Ka pūhia te puna o te kauae runga, kia pūheke ai ngā wai ki te kauae raro: Investigating the inclusion of Māori in Engineering

A Māori Engineers' Journey

A thesis

submitted in fulfilment

of the requirements for the degree

of

Masters of Engineering

at

The University of Waikato

by

TERESA ANGELINA POLI

(Ngāi Tūhoe)

THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

2024

Ariā | Abstract

This thesis explored views held by Māori and non-Māori regarding te ao Māori across the engineering system of education, academia, and industry, in understanding what challenges and experiences Māori engineers may face.

While there are incremental and progressive changes beginning to be seen in the engineering industry when working with iwi Māori, the history of engineering itself is intertwined with colonial contributions that have oppressed Māori. These historical influences continue to impact Māori today as they navigate educational pathways and enter the engineering profession. Colonisation, with its consequences such as stealing te reo, and various forms of cultural oppression, has led to Māori feeling disconnected from the engineering profession. It has also resulted in invisible cultural labour being placed on Māori, as we transition into a profession attempting to rectify the historic wrongs of the past. It was realised a gap existed in engineering education, failing to adequately equip graduates with the essential skills needed for success as engineers in Aotearoa. This gap was particularly evident in the cultural skills necessary for effective collaboration with clients, as well as for working harmoniously with Māori colleagues.

The research framework employed in this rangahau was He Waka Hourua, symbolising the journey towards a vision where Māori not only hold mana but also a sense of belonging in the field of engineering. This framework recognises the importance of both Māori and Pākehā voices, with a preference for Māori engineers taking a leading role in steering the direction towards the envisioned destination. The data collection process involved the use of surveys and whakawhiti kōrero methodologies, gathering both quantitative and qualitative information that played a crucial role in shaping the research findings.

Woven throughout this rangahau are the personal experiences shared by the author, and her journey as a wahine Māori engineer through the engineering system, anchored by her Māoritanga. Throughout, this rangahau analogies of waka are utilised as an acknowledgement of the great engineering feats developed by Māori, and paying homage to the idea that Māori have always been engineers, drawing from characteristics and traits passed down from atua and tīpuna

The author highlights the scarcity of literature dedicated to supporting the kaupapa of enhancing the mana of Māori in engineering. Rather than providing definitive answers to address the challenges that diminish Māori mana in engineering, this thesis serves as a foundational point, anchored at the wharf, for future rangatira to continue the voyage. Enhancing the mana of Māori in engineering presents an enduring wero, but there is optimism for the future of Māori in engineering, as we carve out institutionalism, we begin to make space on our waka.

Dedication

Ka pūhia te puna o te kauae runga, kia pūheke ai ngā wai ki te kauae raro

When the spring of our celestial knowledge swells, the waters flow to the earthy realm (Rio, 2024).

This whakatauākī was gifted and it embodies the āhua held within this thesis.

It encapsulates the connection we have with mātauranga Māori. Our knowledge has always been gifted to us by our tīpuna and atua. Our pūrakau speak to the different ways in which we received this information. When the spring of this realm rises, the knowledge overflows into the earthly realm and becomes part of our mātauranga. It acknowledges our actions and teachings of our celestial place, delving into the profound and ancestral origins of understanding as Māori, recognising that customs and knowledge are gifts from our tīpuna.

This saying encapsulates the distinctive nature of our offering as Māori engineers – our knowledge is a gift, setting us apart and presented upon us with purpose and intention. Our tīpuna carefully choosing the right time to share this knowledge with us. It serves as a reminder of our identity and the sacredness of our Māori heritage, emphasising that our roles as engineers are not only present but long lasting. As Māori engineers, we must actively encourage and support our whānau in the engineering profession. This support is crucial for us to continue to see ourselves represented in the industry and to wield our mātauranga with pride and care.

This thesis is dedicated to the rangatahi Māori, who shared their whakaaro for this kaupapa, I hope in sharing these stories, and reminding our people that we are engineers, it inspires change in engineering.

