid form of role construct repertory tests which explains understanding an individual's perceptions using RGT and that it aids people to come to a decision.

The second piece of work, by Tan and Hunter [48], covers personal construct theory and RGT, explaining how Kelly [38] identified people using their constructs and ideas to interpret events which changed the way they view the world. Kelly's work allowed people to create three main components for repertory grids: elements, constructs, and links which were important. Tan and Hunter identified four papers on page 44, which were Hunter (1997) [49], Moynihan (1996) [50], Pythian and King (1992) [51] and Latta and Swigger [52], and discussed their research objectives, perspectives of their repertory grids and the repertory grid design.

4.4.1.6 Which Audience Would This Method Be Successful For?

RGT can be successful for individual members or small-scale groups. The limitation is the fact it is survey-based and includes a rating scale (one to five) of a traditional hui which can range from three people up to hundreds of people; you cannot give a clear scale for hundreds of people but potentially can up to a group of six people.

4.4.1.7 How Repertory Grid Aligns With Kaupapa Philosophies and Mātauranga Concepts

Allowing for a strong concept and idea, with a clear direction, repertory grids allow for the concept to work for Māori. Codesign can be done by Māori as well, allowing for an environment that can adhere to kaupapa philosophies and mātauranga Māori concepts, making this option viable for an empirical study. With these ideas in mind, a notable limitation of repertory grids is the removal of the agency to give open answers and discuss ideas outside of the scope as it does not allow for the preferences of Māori groups.

4.4.2 Focus Groups

4.4.2.1 Basic Overview

A focus group is used to elicit requirements via an improved open-ended group interview. A focus groups is a technique involving the use of in-depth group interviews in which participants are selected because they are purposive, although not necessarily representative, sampling of a specific population, this group being ‘focused’ on a given topic. Focus groups are separated into two stages: preparation and execution phases [27]. The preparation phase is to determine the target audience, goals, and questions asked. Focus groups are generally asked open-ended questions and take one to two hours to answer four to eight questions [54]. The benefit is the group will give insight into things not considered in an individual interview [55].

4.4.2.2 Preparation Phase

When preparing to conduct a study for a focus group, a five-step process is followed to ensure a focus group interview is conducted correctly, the steps are as follows: [56].

1. Choosing a minimum of six participants, and a maximum of roughly 12 participants
2. Determining opening and closing remarks for the group
3. Determining how to facilitate the meeting to ensure everybody is heard and nobody is dominating the discussion
4. Ensuring that when asking questions and stating objectives, these are higher level questions
5. Choosing the time and location of the focus group and informing participants when and where the study will be conducted.

4.4.2.3 Execution Phase

After preparing for the interview, the interviewer begins the *execution phase* where several factors need to be considered to be classed as a focus group interview; they are as follows: [54]

- Introduce all facilitators of the discussion
- Explain to all participants why the recording will be used (if the discussion is being recorded)
- Follow the script for the open-ended questions but be prepared for unexpected results
- Free interaction between participants is key, encourage quieter members to interact more
- Time management between questions is important

4.4.2.4 Advantages and Disadvantages

To understand the best purpose for a focus group, the first step is to identify the main advantages and disadvantages of a focus group. The following outlines three advantages and two disadvantages.

Advantages

Flexibility. Due to a non-rigid structure or imposed time limit, the open-ended questions allow for discussion between the participants to be flexible and vary in results depending on the knowledge of the group on the given topic [57].

Open access to personal perspectives. The nature of focus groups involves the assumption that an individual participant will bring their perspective and experiences to the focus group interview [57].

Does not apply pre-existing ideas or information. Focus groups are primarily used to understand the individual's decision making, perspective, and the focus group has the ability to extract information in an open environment, which removes the concept of pre-existing ideas or concepts. The nature of the research allows the researcher to engage in how participants process and deliver information [57].

Disadvantages

Poorly formulated or specified. Due to the perspective-based research and lack of scope within the research allowing for open-based sources, focus group interviewers can face a dilemma in data analysis where the information can become poorly specified or formulated to a low standard due to the vast number of responses that can occur [57].

Reliability and validity. Moderator bias is an issue that will be faced when conducting a focus group interview. It can cause the information provided by the participant to be skewed incorrectly and lead to a specific result. To prevent this, the repertory grid gives the interviewee a piece of information which will not prompt the interviewer to ask questions based on the answer and will remain consistent.

International "*Accepted*" Publications

The primary purpose of Wilkinson's [57] paper was to review three research traditions of focus groups to understand the features involved, alongside the focus group data issue, and suggest options for improving future data. Wilkinson also outlined the main advantages and disadvantages of focus groups in the publication for interviewers.

Morgan [56] explained focus groups with a basic introduction. Also touched on are the best scenarios in which they are effective, potential ethical issues, and how to determine if a focus group is correct with a checklist.

The final successful publication by Rabiee [58] gave a focus group overview, explicitly explaining that focus groups are more suited for qualitative research. Draper's [59] and Fade's [60] papers mentioned how focus groups are applied to human behaviour, feelings, and attitudes, alongside information on how to analyse the data for interviewers.

4.4.2.5 Which Audience Would This Method Be Successful For?

Focus groups, with their nature of being flexible and open to personal perspectives, allow this to work for systems that do not follow a rigid structure but rather a more open and adaptive methodology. Examples of where they would be successful would be with small businesses still developing ideas or small gatherings where the information-gathering phase is still occurring; but they would not be beneficial for working with individuals or if you are in the analysis, verification, validation, or development phases.

4.4.2.6 How Focus Groups Align With Kaupapa Philosophies and Mātauranga Concepts

The main alignment between kaupapa philosophies/mātauranga Māori concepts and focus groups is the flexibility to openly view and discuss opinions in a group-based environment. Allowing for adaptation, with time for Māori groups to apply changes to how the groups would be running, in the beginning, allows for pre-meeting discussions. Examples of potential changes are manaakitanga [32] with potential for pōwhiri (Māori welcoming ceremony), the process of giving a koha (gift exchange) [32] and whakawhanaungatanga to allow people to understand one another, all allowing for a strong requirements elicitation process for Māori groups using focus groups.

4.4.3 Soft Systems Methodology

4.4.3.1 Basic Overview

The idea behind SSM is to analyse complex situations with differing viewpoints on the problem (explore different perceptions). SSM is used as an example of discussion with all parties involved. The process in a consensus situation is that all participants get a chance to structure a complex problem to implement feasible changes. SSM is not looking to reduce complexity but takes into account all factors involved.

SSM was based on Vickers's [61] work around the importance of appreciative systems in dealing with human complexity. Checkland and Scholes's [62] attempt to adapt system theory to be used practically is now known as "SSM" [63].

SSM is defined as a problem that "cannot be formulated as a search for an efficient means of achieving a defined end; a problem in which ends, goals, purposes are themselves problematic" [64]. SSM is broken down into seven steps [65]. It is worth noting that in the fourth step, the solution has been found. Step 5 is a comparison between Steps 4 and 2 to ensure quality. If any changes need to be made then they are identified in Step 6, and Step 7 is an action made to improve the "problem-solution" [66]. Figure 4.1 provides a visual representation of the SSM Cycle.

Figure 4.1: SSM Cyclic Process

1. **The problem situation is unstructured.** Identifying the problem in an unstructured format is the first phase, also known as the information-gathering phase. An example of the first step in identifying the unstructured problem is to conduct a formal

interview to gather information about the problem at hand. Generally, when performing this step, the researcher or requirements elicitation engineer is advised to understand the control and structural processes of the problem and apply this to the problem at hand.

2. **Problem situation expressed.** This step sketches the problem, giving a visual aid for the problem solvers to review to ensure the problem has been correctly identified. It is advised to structure how the stakeholders are involved and interact with each other. Participants or stakeholders are trying to understand from the identified problem how to resolve the issue.
3. **The root definition of relevant systems.** Creating "root definitions" assists in understanding the relevant systems involved. The general abbreviation to ensure this process is done correctly is CATWOE which stands for customers, actors, transformation process, world view, owners, environmental constraints [66]; it is used to illustrate the relevant systems.
4. **Conceptual models.** Conceptual models involve "analyzing the activities which need to take place to clearly define what the actors need to do to achieve the transformation" [67]. An example of a conceptual model is to make a map of the process of delivering news reports to the public; it would begin with first receiving the reported information, followed by discussing with all sources, writing the article, and ensuring the information provided is correct, a back-and-forth snowball process of writing and reviewing then finally a release to the public, and repeat the process.
    - **4a. Formal systems concept.** Formal systems are primarily applying the "form of the system and not the system content." They are primarily used to solve complex problems [68]. The two primary systems used are systems and meta-systems. These are used in SSM to apply formal logic to the problem provided in the study.
    - **4b. Other systems thinking.** A paper prototype is an example of a system that does not use conceptual models or formal system concepts, and which can be used to apply to SSM to aid in creating a model to understand the problem.
5. **Using structures to explore the situation.** It is important to ensure the theoretical concept created by Step fouris realistic by comparing it with the problem situation

expressed; when following SSM, stakeholders must be taken into account when this stage is being tested. A common thought process when exploring this step is to compare the theoretical system to real systems and assess whether it would apply appropriately.

6. **Feasible and desirable changes identified.** The primary purpose of this stage is to address any issues that may occur that have not been addressed in Steps 1 to 5.
7. **Action to improve the problem situation.** Finally, the seventh and final step involves taking the ideas and concepts created into the development phase (which is outside of the scope of the requirements engineering phase). This involves implementing the ideas agreed upon from Step 1 until Step 6; if any major changes are identified in the final phase, the RE SSM phase begins again and tries to repair the identified issue in a cyclic process.

4.4.3.2 Advantages and Disadvantages

The research made it possible to identify three advantages and three disadvantages when analyzing the SSM.

Advantages: *Helps with addressing future customer needs.* Addressing and understanding the key issues current and future customers will face before and during the development process of the product will allow stakeholders to raise concerns with the current and future product [69].

Customer satisfaction is a priority. The seven-stage process of SSM is extremely time consuming and does not make it the most efficient product in finding quick results [69]. SSM does allow in-depth understanding by identifying and prototyping the issue at hand and prioritising customer satisfaction with a process that can take one to infinite cycles to ensure the product is correct.

Not commonly used compared to other methodologies. Due to the nature of SSM, in 2000 it was reported to not be widely used in comparison to other methodologies, meaning there are many applications to SSM to explore [69].

Disadvantages: *Paperwork involved can be overwhelming.* Due to the high volume of

paperwork involved in a seven-step process, SSM requires the author and the reader to have extensive knowledge of the process [69].

No parallel technique to compare with. Due to SSM being a unique process, there is no similar technique to compare it to, making it difficult to gauge the level of success in comparison to another technique [69].

Time variance is high. As mentioned in the advantage of customer satisfaction, time is not a priority; the level of paperwork involved can create issues for the reader and the author in terms of the time taken. However, online video calls or emails can replace face-to-face communication or handwritten mail as the primary form of communication [69].

International "Accepted" Publications

The first publication by Presley et al. [69] gave an overview of SSM, explaining the process for SSM and the incorporation of QFD and how the new methodology can be applied to real-world applications for requirements elicitation.

The second publication I was able to identify was by Maqsood et al. [65] explaining a basic overview of SSM and five case studies applying SSM. The basic outline of SSM was explained as an extension of Checkland's [64] work about systems' thinking. One of the studies was called the "*Pretendering*", involving an Australian construction company. The process began with interviewing the team members to understand the broader picture of the company; after the interview process the researchers were able to grasp the picture of the company and begin creating a map of all mentioned information, which is the conceptual model. The researcher was able to do a CATWOE analysis from what the groups mentioned [65] which allowed for a strong understanding of all potential issues in the development process. The projects displayed in Maqsood et al.'s [65] paper mentioned the successful application of the product but that it was an arduous process.

SSM would be successful with industries, companies, and organisations that are willing to focus primarily on customer satisfaction as opposed to a time constraint. Since SSM has a seven-stage process that covers the information gathering, analysis, and verification and

validation (VV) in a cyclic process, it provides an effective tool for an all-in-one tool for an in-depth analysis of an organisation.