He Mihi | Acknowledgements

Ehara taku toa i te toa takitahi, engari he toa takitini

My success is not my own, but from many others.

This thesis is dedicated to all the Māori that are student engineers, engineering professionals and engineering academics who are striving to contribute to our whakapapa and represent our voice in spaces that are not always heard, seen, or represented. This is an acknowledgement of the path that has been forged by Māori engineers for us and is for future generations of Māori engineers, we hope that you will not be telling the same stories in 20 years' time.

Throughout my journey, I have had the privilege of connecting with inspiring Māori and Tangata Tiriti engineers and industry leaders. I express my gratitude to them for our kōrero. To all my mentors formal and informal throughout my journey, Amos Kamo and Theresa Rongard, your continuous support and encouragement to challenge the current practices of engineering, and without your guidance wouldn't make this Kaupapa what it is today.

I would like to thank my supervisors for their efforts in keeping me on track, and believing I could finish this thesis, even when there were times, I didn't think I could. Your expertise and guidance through my post graduate journey has truly helped shape this Kaupapa.

To my participants who identify as Māori engineers, I am profoundly thankful for the taonga you shared with me. As a teina in this space, I appreciate all that I have learned from you, and I hope that this has authentically represented your voice.

To my friend Marama Salsano, thank you for your kōrero, pep talks, challenging kōrero and motivation to continue in this. Thank you to all my friends at the gym who kept hounding me to get out of the gym and to do my masters, and those which filled me with caffeine for those late-night writing sessions.

I express my gratitude to all those who have played a role in shaping my cultural journey. I wouldn't be the engineer I am today, nor would I have the motivation to complete this thesis without your unwavering support and guidance. An acknowledgment goes to my Tūhoe tīpuna,

who fought for our reo, our tikanga, our culture, and the preservation of our identity. Without the strength and legacy of my tīpuna, I wouldn't have been able to take on this wero.

Lastly, I’d like to extend my mihi aroha to my whānau for your endless support and belief in me through what was a very long commitment of my research journey.

Contributing works

This thesis is supported by the following works which are published in international peer reviewed journals, and conference proceedings. The methodology and results of Chapter Four and Five have been formulated from [1], a peer-reviewed publication, was officially published, and was presented at the Australasian Association for Engineering Education Conference in Sydney, Australia. A proportion of Chapter One and Chapter 2 is supported by [2], a presentation shared with the engineering industry at the Future Forum: Next Gen Leadership conference.

[1] **Poli, T**., Lay, M., Owen, M., & Boston, M. (2022). Building the Cultural Capacity of Engineers in Aotearoa, New Zealand: A Students Perspective. *33rd Annual Conference of the Australaian Association for Engineering Education (AAEE 2022)*(33), 1-12. Retrieved from https://aaee.net.au/wp-content/uploads/2023/01/Building-the-Cultural-Capacity-of-Engineers-in-Aotearoa-New-Zealand-.pdf

[2] **Poli, T**. (2023, May 5). My 30 Hopes [Calling out 30 hopes for the engineering industry in supporting Māori, from the perspective of a Wahine Māori Engineer]. *Future Forum: Next Gen Leadership*. Ōtautahi, Christchurch, New Zealand.

Rārangi Ūpoko | Table of Contents

Tohutaka | Glossary

This glossary is based Te Aka Māori English, English-Māori Dictionary.