4.4.3.3 Which Audience Would This Method Be Successful For?

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4.4.3.4 SSM With Kaupapa Philosophies and Mātauranga Concepts

SSM applies the aspect of focusing on future customers in the long term, as opposed to short-term success, allowing this to align well with the goal mentioned in Vision Mātauranga [35]. Allowing the long-term concept alongside the secondary concern with how long the process will take resonates well with the Māori community and allows for processes such as whakawhanaungatanga to be conducted with the full effect and to build a strong set of requirements making the ideal long-term environment, which works well with another key concept of customer satisfaction, being vital to both the methodology and Māori communities.

4.5 Comparison of Each Approach

The main research question was determined after conducting the SLR: “Could Māori groups incorporate accepted techniques into requirements elicitation to create new requirements?” With an understanding of the three identified methods (RGT, focus groups, and SSM), we identified the outline of each method, its advantages and disadvantages, successful publications around each topic, the best audience, and how the method aligns with kaupapa Māori philosophies and mātauranga Māori concepts. Two main criteria helped us to determine which method could be successfully incorporated into a kaupapa Māori requirements engineering methodology. The first was how the methodology aligns with the research question about the success the method when applying kaupapa Māori philosophies and mātauranga Māori concepts; and second, the importance of primarily

incorporating satisfaction with the product, with quality being the main criterion and without speed being important.

4.5.1 Kaupapa Māori Philosophies and Mātauranga Māori Concepts of the Methodologies

Comparing RGT, focus groups, and SSM with their application to kaupapa Māori philosophies made it possible to identify three different approaches; all methods could be successful when adapted but the key differences were:

4.5.1.1 Repertory Grid Technique

RGT has a limited scope and does not incorporate open ideas which means the extent of knowledge you will extract from a participant will be based on two main factors: the knowledge of the participant and the peak knowledge of the interviewer. This is a key issue, as, if a participant such as a kaumātua [32] or kuia joins the student and has a higher standing with mana [32], the limited scope would not be able to unlock their full potential meaning the understanding of all perspectives would not be attained.

4.5.1.2 Focus Groups

Focus groups are an acceptable option as the meeting structure permits adaptation and having no formal procedure allows the group to dictate the best direction when moving the conversation forward; but the lack of structure can cause a large number of issues when a dispute occurs as there is no strict formal method to mitigate the issue aside from facilitators; this needs to be considered when the decision is made. The second key issue that needs to be outlined is focus groups are primarily designed for a group of between six and twelve participants which can be an issue when large-scale Māori discussions happen, particularly with iwi where there can be more than 20 participants attending.

4.5.1.3 Soft Systems Methodology

Finally, with SSM, the direction of working to identify the main stakeholders, identify the issue at hand, create models, and work with the key stakeholders to understand future issues allows for a strong requirements elicitation process, and the focus on long-term

future customers adheres to mātauranga Māori concepts. The key issue with SSM is the rigid structure that causes difficulty when trying to adapt to Māori groups without adding more steps. Overall, with an understanding of the pros and cons of SSM, the process is acceptable when applied to Māori groups.

4.5.1.4 Overall Analysis of Māori Concepts and Philosophies

Understanding the kaupapa Māori philosophies and mātauranga Māori concepts is essential when comparing methods. RGT would be the limited option when adapting for Māori groups due to its limited scope but focus groups and SSM are beneficial for different reasons. Focus groups allow for a more flexible option but have the key issue of having no tools if a dispute occurs; and SSM allows for a full understanding but is rigid, which causes issues when integrating Māori techniques.

4.5.2 Satisfaction with Each Method

The second criterion outlined is the satisfaction provided by each method when making a successful product and incorporating for Māori groups. The success of each method is as follows.

4.5.2.1 Repertory Grid Technique

RGT has been reported to be cognitively demanding, time consuming, and monotonous [46], which would cause a major issue in being able to generate information when applied to Māori groups, as the concept of time would be unimportant. Also, if there is an insufficient number of participants knowledgeable about the question asked, while managing multiple elements, this can become overwhelming and lead to participants dropping out of the study with an incomplete grid.

4.5.2.2 Focus Groups

Free interaction between participants allows for open discussion with open-ended questions being asked by the facilitators, encouraging people to discuss their opinion openly and with a flexible amount of time, allowing for a positive overall environment. The only issue that could arise is that, when a dispute occurs, the environment may wind up not giving sufficient results leading to an overall unsatisfactory product.

4.5.2.3 Soft Systems Methodology

SSM has been recorded as having high-quality satisfactory products [65] with satisfaction the main criterion when applying SSM due to the in-detail seven-stage process allowing for all aspects to be considered alongside important prototypes.

4.5.2.4 Overall Analysis of Satisfaction

Understanding the success of each method will aid in understanding the best method for an upcoming user study to attempt the transformation. RGT has a history of participant dropout, making this the least viable; focus groups have elements that make them successful but other elements that can lead to an unstructured discussion; and finally, SSM has a strong record of customer satisfaction with accepted groups and covering all aspects.

4.6 Study Method Conclusions

Understanding the level of satisfaction and the potential each of the untested methodologies would theoretically have for a Māori group is essential when deciding which method to use to attempt a theoretical transformation from an accepted methodology to a kaupapa Māori requirements engineering methodology. Due to the unsatisfactory nature of RGT, the technique would be the least successful with Māori groups and would lead to an overall unsuccessful result. Focus groups have elements that would be successful when applied to Māori groups but the volatile nature of a flexible structure would lead to potentially unsuccessful results making this a poor method of choice when attempting the test. Finally, SSM has strong elements which could translate well into kaupapa Māori philosophies and Māori techniques, with the minor issue of being a rigid process; SSM also has a high satisfaction rate with accepted groups and organisations, making this the best choice of methodology when applying the adaptation to Māori groups and allowing potential incorporation of accepted techniques into kaupapa Māori requirements elicitation to generate new requirements.

This chapter analyzed the benefits and disadvantages of the techniques for both accepted and Māori groups which aided in determining the overall best approach when applying the kaupapa Māori philosophies and mātauranga Māori concepts for the user study. From the

overall understanding of the techniques used, the best approach to apply will be SSM due to the high-quality results in accepted groups alongside the potential success when observing from a Māori perspective. The next chapter will apply SSM with the kaupapa Māori philosophies alongside the mātauranga Māori concepts to create a suitable methodology for Māori groups. The theory will be tested by the researcher via a pilot and full-scale empirical user study to gauge participants in user studies.

Chapter 5

User Study

After the analysis of the three main techniques, we decided to outline the process of the qualitative empirical test. We identified five main goals for the user study and created a plan for conducting the study. Two main hypotheses for the expected results were created alongside the four main research questions that we were answering from the experiment. After the creation of the hypotheses, goals, research questions, and a main method explaining the current accepted SSM and the adapted SSM, and after creating a plan to test the two separate SSMs, we investigated adding two surveys, to determine their level of satisfaction, alongside a case study that would be relevant to the study. Before testing this with a full-scale group, the process was tested with a group of three participants and their level of satisfaction with the study was observed. With a successful pilot study, the process was conducted with four groups of four people to understand their perspectives. The overall result was positive and participants were satisfied with the new process and mentioned the new Māori methodology incorporating kaupapa Māori philosophies.

5.1 Goals

The research was able to identify five main goals when investigating the SSM approach; these goals are:

- Satisfaction from the methods in a timeless approach.
- Customers like the prototype that was created. It generates the correct requirements.
- Understand the level of satisfaction with the new proposed methodology, using the systems usability scale questionnaire.
- Understand the requirements vs what the customer likes.
- It produces usable software.

5.2 Plan

The most important aspect of planning user studies is being able to get six groups to test the methodology in an online environment and then do another test in person. This can be difficult due to a number of factors, such as finding a time that suits all parties. When doing this in an online environment, a test of the accepted technique can be done with a case study from recent news or events, whereas the updated technique would be done kanohi ki te kanohi (in person). The main advantage of this would be to determine the difference between the in-person and online environments and how the technique works with Māori groups alongside the effect it has on each technique.

5.2.1 Hypotheses

Two expected outcomes were identified, as follows:

- Whakawhanaungatanga and kanohi ki te kanohi and updated techniques will generate the best results.
- Accepted techniques and online will produce the least informative result due to not being kanohi ki te kanohi.

5.2.2 Research Questions

After conducting an SLR, we extracted four research questions for the prototype SSM process; the questions and inclusion criteria are as follows:

- RQ1. (From SLR) Could Māori groups incorporate accepted techniques into requirements elicitation to create new requirements?
- RQ2. Could the improved elicitation technique apply a satisfactory level of efficiency for Indigenous groups compared to the accepted technique?
- RQ3. What are participant perceptions of the improved kaupapa Māori technique?
- RQ4. What is required to ensure a positive experience for all parties involved while generating a viable product?

5.2.2.1 Inclusion Criteria

- Participants who identify as Māori
- People with a basic understanding of the Māori language

- Māori organisations
- Participants with an understanding of whakawhanaungatanga

5.2.3 Independent and Dependent Variables

Taking into account the independent variable (the variable looking to change in the empirical test) and the dependent variables (the variables to keep consistent) when conducting the study, we identified one main independent variable and three dependent variables: they are as follows.

5.2.3.1 Independent Variables

- The methods used when approaching requirements visualisation (SSM)

5.2.3.2 Dependent Variables

- The quality of the prototype produced from the methodologies
- The satisfaction generated by the prototype delivered to the participants
- Whether the satisfaction generated by the result is sufficient to outweigh the inefficiency of the process.

5.3 Method

The best approach would be to split the process into two separate stages with an introduction process beginning with a karakia, an interview process prior and two surveys completed individually outside the study, and a conclusion phase explaining the overview of the process finishing with a karakia. Both phases incorporate the overall structure of the SSM but the proposed Māori methodology slightly alters the process to cater to Indigenous groups. The main difference between the two requirements elicitation techniques is that traditional SSM creates a prototype and then receives feedback from the participant on desirable changes, whereas the Māori methodology conducts both stages at the same time. Both methods were tested in a pilot user study with a satisfactory result that allowed us to successfully test the proposed methodology in a full-scale study with four groups of four participants.

5.3.1 Introduction Phase

The introduction phase was separated into four steps. First is a karakia to open the study and receive guidance and spiritual protection from participants' ancestors. This is generally performed by the person who is not conducting the study; the participants are asked if anybody is confident to perform a karakia, if not, then the karakia is conducted by the researcher. Next, the formal whakawhanaungatanga phase begins where the participants can interact with each other and get to know each other; if they have already met prior, they are building on the relationship that has already been established. Third, a background on the Huri Whakatau project is presented explaining the overall process and the purpose of the study; if anybody is unclear after the explanation the participants are encouraged to ask any questions they may have. Finally, the interview process begins with each participant answering the questions created to understand their Māori background and experiences, alongside their development experience.

The internationally accepted methodology called the *accepted method* in the scope of the SSM follows the SSM process with the seven-stage process mentioned in Chapter 4. Due to the time available with the participants, it was decided to only conduct the first six steps. The process went as follows:

1. **The problem situation is unstructured.** The participants are provided with the case study and then prompted to discuss among themselves potential issues they have identified. This phase also provides participants with an opportunity to ask questions about anything they may be unclear about in the case provided.
2. **Problem situation expressed.** The second phase involves participants brainstorming the relevant ideas and then discussing how they would resolve the issue identified in the first phase. This step considers any potential actions that may be needed to understand if any external factors need to be taken into account when developing the project.
3. **The root definition of relevant systems.** Due to the high potential variance in knowledge around creating software, an indirect CATWOE [70] analysis is performed where the participants are asked from their perspective who they think would be the

best party to include in the software development process and any party that needs to be considered when making the software to ensure the process is taking all relevant parties into account. Although participants can provide indirect answers to a CATWOE analysis, asking them the question “Who do you think would be important to consider if the product being created is used in a realistic scenario and why?” allows participants to answer the question without using technical detail.