Āhua	*Expression or character*
Āhurutanga	*Comfort*
Aronga Takirua	*Double labour*
Atua	*Ancestor with continuing influence, god, demon, supernatural being, deity, ghost, object of superstitious regard, strange being - although often translated as 'god'*
Hanga Whare	*To make, build, fashion, create a house or building*
Hāpū	*Subtribe*
Hauora	*Health, be fit, well, healthy, vigorous, in good spirits.*
Hīkoi	*Step, march, hike, trek, tramp, trip, journey*
Hītori	*History*
Hourua	*Double canoe*
Kai	*To eat, consume, feed (oneself), partake, devour*
Kaiako	*Teacher, instructor.*
Kaipūkaha	*Engineer*
Kaitiaki	*Trustee, minder, guard, custodian, guardian, caregiver, keeper, steward.*
Kaitiakitanga,	*Guardianship, stewardship, trusteeship, trustee.*
Kākahu	*Clothing*
Kanohi ki te kanohi	*Face to face*
Karakia	*Prayer*
Karakia	*To recite ritual chants, say grace, pray, recite a prayer, chant.*
Kete	*Basket, kit.*
Kirikiriroa	*Hamilton a town in New Zealand*
Kohanga reo	*Māori language preschool.*
Kōrero	*Speech, discussion, talk*

Kotahitanga	*Unify*
Kupenga	*Fishing nets*
Kupu	*To speak, word, vocabulary*
Kura kaupapa	*Primary school operating under Māori custom and using Māori as the medium of instruction*
Mana	*Prestige, authority, control, power, influence, status, spiritual power, charisma – 'mana' is a supernatural force in a person, place or object.*
Mana Rangatira	*To be of high rank, become of high rank, ennobled, rich, well off, noble, esteemed, revered.*
Mana tangata	*Status*
Manaakitanga	*Hospitality, kindness, generosity, support - the process of showing respect, generosity and care for others.*
Māori	*Indigenous New Zealander, indigenous person of Aotearoa/New Zealand - a new use of the word resulting from pākehā contact in order to distinguish between people of Māori descent and the colonisers.*
Māoridom	*Is a world for Māori*
Māoritanga	*Being Māori, Māori culture, Māori practices and beliefs, Māoriness, Māori way of life.*
Mātauranga	*Knowledge, wisdom, understanding, skill, education, Traditional and contemporary Māori knowledge*
Maunga	*Mountain*
Mauri	*Life principle, life force, vital essence, special nature, a material symbol of a life principle, source of emotions the essential quality and vitality of a being or entity. also used for a physical object, individual, ecosystem or social group in which this essence is located.*

Mihi whakatau	*Speech of greeting, official welcome speech - speech acknowledging those present at a gathering.*
Ngahere	*Forest or bush*
Oriori	*Lullabies, song composed on the birth of a chiefly child about his/her ancestry and tribal history.*
Pā	*Fortified village, fort, stockade, screen, blockade, city (especially a fortified one).*
Papatūānuku	*Earth, earth mother and wife of Ranginui all living things originate from them.*
Pepeha	*Pepeha is a way of introducing yourself in Māori*
Pou	*Supporter, stalwart, mentor, symbol of support, metaphoric post - someone, a group, tribe, gathering or something that strongly supports a cause or is a territorial symbol.*
Pūrākau	*Myth, ancient legend, story*
Rangahau	*Research*
Rangahau	*To seek, search out, pursue, research, investigate*
Rangatira	*High ranking, chiefly, noble, esteemed, leader*
Ranginui	*Atua of the sky and husband of Papatūānuku, from which union originate all living things.*
Tāne	*Short for Tāne Mahuta, "god of the forest"*
Taniwha	*Water spirit, monster, dangerous water creature, powerful creature, chief, powerful leader, something or someone awesome - taniwha take many forms from logs to reptiles and whales and often live in lakes, rivers or the sea. they are often regarded as guardians by the people who live in their territory but may also have a malign influence on human beings.*
Taonga	*Property, goods, possession, effects, object, treasure, anything prized*
Taonga Tuku Iho	*Heirloom, something handed down, cultural property, heritage*

Tapu	*Be sacred, prohibited, restricted, set apart, forbidden, protected*
Tari	*Office*
Te Ao Mārama	*The world of light*
Te Ao Pākehā	*Non -Māori world view*
Te Kitea	*The glimmer of light*
Te Pō	*Darkness*
Te Reo Māori	*Māori language*
Tekau	*Ten, 10*
Tika	*To be correct, true, upright, right, just, fair, accurate, appropriate, lawful, proper, valid.*
Tīpuna	*Ancestors, grandparents, plural form of tipuna*
Tohu	*Instruct, advise, save the life of, spare, guide, direct, instruct, appoint, sign*
Tohunga	*To be expert, proficient, adept, killed person, chosen expert,*
Tohunga Hanga Whare	*Expert house builder*
Tohunga Tārai Waka	*Expert canoe builders*
Tohunga Whakairo	*Expert carver*
Tuakana	*Mentors, elder brothers (of a male), elder sisters (of a female)*
Tūhoetanga	*Being Tūhoe*
Tūmatauenga	*Atua of war and humans, also known as Tūkāriri and other names, he was one of the offspring of Ranginui and Papatūānuku who wanted to kill his parents for not letting the sunshine on their children.*
Tutū	*To be stirred up, churned up, insubordinate, mischievous, disrupt, to 'fiddle around with something,*
Uepoto	*A god from the Māori creation story, who through all the darkness saw a tiny speck of light that stimulated his curiosity and his search for other ways of existence*

Waahi Tapu	*Waahi tapu refers to land of special spiritual, cultural and historical significance to the tangata whenua (indigenous people) of Aotearoa*
Waiata	*Māori songs, song, chant, to sing*
Wairua	*Spirit, soul, spirit of a person which exists beyond death. it is the non-physical spirit, distinct from the body and the mauri.*
Wero	*Challenge*
Whai Ora	*In search of wellbeing*
Whakaakoako	*To teach, learn, practise, instructional, educational.*
Whakaaro	*To think, plan, consider, decide, thought, opinion, plan, understanding, idea, intention, gift, conscience.*
Whakairo	*To carve, ornament with a pattern, sculpt.*
Whakamā	*To be ashamed, shy, bashful, embarrassed.*
Whakapapa	*To recite in proper order (e.g. genealogies, legends, months), recite genealogies. or to place in layers, lay one upon another, stack flat.*
Whakawhanaungatanga	*Process of establishing relationships, relating well to others.*
Whanaunga	*Relative, relation, kin, blood relation*
Whānaungatanga	*Relationship, kinship, sense of family connection, a relationship through shared experiences and working together which provides people with a sense of belonging.*
Whare	*House*
Whāriki	*Woven mat*
Wheke	*Octopus, squid, a general term, particularly for octopuses.*
Whenua	*Country, land, nation, state, territory, domain, ground*

List of Figures

List of Tables

Chapter One: He Tīmatanga Kōrero | Introduction and Context

Māori are the indigenous peoples of Aotearoa, New Zealand. As Māori, "our deepest human sense of belonging is rooted in our connection to place" (Kelly & Nicholson, 2022). I live in a city three hours away from my tūrangawaewae, but as I sit in my wharenui, I admire the engineering skill my tīpuna held, appreciating the single beam that spans the length of the building, integrating the entire articulated timber frame. Acknowledging the foundations on which our wharenui rests upon, my ancestor, Tama ki Hikurangi, is embodied in our wharenui, making it not merely a building, whare or house, but something far greater. His legacy and leadership is held alive through his embodiment in our wharenui, representing what it means to be Ngāti Haka. Māori words often have several meanings, where 'waha', the entrance of a wharenui, is both 'mouth' and 'entrance' (Treadwell, 2016), personifying what would be typically an object in te ao Pākehā. The wharenui enables our people to trace our whakapapa back to the origins of our world, Te Ao Mārama (Treadwell, Cosmology and structure: The "Tāhuhu" in the 19th Century whare Māori, 2017). For Māori, the building of the wharenui is understood to represent the creation story, the floor representing Ranginui separated by a ridge pole acting as Tāne as he separates his parents, suspending Papatūānuku as the roof. It is the walls and roof of the whare which depict the reconstruction of the world, both cosmologically and structurally (Treadwell, 2016). My wharenui invokes strong feelings of connection, safety, mental clarity and wairua. The engineering processes and design are seen through Māori history as my tīpuna crafted these structures without calculators, computers, and software. I believe my tīpuna were engineers of their own kind.