4. **Conceptual models:** In the conceptual model step, a paper prototype is incorporated using Figma where five minutes is used for the researcher to provide a Wizard of Oz paper prototype. Due to time constraints, premade assets are used based on the information provided in the first step by the participants; once the researcher is happy with the prototype the participants review the prototype.

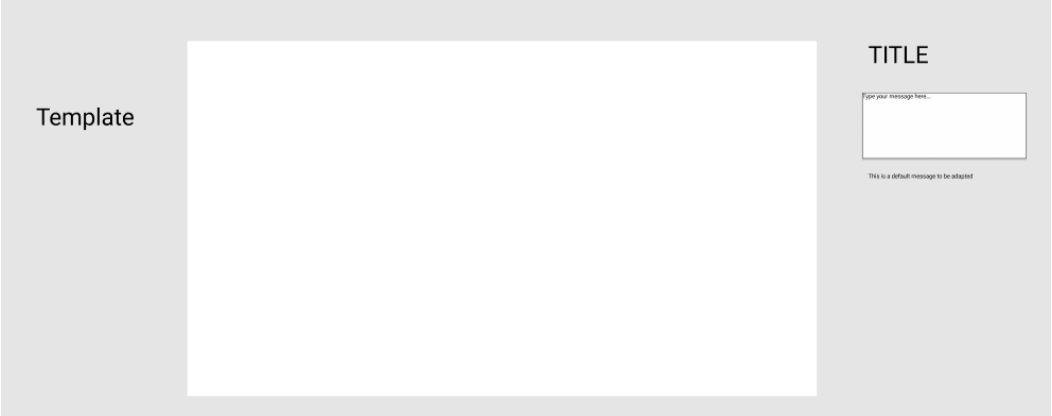

Figure 5.1: Template assets that were used when conducting the SSM study for both methodologies

I created four example assets (see Figure 5.1) when considering what would be necessary for a user in the study and to prepare for any solution provided. First is a blank textbox to simulate the user input provided; this is easy to scale and modify for any situation that could occur, such as a search bar, commenting on a specific item, or providing feedback for improvements to the platform. Second is a 1920x1080 prototype screen that is the size considered to be the average user’s monitor size when using the product via desktop. Third is a premade header text with the purpose of a title so the purpose of the platform is understood. Finally, small pieces of text allow for any descriptions mentioned by the participants for any scenario where the header would not be considered, for example, a

user who provided feedback on the platform with a long explanation would create a bad user interface design which would be displayed on the home page.

5. **Using structures to explore the situation.** Participants are allowed to mention any issues or items that are not considered when making this application in a real-world environment. In the scope of the study, this means asking the participants if they are happy with the prototype and feel it adheres to the CATWOE analysis created and the problem situation expressed solutions identified.
6. **Feasible and desirable changes identified.** Once the participants have identified the issues provided in Steps 1 through 5, the participants are asked about any potential changes they would like to see for the product that has been provided, and any suggestions they may have regarding how to incorporate their idea, before concluding the study, due to being unable to test Step 7.

5.3.2 Midway

Due to the realistic scenario of participants not being able to complete the study or potentially needing a break, the midway section serves as an intermission period. The intermission process involves the researcher explaining the overview of the survey analysis provided and encouraging participants to complete the survey individually to improve the process for future studies. Once the survey explanation is completed, the participants are asked if they have any questions; if not, then the participants are allocated time to fill out the survey. The participants are encouraged to ask questions regarding any aspect of the survey to ensure the information is filled out correctly.

5.3.3 Improved Method for Indigenous Groups

Creating a collaborative process between the researcher and the participants and allowing participants to perform whakawhanaungatanga allows for a process that incorporates kaupapa Māori philosophies. Collaboration is provided throughout the proposed SSM process but mainly in Stage 5 where the real-world analysis is conducted in parallel with the prototype, which reduced the process from six stages. The reason behind the change is to try to minimise the issues that could potentially occur in the seventh and final step

and to reduce the number of cycles needed to create a high-quality prototype. The only changed step from the original SSM process is as follows.

Conceptual Models: In the conceptual model step, incorporating a paper prototype is considered the most effective conceptual model for the target audience. The paper prototype is created primarily using Figma, which is used for the researcher and participants to create a Wizard of Oz paper prototype using premade assets based on the information provided in the first step by the participants. Once the researcher is happy with the prototype, the participants review the prototype. The back-and-forth snowball process about the application of the prototype continues until all parties are satisfied.

5.3.4 Planning Conclusion

Once the improved methodology is completed, the participants are once again provided with the survey (see Appendix C) and they are encouraged to ask any questions if they are stuck. Once the survey is completed, the participants are thanked for their time and asked if they wish to receive a record of the information collected concerning the study. A karakia is done, preferably by a participant, to close the study. If a participant is unable to perform a karakia, the karakia is conducted by the researcher.

5.3.5 Functional and Non-Functional Requirements

It was important to be able to generate functional and non-functional requirements for the systems that were planned to be used during the study. The functional requirements identified include the necessary functions of the software and the background information on the software such as security and safety requirements. The identified requirements are as follows.

5.3.5.1 Functional

- When2meet will be used for scheduling each group's time slot.
- Users will decide their nickname on Huri Whakatau and can use their real name but are not encouraged to.
- Google Meets or Zoom will be the preferred method of communication with the participants.

- The software will be tested to ensure meeting rooms are created via Zoom link or Google calendar.
- Ensuring screen sharing functionality is possible.
- Allowing participants to see all relevant information on the background of the specification by giving “view”-level access to the Google Document.

5.3.5.2 Non-Functional

- Keeping up to date with any potential server-wide updates for Google Meet, Google Calendar, or Zoom that may lead to being unable to meet.
- Understanding the server status of When2Meet and ensuring that all functions are understood by the participants in order to adequately set up meetings.
- Ensuring the share-link functionality on Google Documents works and that users can access all relevant information.

5.3.5.3 Security

Ensuring the participants are in small groups with people they will feel comfortable around is of utmost importance. Since the groups consist of people from organisations, this will lead to anonymity being the least of the researcher’s concerns. The information is stored in Tamahau’s Huri Whakatau Google Drive. Google Drive uses 256-bit SSL/TLS encryption for files in transit which should be safe to prevent people from intercepting information.

5.3.5.4 Safety Requirements

To ensure the safety of participant information, only people mentioned on the participant consent forms (see Appendix B) will be granted permission to view all notes made by the researcher or any recordings (written or audio) of any given participant. Participants will receive a copy of any written information regarding research notes about them and a quick overview of the results if they indicate they would like an update on the results.

5.3.6 Exclusion and Inclusion Criteria

When testing the study, clear inclusion and exclusion criteria need to be set due to the nature of the study, to ensure it can formulate high-quality results. Three items have been created for exclusion criteria and four items for inclusion criteria. This will assist in ensuring the highest quality results are found; the criteria are as follows.

5.3.6.1 Exclusion

- People below the age of 16
- People who do not identify as Māori
- Participants who are unable to provide written consent for the study

5.4 Limitations

When considering the study, it is necessary to identify the limitations that need to be taken into account that could directly impact the results of the study and lead to invalid results in an empirical test environment, as opposed to a realistic kaupapa Māori software development team. The identified limitations are as follows:

- People with a limited understanding of kaupapa Māori practices may not perform the study correctly, which could lead to invalid results.
- Participants unable to communicate with the researcher will hinder the study's progress.
- Participants could provide incorrect information to the study which could lead to misleading results.
- Selecting participants from one iwi or region specifically can lead to similar thinking.
- Language limitations between participants or between the researcher and a participant can create misunderstandings or lack of participation. This leads to the question of whether participants should be allowed, or even encouraged, to speak in te reo Māori, and how this could be analysed, e.g., is the weighting different for different languages?

5.5 Pilot Study Results

Before it was possible to conduct a full study, a pilot user study was conducted with a group of three participants who were all close to me to ensure the process was correct and to check whether any additional changes needed to be made. I decided to test by conducting an online voice call explaining the process and doing a pre-study interview; participants received a case study but first did the study using the accepted method of SSM followed by a survey, then the second iteration was the kaupapa Māori technique with a survey at

the end. Once all these were completed, I thanked the participants for participating and offered to let them know the results.

5.5.1 Interview

The interview process was simple, all participants were able to identify their tribes, all classified as Māori, and understood the aspects of whakawhanaungatanga but were unable to provide new aspects; all participants had involvement within their communities and had shared positive aspects using whakawhanaungatanga. A note is that all participants were within the age range of 41–50 years old which could lead to a limited scope of understanding.

5.5.2 Study

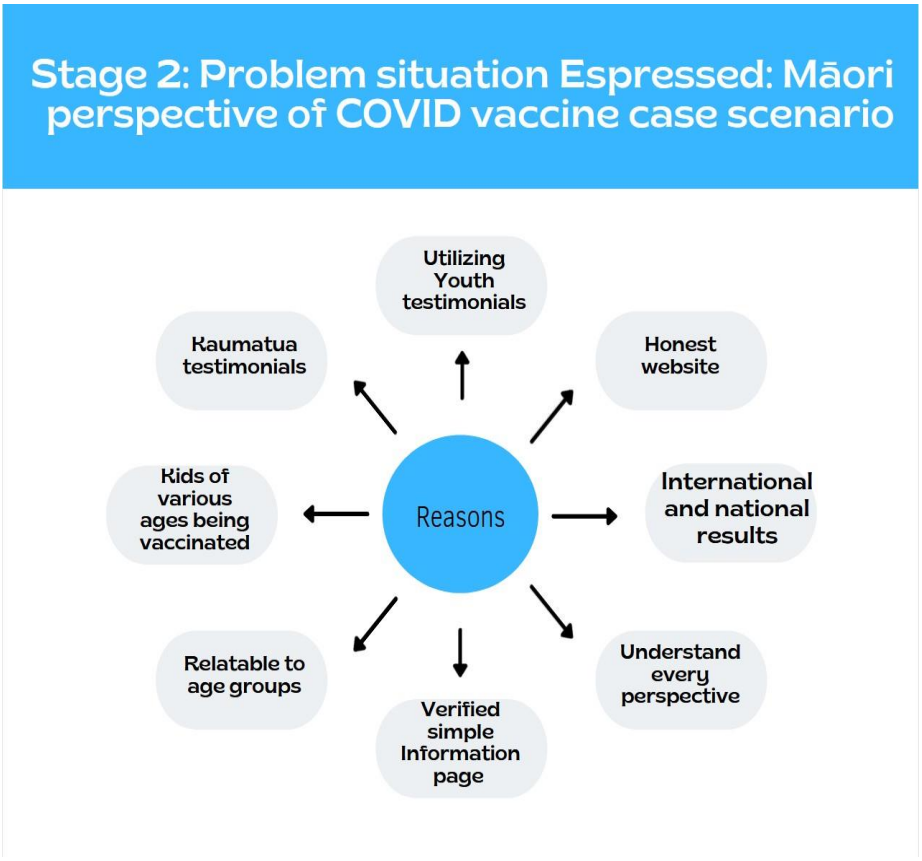

Figure 5.2: Pilot user study Stage 2: Problem situation expressed

All participants were familiar with each other, leading to a positive relationship from the beginning of the study. The case study was about asking why Māori people were reluctant to get the COVID-19 vaccine and how the health sector could encourage people to be vaccinated. The study was broken into six steps of SSM, as the seventh was outside the scope of the research.

Many suggestions were made on the identified issues such as lack of information, historical distrust between Māori people and the Crown, and racial profiling accusing Māori of spreading the disease due to their ethnicity. Once all aspects had been considered, the second step was to propose a potential solution which was expressed in a brainstorm (shown in Figure 5.2) that considered many factors involving honest information, testimonials, relating to age groups, and international results alongside domestic COVID-19 vaccination results, allowing for an open perspective.

Table 5.1: Relevant systems: CATWOE analysis

CATWOE	Description
Customer	Māori population
Actors	Māori representatives (iwi, kaumātua, kuia), Māori people, people with high mana
Transformation	To allow clear-cut access to all people.
World	Allowing Māori to understand what the vaccine contains
Owner	The Māori community.
Environment	Ensuring the information is accessible to the Māori population.