In the past I have reflected on how colonial actions have influenced Māori in engineering. Being Māori and an engineer, I often get asked "Why are there no Māori in engineering?" or "How can we help Māori choose engineering?" This is asked by well-meaning non-Māori engineers. I remember going through my Bachelor of Engineering and often thought there were not many Māori. While working in the industry, I saw even less of us. As Māori in Engineering, we only represent a small proportion of the industry, which is not representative of the total population of Māori in New Zealand. This is a shame, as Māori have a strong cultural connection to the land,

and the role of an engineer provides an opportunity to have leadership positions and make decisions on how we use and build on the land. Being an engineer also provides us with the opportunity of higher earning capacity. As Māori, we have so much to offer the engineering industry, yet we are not the ones making decisions.

I have always felt the desire to be a kaitiaki (guardian), to protect our whenua (territory or land) as well as our people and felt that engineering provided us with that opportunity to ensure we are providing the social infrastructure for our people to get to health care, access to jobs and education. However, I feel I would not be a good kaitiaki for our people, to encourage them into our industry until our industry is ready for our people, that is our people feel protected and safe, physically, mentally, and spiritually in the engineering industry.

Researcher Positionality

In the book, Decolonizing Methodologies, Smith discusses outlining a researcher's positionality of the research being an essential component in indigenous research, where theory, action and reflection are connected. This reduces the need to try to guess the identity and intentions of the researcher (Smith, 1999). The positionality of a researcher includes concerns of the attributes of Māori researchers, gender, age, whakapapa, knowledge of tikanga, the degree of involvement in Māori communities, tribal differences, and collaborations with other Māori and/or Pākehā. For many, just being Māori is not enough. (Bishop, 2010; Bishop & Glynn, 1992; Durie, 1998; Irwin, 1994; Pihama et al., 2002; Smith, 2003; Smith, 2013; Walker, 1996). As Māori are the indigenous peoples of Aotearoa, New Zealand, we identify ourselves as tribal peoples by sharing our whakatauki (proverbs), providing our specific connections to the land and through that our whakapapa (Rameka, 2016).

Ko Wai?: From What Waters Do I Descend?

“Ko wai koe?” is the fundamental Māori question of “who are you?”, questioning where do you descend from, what mountain, land and river but more literally translating as “Who are your waters?” (Doyle, 2023). In te ao Māori whakapapa tells us that we are water; we comprise of the waters that flowed from Ranginui and Papatūānuku, our primal parents. It is customary for us to share who we are, by acknowledging the lands and waters, the geographical identity markers

that are linked to water in which our ancestors came from, in the form of pepeha (Doyle, 2023). Nō reira, ko wai au? So, then, who am I?

Ko Maungapōhatu te maunga

Ko Waikaremoana te moana

Ko Mātaatua te waka

Ko Tūhoe te iwi

Ko Hikurangi te maunga

Ko Rangitāiki te awa

Ko Ngāti Haka te iwi

Ko Waiohau te marae

Ko Atarau rāua ko Hare tōku tīpuna

Ko Teresa Angelina Poli tōku īngoa

Tēnā koutou tēnā koutou tēnā koutou katoa.

Maungapōhatu is my mountain,

Waikaremoana is my ocean,

Mātaatua is my canoe,

Tūhoe are my people,

Hikurangi is my mountain,

Rangitāiki is my river,

Ngāti Haka are my people,

Waiohau is my home,

Atarau and Hare are my familial ties,

Teresa Angelina Poli is my name.

On my father's side, my whakapapa is Māori and Italian, while on my mother's side my whakapapa is mostly English, Irish, and French. My European ancestors travelled, they settled, they traded, they innovated, and they developed. "I am made up of all of my ancestors, and all of the lands they came from" (Doyle, 2023). Perhaps it is ironic that my ancestors are both the colonised and the colonisers. I am the product of colonisation. I exist both as Māori and Pākehā, walking and navigating in te ao Māori and te ao Pākehā simultaneously. Nō Māori ahau. Nō Pākehā ahau.