Once a potential solution had been discussed and agreed upon, the next stage was to perform a CATWOE analysis [70], seen in Table 5.1 above, in which the participants were able to give their perspectives on all aspects indirectly, and which was transformed into a CATWOE table. Finally, once all perspectives had been considered, a paper prototype (see Figure 5.3) was made with feedback on desirable changes in the accepted analysis, whereas the kaupapa Māori methodology collaborative approach was immediately tested after the prototype which received high participant satisfaction and a more positive overall result.

Finally, when the participants were asked if they felt the work conducted would work in a realistic scenario, they said yes, but on the grounds that the relevant parties (actors in the CATWOE analysis) were consulted. Due to the scope of the project, it was not possible to test the 7th stage of the SSM process.

Figure 5.3: Pilot user study Stage 4: Concept prototypes, low-fidelity paper prototype

5.5.3 Survey

All participants had similar answers in that they did not feel any mental or physical demand, they were extremely satisfied with the process and the prototype created and believed the Māori techniques were conducted correctly, especially in comparison to the accepted SSM approach. All participants did not feel a time limit should be imposed and stated that if a time limit had been incorporated, it would have distressed them making them uncomfortable to complete the study, which could have potentially led to them withdrawing. Due to the environment being comfortable for everyone, they were able to feel satisfied, give open answers, and reported feeling no discouragement, irritation, or distress at any stage of the study. Finally, they were asked whether, if the prototype was to be created, they would want the interface in English or te reo, they said both as they are equally as crucial in New Zealand.

5.6 Results and Analysis

After completing the pilot user study, it was possible to determine whether the planned methodology created would be able to be correctly used in a full-scale user study. Before joining the study, participants were asked to sign a consent form that explained the process of the study and any ethical concerns they may have had with the results produced. Once the consent forms were signed, we decided to separate the study into three sections: first, the interview phase, to allow us to understand the participants' background with Māori and understanding of software and whakawhanaungatanga. Second, the main study was first conducted using non-kaupapa Māori methods, and then using kaupapa Māori; the participants were asked to complete surveys after each method. Once completed, the participants would be thanked for their time and have any questions they may have had about the study answered and sent the results of the study.

5.6.1 Interview

During the interview, participants were asked a range of questions about themselves and to gauge their understanding of aspects of the study; the questions concerned:

- Identification
- Affiliation
- Age range
- Level of Māori fluency
- Involvement with the Māori community
- Understanding of software
- Understanding of whakawhanaungatanga
- Application of whakawhanaungatanga with software
- Any positive experience using whakawhanaungatanga

The answers to these questions gave the person eliciting requirements (the researcher) a strong understanding of how to approach conducting the SSM user study.

5.6.1.1 Participant Tribal Affiliations and Identification

When participants were asked if they identified as Māori, all responded “yes”. All participants were able to give a response about their tribal affiliations, some participants responded with multiple answers and others responded with one; for easier identification, it was decided to record the tribe they primarily affiliated with.

The majority of the participants were primarily affiliated with Ngāti Porou with eight out of the 16 participants; three were primarily affiliated with each of Ngāti Kahungunu and Te Whānau-ā-Apanui; and two participants had a primary affiliation with Ngāi Tāmanuhiri (see Figure 5.4).

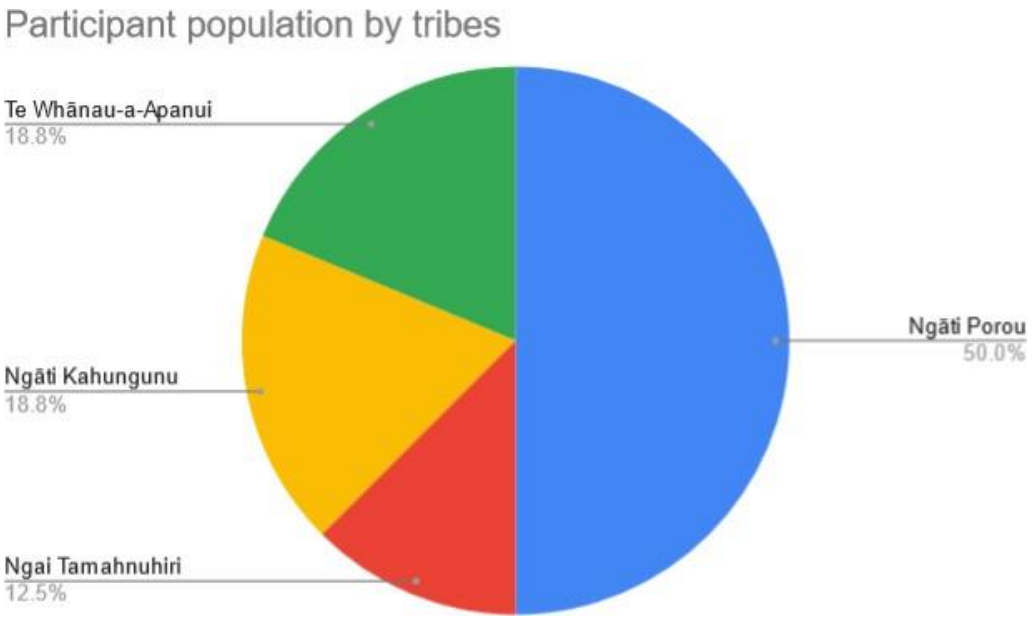

Figure 5.4: Participants by primary tribal affiliation

5.6.1.2 Age Range

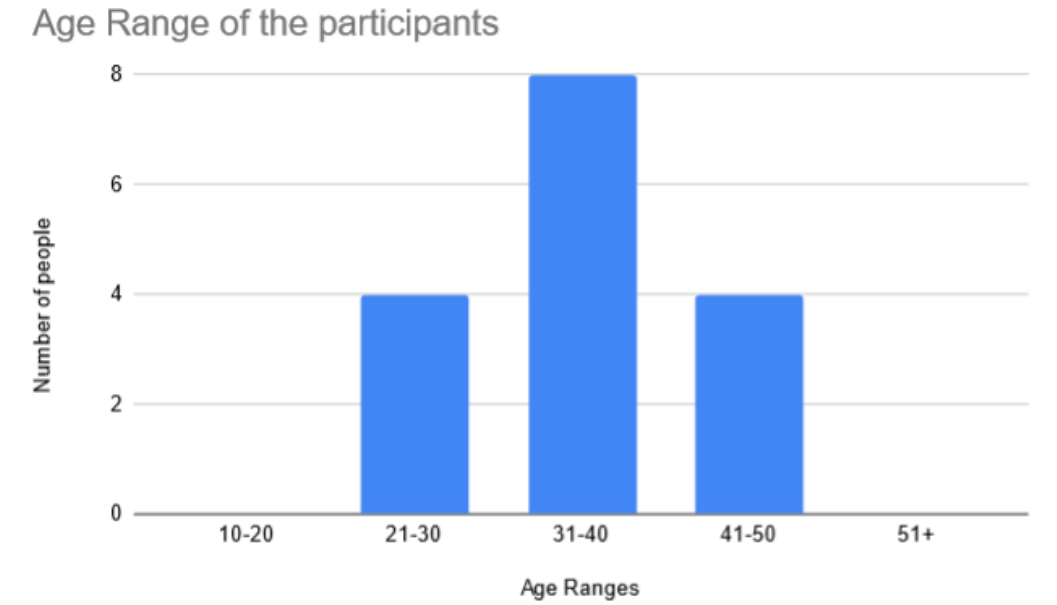

Figure 5.5: Age range of the participants in the study

All participants were in the age range of 21 to 50, which indicates that the participants are within the age range of being exposed to technology as shown in Figure 5.5.

5.6.1.3 Level of Māori Fluency

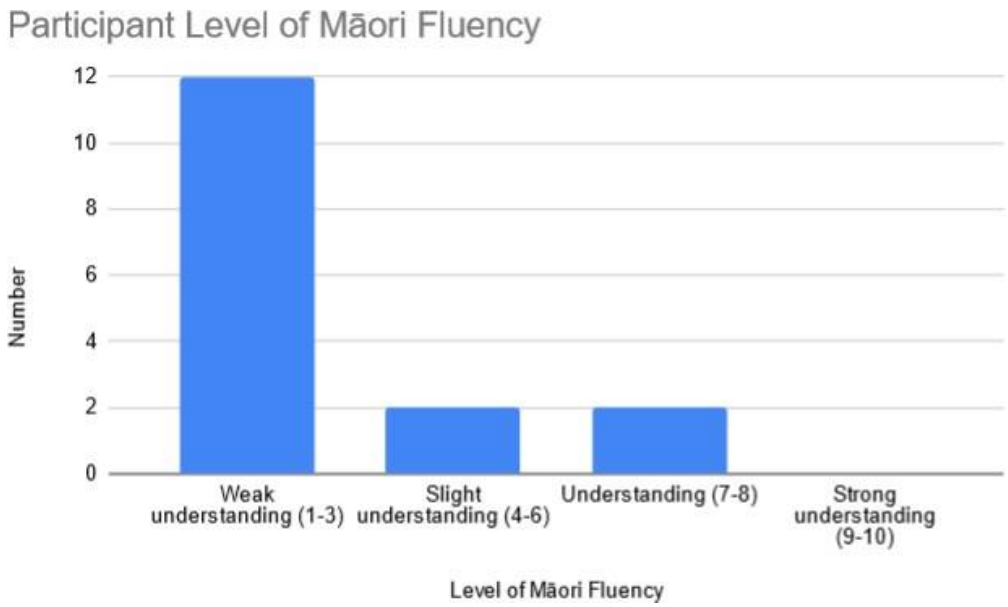

Figure 5.6: Participant responses to the level of Māori fluency

Participants were asked about their level of Māori fluency (see Figure 5.6); most participants felt they did not have a strong understanding, rating themselves as 1 to 3, a

few participants felt they had a satisfactory level of understanding with a rating between 4 to 6, and two participants felt they had a strong understanding with a rating of seven to eight.

5.6.1.4 Involvement in Māori Communities

When asked about their level of involvement in Māori communities, it was apparent that all participants had involvement with aspects such as family gatherings, and there was involvement with some other activities such as kapa haka, and Māori mentorship. With a large range of activities being performed, it was evident there is a strong level of commitment with a number of perspectives from the activities performed.

5.6.1.5 Definition of Somebody Who Is Māori Responses

When asked their definition of somebody who is Māori, participants responded with four main answers: first, somebody with Māori descent/heritage/ancestry, by this they mean people with blood connections to iwi from the lineage of the original Māori people. Second, somebody who embraces Māori culture who is not of Māori descent or does not have Māori blood but has a strong cultural understanding and embraces the level of the intended culture, in turn integrating them with the culture. Third, a person from the land of New Zealand, meaning that a participant who originated from the land of New Zealand is considered somebody who is Māori. Finally, somebody who is not necessarily a citizen of New Zealand nor lives in the land of New Zealand but has a strong cultural understanding of Māori culture, people who are included in this group are people who understand aspects such as whakawhanaungatanga, mana, kaumātua, kuia, manaakitanga.

5.6.1.6 Proficiency of Software Development

When asked about their level of software proficiency and understanding of how software is developed, most participants mentioned they did not have any experience; some said they had degrees of understanding and only one participant had a strong enough understanding to define themselves as proficient. While most of the participants did not work in technology-related fields, a few of the recruited participants worked in a field that exposed them to how technology is created.

5.6.1.7 Identified Aspects of Whakawhanaungatanga

Participants were asked “I managed to identify four aspects of whakawhanaungatanga. These were manaakitanga, kanohi ki te kanohi, kaupapa Māori, and Mātauranga Māori; do you feel these aspects could translate well into software development?” Everybody responded immediately with “yes” except for one participant who abstained as they felt they were not knowledgeable in both fields to answer. All participants who did answer stated that these are the core foundations when understanding Māori culture and are essential when creating software, other answers included:

- Stronger relationships aid to discussing items in detail, allowing creativity in the design process, building trust, and deciding project details and design requirements.
- Informative to ensure strong relationships are built, essential to learning the aspects of whakawhanaungatanga.
- Core aspects to understand when building processes for Māori.