My whakapapa in engineering

My childhood was spent 226 km away from my marae, in Kirikiriroa (Hamilton, New Zealand). During my childhood, I dedicated numerous hours in primary school to writing letters to parliament and the editor of the local newspaper. These letters addressed issues that deeply concerned me, such as climate change and child poverty. From a young age I felt the pull to act as a kaitiaki for our whenua and our people. When I was 15 years of age, my family moved to Australia. I was physically distanced from my iwi, living as an urban Māori in Australia. It was not until I returned back to Aotearoa to commence my engineering studies, where I sought to discover more of my cultural identity, however I always held whakapapa Māori, and āhua Māori, whakaaro Māori.

In this rangahau (research), I want to highlight my personal cultural journey in reconnecting to Ngai Tūhoe. My cultural identity is an integral part of my narrative in the engineering industry. As my cultural journey properly commenced in my final year of my engineering undergraduate qualification. I had a special interest in how engineering impacts our Māori communities and understanding the interface between Māori and engineering. I had selected an honours research project 'Pathway to my tīpuna – Building culturally inclusive and sustainable roads'. This project not only highlighted some of my own experiences as a Māori in engineering, but also provided insights of how my whānau interacted with engineers and the engineering practice. This

particular research project prompted reconnection to Tūhoe, and furthered my understanding of my Māoritanga, and Tūhoetanga.

Through my experiential journey of delving deeper into my whakapapa, I have engaged in dialogue with literature concerning the histories of engineering and education systems, interactions with Pākehā engineers, and involvement with rangatahi Māori. This positions me as a researcher firmly rooted in my whakapapa and, consequently, in Kaupapa Māori, which will be further explored in subsequent chapters. The significance of whakapapa is later emphasized as crucial for cultivating whanaungatanga in research contexts. Also noteworthy is my position as a wahine Māori Environmental Engineer, offering a unique perspective on the topic of engineering.

It is through my own experiences of being Māori in the engineering profession that I have come to the realisation, engineering requires further alignment with te ao Māori for the engineering education, the engineering industry to be better reflective of modern-day Aotearoa, New Zealand, to permit inclusion and representation of Māori in the engineering profession.

My hopes for the future of engineering

I had written a list of 'hopes' for the engineering industry based off my experiences (Poli, 2023), inspired by Tara McAllister's articles, 50 Reasons Why There Are No Māori in your Science Department (McAllister T. , 2022). In sharing these, it serves as my personal vision of what the future of engineering could look like. It also shapes my thinking of the current interface between Māori and engineering.

1. **Instructions to include pepeha become irrelevant because its automatic and we do it anyway.**

   Today you have heard a lot of speakers including myself share their pepeha and use te reo in this kōrero. We were asked to share our pepeha as our introductions to our presentations. It is our opportunity to share connections and where we are from in this world. I hope to see the day when beginning a presentation or kōrero with a mihimihi or a pepeha, and using te reo Māori is so ingrained in our spaces that it comes naturally for engineering graduates and indeed engineers.

2. **Māori engineering scholarships are redundant because we have representation in these spaces.**

When I was at university, I received comments from peers such as "you only got that scholarship because you're brown". The use of these scholarships are not intended to disadvantage pakeha or non-Māori students but to encourage and increase the number of Māori students who are typically underrepresented in our profession and in our universities. Māori make up a small percentage of engineers in the industry. I hope to see the day where our engineering work force is full of Māori engineers.

3. **We would have Māori engineering academics.**

It was not until my starting my masters, did we have a Māori lecturer and academic. Māori make up approximately 5% of the total academic workforce. Māori make up between 2 and 3% of the total number of professors/ deans in academia. Studies have found that Māori university student experiences and success are positively influenced by being taught or supervised by Māori staff and through the integration of mātauranga Māori and te reo Māori within the curriculum. Increasing the number of Māori obtaining engineering qualifications is important given the private benefits (e.g., income, employment) and social benefits for graduates' whānau and communities that can come from having a university education. I hope to see the day when there is a strong number of Māori academics in engineering to support the next generation of engineers.