Other important aspects of whakawhanaungatanga that were not in the original question were also mentioned by participants, these were:

- Ukaipotanga – roots and links (software hierarchy and structures)
- Hononga, connections with a person
- Kotahitanga
- Kaitiakitanga – People enjoy standing up proud
- Language and communication aspects
- Understanding of your roots

5.6.1.8 Positive Experiences Using Whakawhanaungatanga

The last question participants were asked was if they were able to build a positive relationship how they use whakawhanaungatanga ; the answers were varied, and include:

- Family-related activities;
- Reconnecting with family/friends;
- Gatherings/storytelling;
- Every experience they have, generally the process is good but, on some occasions, the process can be unpleasant, such as confrontations;

- As a cop they have seen positive and negative relationship building with the uniform allowing them to receive understanding from some and acts of anger or aggression from others;
- Linking and reconnecting with people.

5.6.2 Study

It was decided to conduct a full-scale user study that had a total of sixteen participants who were divided evenly into four groups. Three out of the four groups were given a case scenario that was performed with both the accepted SSM method and the kaupapa Māori method to successfully determine the differences between the two methods. It was observed the Māori method did create an open, collaborative environment where people were more open to discussion and participants agreed the Māori method did adhere to kaupapa Māori philosophies. There was one group that was able to conduct the study in one period; labelled the kanohi-ki-te-kanohi group, this group was different from the other two groups as they were able to conduct the study in a face-to-face environment and provided a case scenario which they wanted to test with the Māori method. Overall, the observations of the Māori method were that the two components provided a realistic scenario that the participants were passionate about. Also, the collaborative face-to-face environment allowed for a satisfactory result with participants reporting they were more satisfied with the Māori method.

5.6.2.1 Accepted Method

Stage 4

The paper prototype managed to produce a result that the participants deemed acceptable with no critique. Participants did request adjustments to meet what they were expecting with a high satisfaction rate.

Stage 5

Participants identified the problem and brainstormed ideas for how to tackle the problem with the paper prototype to ensure the product that was being developed from a low-fidelity prototype would meet what the people identified in the CATWOE analysis would

expect to see. Due to the scope of the project, there was no interaction with the people mentioned in Stage 3.

5.6.2.2 Kaupapa Māori Method

Pre-study whakawhanaungatanga phase

A key Māori ideal is the process of whakawhanaungatanga which is essential when adapting the method to a Māori method. It allows participants to openly discuss topics of their choosing with each other. In all groups, it was observed to provide a positive environment that allowed for open discussion without the fear of judgement from other participants due to being able to understand each participant's current perspective.

Stages 4 and 5

The back-and-forth snowball process occurred when the participants mentioned how they viewed the prototype and the researcher developed the prototype with the participants' supervision and made changes that the participants deemed necessary, while, through each change, ensuring the prototype met the answers in Stage 2 to ensure it met the realistic expectations when moving into Stage 6.

5.6.2.3 Observations of the Overall Study

Steps 1 to 3 had similar processes. The kanohi-ki-te-kanohi group produced a different format following a free-flowing process but managing to meet the criteria of SSM. A template of the study can be found in Appendix D.

Answers to questions from groups to the provided scenario are as follows.

Stage 1: Problem Unstructured

Participants provided several potential reasons for Māori people not trusting the vaccine in September 2021, ranging from lack of trust due to the historical conflicts between Māori and the Crown, to lack of information. A full list with a combination of answers from all groups is:

- Lack of information/misinformation was a common answer
- Over-advertising can lead to frustration for people and people will refuse out of spite

- Social media helps but needs to be engaged correctly – lack of personal opinion at younger ages which can make them just want to fit in
- False assignment of blame to Māori giving COVID-19 in 2020
- No Māori representation to convey correct information
- Most representatives are government bodies making the verification of the source hard to trust. Education levels vary and specialties meaning the information is hard to process
- Consignment attitude has an effect – "World is over" "Why bother to vote"
- Peer pressure
- Propaganda swaying Māori opinion
- Mandates and the pressure of the government
- Word of mouth having an effect
- Producing the vaccine to the public before being fully tested means potentially unsafe
- Māori cannot trust what is being said making it hard to want to get the vaccine

Stage 2: Problem Situation Expressed

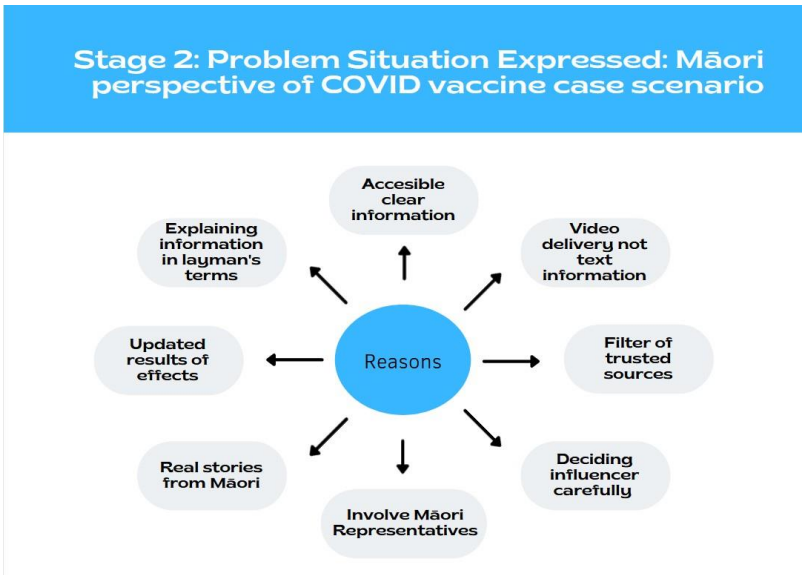

Figure 5.7: Merged brainstorm of participant responses to COVID-19 vaccine case scenario

Participants were able to examine the problem and the potential resolutions to resolve the issues. An example answer from Figure 5.7 that participants gave was: accessible and

clear information is necessary to begin the trust-building process as people can understand what the vaccine contains and make an informed decision; one group also mentioned a potential flaw with having more accessible information is that it increases the chance of information being misinterpreted, leading to misinformation, which is what people are claiming as mistrust of the Crown.

Stage 3: Root Definitions of Relevant Systems

Table 5.2: CATWOE analysis from participants

CATWOE	Description
Customer	Māori Population and people of Aotearoa.
Actors	Māori representatives (iwi, kaumātua, kuia), Māori people, Māori software developers, district health boards, public servants (police), tertiary entities, contracted Māori health professionals, influencers (for the youth), city councils, people who are defined as Māori software developers (both ancestry and cultural awareness).
Transformation	To create an environment that reduces misinformation and clear-cut access to all people regardless of their experience with technology.
World	This would impact the Māori community to understand and make an educated opinion on the vaccine with hopes to encourage people to get vaccinated.
Owner	The Māori community would own the product as this is information created by Māori to serve the Māori people.
Environment	A closed source environment made with a budget on a koha basis to aid with the development and support to ensure the information is accessible.

When identifying the relevant stakeholders and parties involved when creating a software product that would assist in bringing correct information to Māori people, participants were asked “Who do you believe is important when creating a software product to ensure the correct information is provided and what value do they provide?” Participants responded with whom they deemed important with their reasoning but did not answer in

the form of a CATWOE analysis. The results from all responses were identified in a CATWOE table (see Table 5.2) to generate the main people who should be involved when making considerations regarding software.

Stage 4: Paper Prototypes

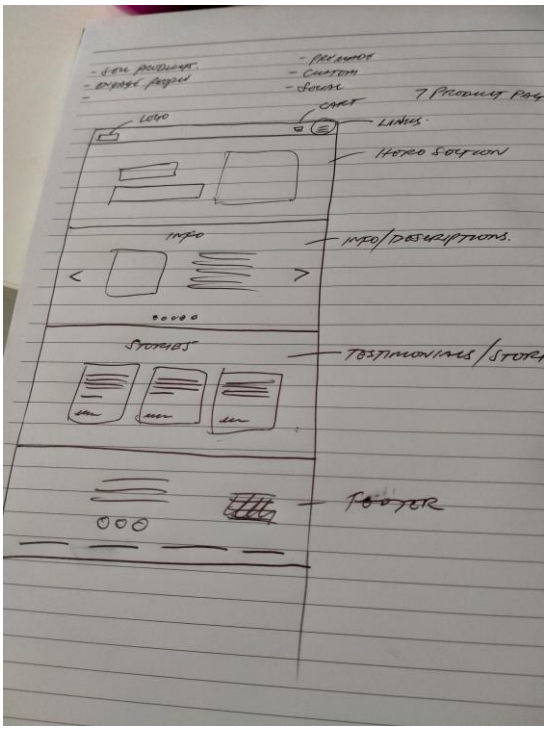

Figure 5.8: Paper prototype of custom participant-selected prototype

Creating conceptual models aids in creating a visual understanding of the product and allows for an interaction between the researcher and the participants. Participants mentioned that to ensure the prototype incorporates all perspectives, the stakeholders mentioned in the CATWOE analysis would need to be consulted with a strong emphasis on collaboration with iwi.

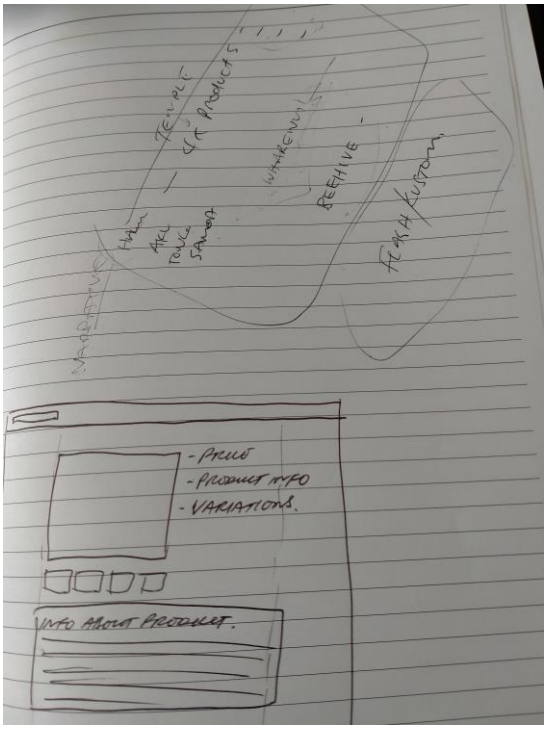

Figure 5.9: Ideas generated by the participants with brainstormed ideas and the draft of interface

The kanohi-ki-te-kanohi group decided to create a physical paper prototype for the case study of their choosing, Figures 5.8 and 5.9 are the results of their prototypes:

Stage 5 (Option A only): Desirable Changes

Due to the accepted approach not following the back-and-forth collaborative approach, participants were asked what changes they would make to the low-fidelity paper prototype. Participants made several suggestions for each of their prototypes ranging from informative phrases which could assist in engagement to ensuring links are provided below, to video sources, so people could track the validity of the source. The main issue mentioned by the participants was that the nature of people and the way they perceive the world makes the one-size-fits-all solution not possible with a software interface, and will be affected by external factors, but would be able to give people an informed decision and be able to conduct their research with trusted sources, assisting in understanding improvements that could occur in the prototype. The full list of suggestions is:

- Other good links to learn more information;

- References at the bottom;
- Links for the video sources;
- Examples sources of govt. sources, social media;
- Context menu on the top navigation bar, other links/other sources;
- Graphics for high-fidelity prototype;
- Catchy sentence – whakatauki/engaging image in background or foreground;
- More than software is required to break their "stubbornness" said Participant B. Stand up for what they believe. People would like honesty but Māori are strong in their beliefs, and withholding information makes them wary. People believe governments are never honest and software can't fix this bigger issue;
- Need a slogan that pulls in the attention of the user.

Stage 6: Using Structures to Explore the Situation

When participants were asked if they believed the product was up to the standard of a realistic application that could go into the development phase, most agreed it was to their standard and that it was acceptable, but the consultation with all participants needed to be taken into account when creating a study with controversial opinions. With participant satisfaction being so high from the answer to the desirable changes from the Wizard-of-Oz paper prototype, in comparison to the identified issue, brainstormed solution, and CATWOE analysis, they believed the product was in a good position to understand the next stages moving forward and the proposed solution would be able to be incorporated correctly in a real-world environment, which satisfies the question of whether the prototype in Step 4 meets the requirements mentioned in Step 2.

5.6.3 Survey

The user surveys after the study used the NASA TLX scale [71] (see Appendix C) which asks participants to rate their answer out of seven to the questions asked, with 1 meaning strong disagreement and 7 meaning strong agreement, for example, for a question on mental demand, a 1 means no/minimal mental demand was required and 7 means a high level of mental demand was required from the participant. Users were asked twelve questions overall which included the original questions provided by the NASA TLX [71]

source followed by questions with relevance to the user study conducted. The questions covered mental demand, physical demand, the pacing of the task and whether the task made them feel hurried or rushed, their level of success, how hard they worked to achieve their level of success, how discouraged they felt, their views on a time limit being incorporated, the level of satisfaction, the application of Māori techniques and whether the interface should be in English, te reo or an option for both languages. The results of the kaupapa Māori methodology were as follows.

5.6.3.1 Mental Demand

When questioned about the level of mental demand required (see Figure 5.10), most participants responded with a low level (1 to 3) of mental demand but a few participants responded with a moderate level (4 to 5). There was a trend towards a higher level of demand from more knowledgeable participants to the specific study as they had a higher level of investment compared to less knowledgeable participants. The potential reason for the difference in mental demand could be the level of interest/investment in the specific study.

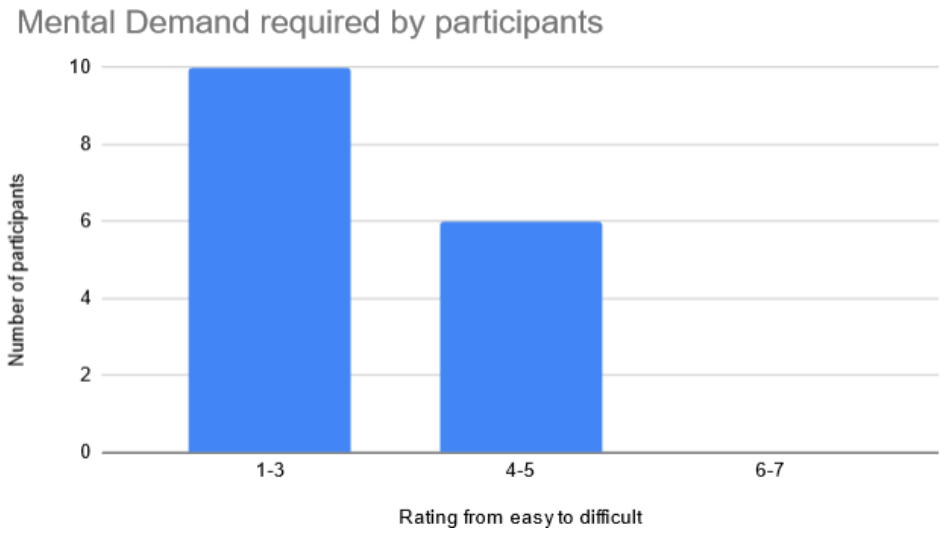

Figure 5.10: Participant responses to the level of mental demand

5.6.3.2 Physical Demand

When asked the level of physical demand, the participants said the study required no physical demand (see Figure 5.11). Participants said they found expressing their perspective of the study straightforward.

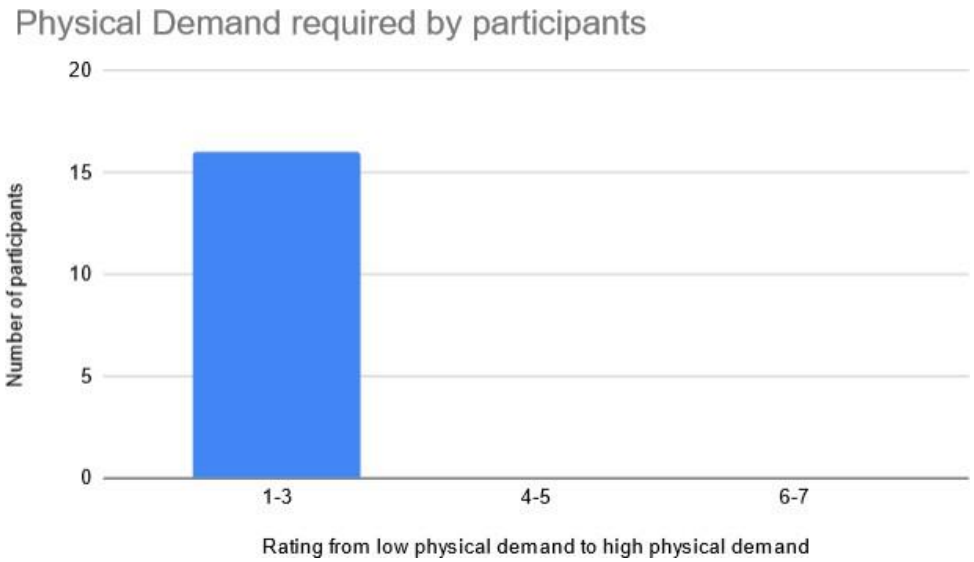

Figure 5.11: Participant responses to the level of physical demand

5.6.3.3 Hurried or Rushed

No time limit was incorporated when the study was performed, which could be why participants did not feel hurried or rushed and which allowed for their full perspective to be accounted for. Thus all participants responded with strong disagreement (1 to 3). See Figure 5.12.

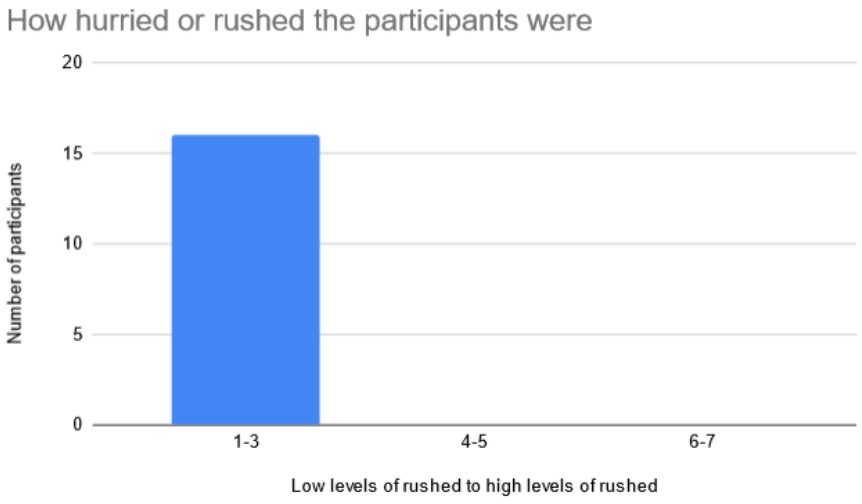

Figure 5.12: Participant responses to how hurried or rushed they were

5.6.3.4 Level of Success

When asked how successful they deemed their contributions to the study and whether or not the result was produced, all but one participant considered the product created of high quality, with a rating of 6 or higher as shown by Figure 5.13. One participant deemed the product of satisfactory quality; when questioned why they did not rate the product as high quality, they responded that they did not have sufficient knowledge. High and low quality are subjective and can vary depending on a participant's level of knowledge of software and creating prototypes, their viewpoint on a high-quality product, the people surrounding them, and the group environment with like-minded people.

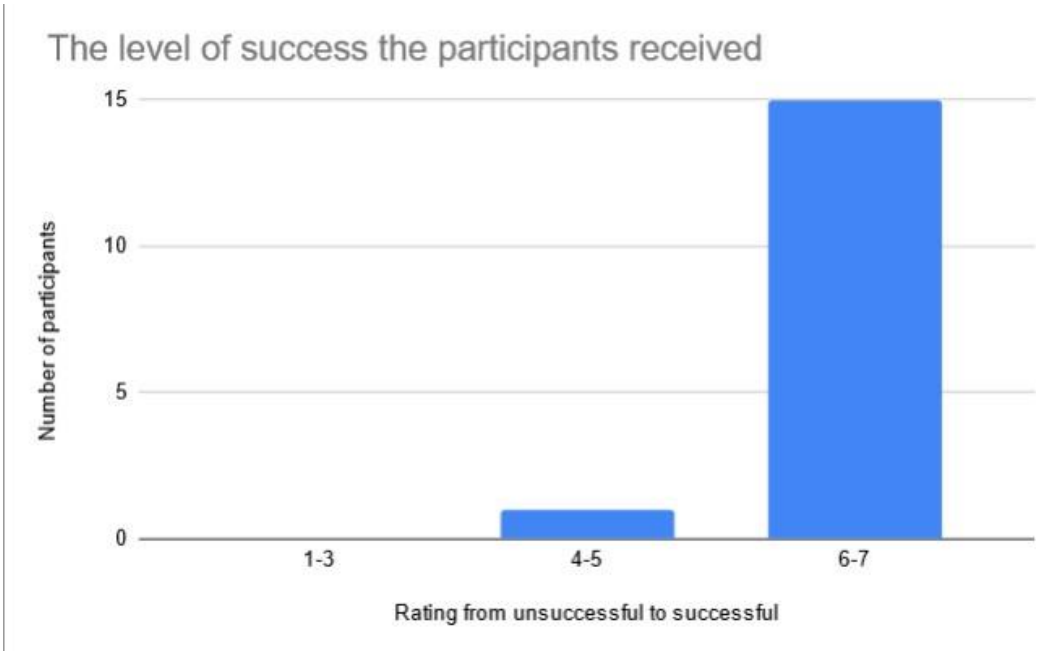

Figure 5.13: Participant responses to the level of success in the scenario

5.6.3.5 How Hard the Participants Worked

When determining how hard participants worked, the main observation was most participants deemed this the same question as how much mental demand was required, which is why if you compare the results of the mental demand in Figure 5.10 and Figure 5.14 for how hard participants worked, the received responses were similar. This means only one of the questions will need to be asked for future studies. Since the method was able to generate consistent results, this allowed the researcher to determine the results were at expected levels.

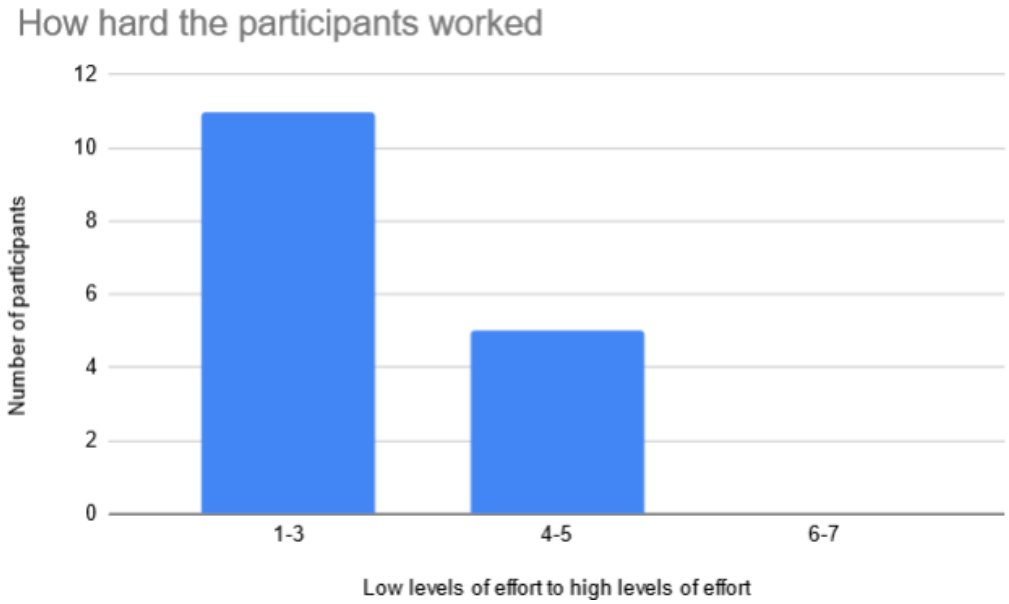

Figure 5.14: Participant responses to how hard they worked

5.6.3.6 Discouragement

When questioned on whether they felt “discouraged, irritated, worried or stressed”, due to being put in an environment where they felt comfortable when questioned, participants claimed the process of whakawhanaungatanga assisted them to build a positive relationship which meant they didn’t feel discouraged (see Figure 5.15).

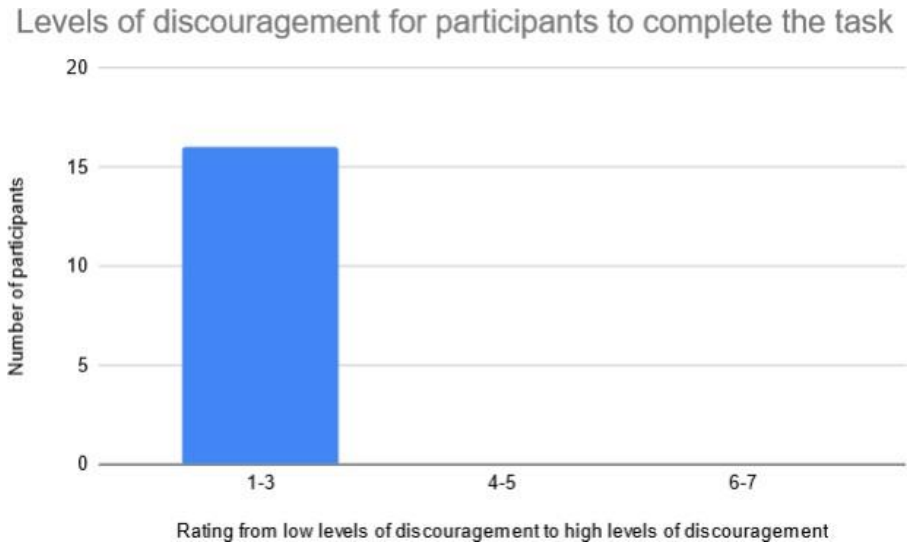

Figure 5.15: Participant responses to the level of discouragement

5.6.3.7 Imposed Time Limit

Asked if they would prefer an imposed time limit if it was possible to reproduce the kaupapa SSM study, all participants immediately stated “no” and all gave similar reasons: a time limit would cause them to feel uncomfortable and pressured which would prevent them from considering all perspectives (see Figure 5.16). For this reason, a time limit would generate less satisfactory results which would be to the detriment of the quality of the product.

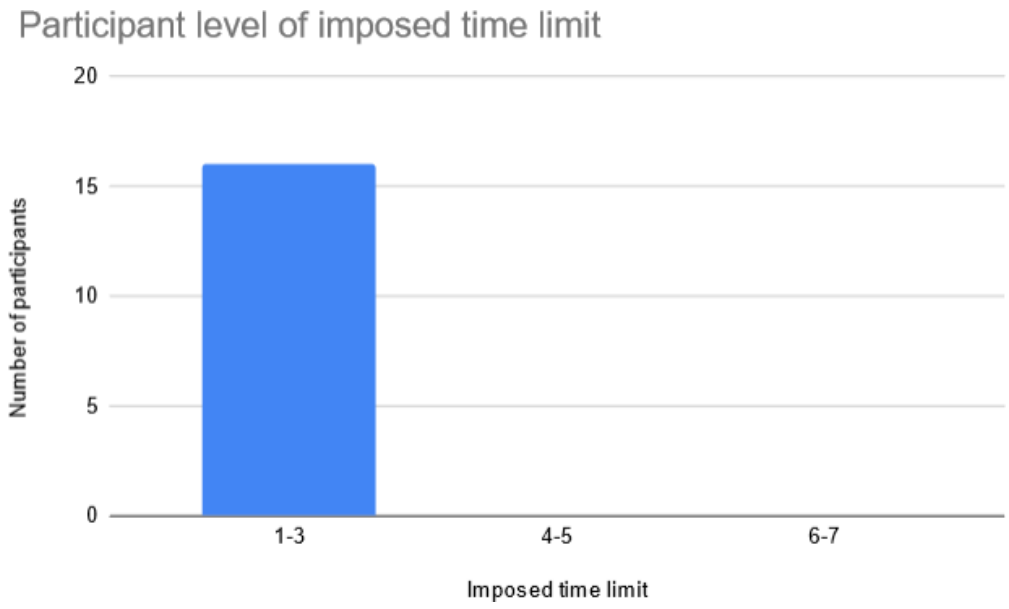

Figure 5.16: Participant responses to including an imposed time limit

5.6.3.8 Satisfaction

Understanding the satisfaction of the product produced was an important aspect considered when conducting the user study. Each participant was asked “How satisfied were you with the prototype?” All except one participant were very satisfied with the process as displayed by Figure 5.17. When the outlier participant was asked why the product was not to their satisfaction, they claimed they were not the correct person to consult for a high-quality prototype.

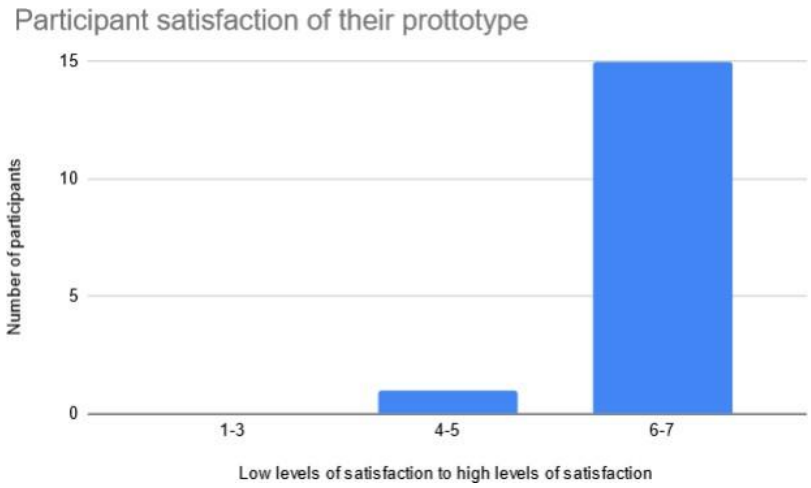

Figure 5.17: Participant responses to the level of satisfaction with the paper prototype

5.6.3.9 Application of Māori Techniques (Māori Method)

When asked how they would rate the application of kaupapa Māori techniques, most participants responded that there was an above-average level of application (see Figure 5.17). When asked why they believed this, most participants answered that the Māori process incorporated more than a sufficient level of Māori techniques but community involvement needed to increase with all perspectives to be more applicable.

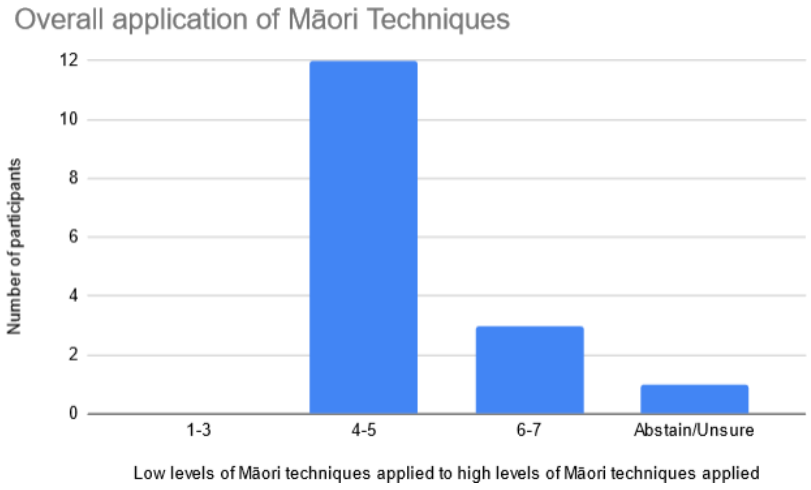

Figure 5.18: Participant responses to application of Māori techniques in Māori method

5.6.3.10 Language of the Interface

Participants were asked if they thought the interface should be in English, te reo, or both languages. Everybody answered both English and te reo, with several reasons mentioned; first, because not everybody speaks te reo Māori, an English interface would be

internationally understood and accepted. Second, since Aotearoa is a multilingual country, with the two main languages of concern being English and te reo Māori, they both should be given equal value, so both interfaces are necessary. As Māori cultural and language awareness is increasing, there is more demand for a Māori language interface, which is why participants mentioned the importance of a Māori interface. Finally, one participant mentioned that adding both interfaces is necessary but the concept of adding two separate interfaces would potentially not be realistic for several reasons involving UI (user interface) design, cost, and finding people who can ensure the same message is sent.

5.6.3.11 Comments:

The only comment participants made was the lack of familiarity with the NASA TLX scale rating between 1 as the minimum and 7 as the maximum, which confused them; they mentioned if future work is to be conducted using surveys, they would prefer a more familiar scale such as one from 1 to 10.

5.7 Threats to Validity

The only threat that was able to be identified was that three out of the four groups were provided the same scenario in regard to both the Māori and accepted method, which has two primary issues. The first issue is the answers provided by participants were repeated on both methods which allows for a similar result, with a separate topic being able to differentiate the quality of answers and determine the success of each technique in more detail, this was observed in the group using two separate topics. The second is that the Māori method came second, which allowed participants more time to generate new answers, giving a more successful result, which could make the Māori perspective seem more successful.

5.8 Study Result Conclusions

Overall, the observations determine that all participants in the four groups preferred the Māori methodology and deemed it was both more satisfactory and it adhered to kaupapa Māori philosophies. The pilot study allowed us to understand the Māori philosophy to fulfil the research questions by incorporating SSM (an accepted technique) and adapting the

technique to adhere to kaupapa Māori philosophies. During the pilot survey, participants seemed happy overall with the product and reported they were able to achieve what they set out to do with a low level of cognitive demand. When tested on a full-scale study, the only difference was some participants reported they had a higher level of effort and cognitive demand but were satisfied overall with the product and felt the Māori method was preferable and did include a sufficient level of kaupapa Māori philosophies. During the interview (see Appendix B) it was observed four main tribes were mentioned, they were:

- Ngāti Porou
- Ngāi Tāmanuhiri
- Ngāti Kahungunu
- Te Whānau-ā-Apanui

The final section of this chapter has outlined that the techniques used in the kaupapa Māori approach for SSM were successful but some participants felt there was a level of effort required in the approach; in addition, the majority of participants felt key Māori techniques were not applied. The limitation allows for improvement to the SSM approach in the future but outlines the overall potential success of the approach if applied in the Māori community with minor improvements. The next chapter explains the conclusion of the research and any limitations, improvements, and overall success of the research which can be applied in future research for Māori groups to aid in creating software requirements.

Chapter 6

Conclusions

This analysis has presented insight into both mātauranga Māori and accepted groups for requirement elicitation techniques and processes. It has displayed research into existing fields such as requirements engineering, visual design, ethnography, linguistics, and anthropology to create an overall understanding of the areas of research that have been discovered and finding gaps by creating an SLR with planning and identification stages.

During the SLR, the researcher managed to determine common elicitation techniques for both accepted and mātauranga Māori fields respectively, an example was the most common technique found which was interviews but with the caveat that a few papers mention interviews are not the most effective technique for gathering information. Observational techniques were used to understand the environment and applicable-use cases of the application being created.

With an understanding of both the most common and most effective elicitation techniques created, we were able to identify seven similar techniques used in both the mātauranga Māori and accepted fields. One major difference was apparent when observing both fields: the differences in the process they used to begin the requirement elicitation technique phase. Mātauranga Māori holds onto the cultural aspects of manaakitanga, whakawhanaungatanga, and kaupapa Māori to create “rich matauranga Māori” research. Accepted groups, on the other hand, follow a more formal process of identifying key stakeholders and building a relationship through the requirement elicitation process.

Only one requirement elicitation process common to the two fields was identified, it provided a basis for being able to compare the different approaches to the same process.

With a large number of differences between the two fields and common existing techniques and processes, this research can approach numerous undiscovered areas, and identified three main potential research questions. Supporting evidence from external

fields and SE around approaching cultural groups and the different processes required to generate successful results encourages research to analyse how to improve both mātauranga Māori and accepted fields.

Three techniques were identified in the SLR that were not used by Māori groups, which allowed for the comparison of satisfaction with the application of kaupapa Māori philosophies and mātauranga Māori concepts alongside the application of techniques in existing Māori studies. The accepted repertory grid technique was reported as having a high cognitive demand due to having to consider multiple factors, which led to people feeling overwhelmed and being unable to complete the study, although the opportunity to codesign with iwi and other respected members in the Māori community could mitigate this issue in comparison to SSM. In regard to focus groups, the low level of satisfaction deemed this technique inappropriate for testing the adapted methodology. When comparing SSM and focus groups, the main difference found was the flexible unstructured environment of focus groups allowed for a quick study but SSM's process allowed for a structured process presented to adapt to Māori methodologies with a higher level of satisfaction, hence SSM was chosen.

The final stage was conducting a user study using the Māori SSM methodology which was compared to the existing accepted SSM methodology. After the pilot user study, a face-to-face approach was used with four groups but due to limitations of location, one of the groups was performed by meeting online. The user study was able to identify users who had a higher satisfaction rate using the proposed adapted Māori methodology due to the elements of collaboration and being able to conduct whakawhanaungatanga throughout the whole process, which were reported to produce a less tense environment.

Overall, being able to understand the research questions mentioned in the SLR Section 3.4 when examining the whakawhanaungatanga and kanohi-ki-te-kanohi approaches generated acceptable responses from the participants in Chapter 5. The level of demand compared to results was very similar but the participants did specifically mention that aspects such as sharing kai are an essential process in Māori culture. It was observed that

the improved mātauranga Māori approach was able to generate a comparable level of satisfaction to the accepted counterpart.

Second, although the results did not display a significant difference between the comparable aspects and the accepted method, the research results were able to see enough of a difference that further development from Māori rōpū could create successful results for developing software.

Third, the Māori groups were able to successfully apply the accepted techniques to the Māori approach to generate high-quality requirements and create an innovative approach beneficial to their specific needs.

Finally, there are areas identified where SE methodologies can aid all groups with the Indigenous groups to apply better relationship-building processes (whakawhanaungatanga) in any environment to create a significantly closer face-to-face space without the use of cameras. The accepted methodology can apply techniques such as SSM and focus groups to Māori groups by applying more applicable software requirements.

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Appendix A Interview Questions

Interview Question Sheet

Ethics Committee, Faculty of Computing and Mathematical Sciences

Project Title
Huri Whakatau

Interview Questions

Participant ID:

Date:

1. Do you identify as a Māori?
2. Which iwi do you affiliate with?
3. How old are you?
4. On a scale of 1-10, 1 being unable to comprehend and 10 being fluent, what would you say is your level of Māori Fluency?
5. Could you please detail the opportunities that you have to be involved with your Māori community?
6. What do you define as someone who is Māori?
7. Do you have any experience or knowledge about how software is developed?
8. We managed to identify 4 aspects of Whakawhanaungatanga? These were:
    a. Manaakitanga
    b. Kanohi ki te kanohi
    c. Kaupapa Māori

d. Mātauranga Māori

Do you feel these aspects could translate well into software development?

9. What other principles of whakawhanaungatanga are important to you? And do you feel those aspects have a role in software development?
10. Have you had any positive experiences to build a strong relationship using Whakawhanaungatanga? If so, (if you are comfortable) what were they?

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Appendix B User Consent Forms

Participant Information Sheet Ethics Committee, Faculty of Computing and Mathematical Sciences

Project Title
Huri Whakatau

Purpose

This research is conducted as a partial requirement for the Master of Science (Research). The researcher has the objective of testing an updated model for Software Engineering. To test this we will use our current prototypes designed for Huri Whakatau, a specifically developed tool for consensus building. Users will participate in group discussions with the goal of reaching a consensus and building relationships. We are testing how best to develop applications that support consensus building.

What is this research project about?

This research is to investigate ways of improving user interaction and user experience of a web application. The application is designed to be a tool for Indigenous groups to discuss topics with the goal of reaching consensus. The text of these discussions can then be used by researchers to determine how online discussions flow and how agreement is reached in a group.

What will you have to do and how long will it take?

We will invite you to be a participant in a user observation study of a group discussion with up to five other participants. The goal of our user observation study is to create an updated model for Software Engineering. The discussion that will be observed is simply a method for us to examine our Software Engineering models with real users.. The discussion will take place online using a range of tools from Google Meets or Zoom for virtual discussions and email or social media for text-based updates. You will be asked preliminary questions in regards to your views on Māori Culture, once completed the observation study will begin where a portion of the groups will conduct the internationally accepted method first, once the process has been completed you will perform the task again using the updated method. After both methods have been completed, you will be asked to individually complete a questionnaire and the study will conclude and the discussions will be exported for further analysis. You will be asked to give consent to the study before it starts, and also to verify consent to storing data for over 5 years. The overall completion of the research is expected to take a maximum of 5 hours total (2x 2 hour sessions and 1 hour to complete surveys) accumulated (this could be done in one session or multiple sessions) due to multiple processes being incorporated into the study and the process of whakawhanaungatanga being a vital component of the study.

What will happen to the information collected?
The information collected upon analysis of the discussions will be used by the researcher to improve the design of the application. Anonymised data may also be included in a research report for the credit of a specific paper. It is possible that presentations and a published paper may be the outcome of the research. Only the researcher and supervisors will be privy to the data collected. No participants will be named in the publications, and every effort will be made to disguise their identity.

Declaration to participants
If you take part in the study, you have the right to:
Refuse to answer any question, and to withdraw at any time during the study, but not after. Ask any further questions about the study that occurs to you during your participation.
Be given access to a summary of findings from the study when it is concluded.

Who's responsible?
If you have any questions or concerns about the project, either now or in the future, please feel free to contact either:

Researchers:
Tamahau Brown
Role: Study Conductor
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Supervisors:
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Te Taka Keegan:
Email: tetaka1@gmail.com

Nicholas Vanderschantz Email: vtwoz@waikato.ac.nz

This research project has been approved by the Human Research Ethics Committee of the University of Waikato under HREC(HECS)2021#55. For any ethical questions or concerns please contact the Chair of the Committee, email hecs-ethics@waikato.ac.nz, postal address, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Research Consent Form Ethics Committee, Faculty of Computing and Mathematical Sciences

Huri Whakatau

Consent Form for Participants

I have read the **Participant Information Sheet** for this study and have had the details of the study explained to me. My questions about the study have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I also understand that I am free to withdraw from the study before 21/01/2021, or to decline to answer any question in the study. I understand I can withdraw any information I have provided up until the researcher has commenced analysis on my data. I agree to provide information to the researchers under the conditions of confidentiality set out on the **Participant Information Sheet**.

I agree to participate in this study under the conditions set out in the **Participant Information Sheet**.

Signed: _____

Name: _____

Date: _____

Researchers names and contact details:

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Supervisors:
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This research project has been approved by the Human Research Ethics Committee of the University of Waikato under HREC(HECS)2021#55. For any ethical questions or concerns please contact the Chair of the Committee, email hecs-ethics@waikato.ac.nz, postal address, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

Appendix C Survey Questions

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Survey Question Sheet

Ethics Committee, Faculty of Computing and Mathematical Sciences

Project Title
Huri Whakatau

Survey Questions

Participant Name:

Date:

1. How mentally demanding was the task?

2. How physically demanding was the task?

3. How hurried or rushed was the pace of the task?

4. How successful were you in accomplishing what you were asked to do?

5. How hard did you have to work to accomplish your level of performance?

6. How insecure, discouraged, irritated, stressed and annoyed were you?

7. Do you feel the task should have imposed a time limit? Why or why not?

8. How satisfied were you with the prototype?

9. At any point did you feel discouraged to complete the task? If so, why or why not?

10. If yes to the previous question, how would you scale your discouragement from the completion of the task?

11. How would you scale the application of Kaupapa Māori Techniques?

12. Would you prefer if the Huri Whakatau interface was displayed in Te Reo? If so, why?

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Appendix D Study Template

Huri Whakatau Pilot Study October 25th 2021

Scenario:

New Zealand has identified Māori people between the ages of 12 and 19 have a significantly low vaccination rate. 16% of people between 12 and 29 are fully vaccinated and only 44% have had their first jab. Grayson Nepia mentions that social media has been recognised as the best communication for people within that age group. Nepia has been using photos of younger people getting vaccinated on these social media platforms to engage and encourage users within the 12 to 29 age range. Te Piki Oranga and other health services are aiming to have 80% of people vaccinated by the end of 2021. They wish to encourage people to ask questions if they wish to get more information and answer questions that have been asked frequently.

Stage 1: Problem Unstructured

Stage 2: Problem Situation Expressed

Smarter idea to get kaumātua or kuia to have input into the program. Might be smart to get them to peer review. Māori do not take well to strange people coming into strange people coming in. Level of trust is essential.

Utilise the youth as the most important factor but the kaumātua as the "backup" so a page with testimonials. People from various age groups.

Home page with kids of various ages in a slide show and large families well known in the community.
Other pages: Kaumātua testimonials (older age groups), information page, contact (social media) and FAQ Page.

Due to kaumātua influence being weaker make it more relatable via their age group.

Due to the nature of most adults knowing the truth, an honest website would be best mentioning risks and potential outcomes from all possibilities. Include international results from the vaccine and recent cases of how effective the vaccine is as this allows everybody to make an informed decision.

Stage 3: Root Definition of Relevant Systems
Key people need to interact with are the kaumātua, and the iwi. Leaders with high mana are important. Māori people who are involved with government organisations as well.
Scenario Link:
https://www.rnz.co.nz/news/te-manu-korihi/453573/social-media-used-to-reach-maori-in-vaccination-drive

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Kaumātua, iwi and any Māori Medical Professionals. A view from the traditional Māori Medicine to understand all perspectives.

Stage 4 option A: Conceptual Models Individually:
https://www.figma.com/file/LF8Ka0qIc8UHrcRewnREaQ/HW-Oct-Pilot-Study-2021?node-id=0% 3A1

Stage 4 option B: Conceptual Model Collaborated

Stage 5 (Option A only): Feasible and Desirable Changes identified
The only thing is with the images, permission will need to be required. If not then alternatives will need to be found. Consent and collaboration with Kaumātua is also needed to ensure it is correct to ensure it is correct for their community.

Stage 6: Compare step 5 to step 2 does it suit?
A: Meets the requirements from step 2 to move onto step 7. Needs to be assessed by kaumātua

B: Yes information sharing and understanding is key, the prototype meets requirements from step 2.

Comments:
Not a difficult process, I did feel they needed clarity on scenarios and understand the point in each step of the process. As long as questions are free to be asked then it is fine. Main issues were words such as: whakawhanaungatanga and how to apply to software. Mentioned difficult to get across on a program.
Process was not done formally but merged and steps were extracted from information

given. Person 3: No issues, easy to follow

Scenario Link:
https://www.rnz.co.nz/news/te-manu-korihi/453573/social-media-used-to-reach-maori-in-vaccina tion-drive

Notes:

- Discuss Problem Unstructured – This will lead where the problem will be explained with the specification and current prototype to participants
- Problem Situation Expressed
- Root Definition of Relevant Systems
- Tamahau completes individually conceptual models
- Discussion continues where Tamahau proposes conceptual models to participants based on discussion and explains any confusing aspects, the team then discusses any necessary changes to improve the current model to be better suited for the problem situation expressed.
- Feasible and desirable changes identified - The team discusses any changes they feel are necessary and Tamahau fixes the prototype in the background (Figma) then displays changes to participants, this cycles until all parties are satisfied.
- Action to improve the problem situation - This stage will be the stage we will be unable to test in the scope of this study as there is no found method to develop this within the time limit allocated.

Scenario Link:
https://www.rnz.co.nz/news/te-manu-korihi/453573/social-media-used-to-reach-maori-in-vaccination-drive