4. **No need to advocate for te ao Māori and mātauranga Māori in education as it would be common practice.**

Imagine if the gradates we had coming into industry had understanding and advocated for co-design in projects. That when our engineers came through industry their knowledge grew. A reason why I am so passionate and why I am completing my master's thesis on this is because when I did my undergraduate degree, we had one lecture on iwi engagement over four years of studying. I was so disappointed and confused that we had to wait until fourth year to have this lecture. Whereas when I look around in industry, there has been huge progress in te ao Māori in projects and understand that it once was

not like this. I hope to see the day where te ao Māori and mātauranga Māori is fully integrated into a project and never seen as an afterthought.

5. Māori no longer are seen as a 'tick box'.

Too often we as Māori are the token Māori, Its exhausting:

Always being looked at for karakia;

Always being asked to share your pepeha during Māori language week;

And when you are only just reconnecting, I felt hurt, embarrassment and whakamā when I was only just learning bits of my whanau history;

Always having to be asked for CV's to be added to a project because of my whakapapa;

We always need more diversity on an application;

Always being expected to understand what Mana whenua want;

And, always being asked to bring your cultural knowledge to work.

I hope to see the day where in the engineering industry we have knowledge and feel comfortable in speaking te reo – and karakia. And for Māori to feel comfortable in our spaces.

6. The emotional and intellectual labour held by Māori did not exist.

The heaviness that you carry, always driving for change. During my master's I had been engaging with students regarding their experience after delivering lectures on te ao Māori and engineering, and feedback that I had received was:

"An engineering degree is of science, not politics".

"*Legislation surrounding the treaty of Waitangi had changed to include the Moriori of which were in New Zealand before the Māori. History is written by the Victors".*

These comments were blatantly racist and demoralising. Moriori leader Maui Solomon and many other writers debunk this myth that Māori colonised Moriori, and it fed into

the narrative of if Māori can do it Moriori, then the British can do it to Māori. When I first read those comments, I was in shock that there are still engineers coming into our industry with these preconceived ideas. I hope to see a day where myself and the many other Māori currently holding space in engineering for our mātauranga is a role that is no longer needed.

7. **Māori are recognised as engineers, in our past, our present and our future.**

We are engineers – we have a long history of engineering practices we built waka, marae, pa and used our mātauranga to inform us.

8. **Our histories are taught and widely understood, without acknowledging our past, nothing can change.**

I hope to see the day that our history is acknowledged and known by all who are standing on our whenua.

9. **There is understanding of Māori relations with our whenua, land.**

In te ao Māori, we have relations with human and non-humans, where land is considered our whanaunga. It's in our whakatau "Ko au te whenua, te whenua ko au, Ko au te awa, te awa ko au". There is no hierarchy between us and the land, the land is not something in which we can own. This is seen in Te Urewera and Wanganui River where personhood has been associated with these. I hope to see the day our interconnectedness between ourselves, and our land are considered in engineering disciplines and projects.

10. **Our reo is understood and used**.

The basis of te ao Māori and mātauranga is on the reo, where our language has double meanings, whenua meaning placenta and land, or hapu meaning to be pregnant and subtribe.

11. **To have our reo pronounced correctly.**

To not be asked if someone pronounced something correctly, or when naming a project not considering how it is going to be butchered in pronunciation, that thought not even cross our minds when choosing a name.

12. To have Māori in leadership roles.

I want to see people that look like me in leadership so I can see there is space, and pathways available for me to get there. I hope to see the day our people have the opportunity to influence and make decisions that are going to affect us and our tamariki.

13. There are established Tuakana-Teina programmes.

When seeking a mentor in the engineering space I had to ask for a wahine Māori, although I was matched with a pakeha male. I hope to see the day where I can be an engineering mentor for rangatahi.

14. Matariki is understood and celebrated.

15. We are not just employed for the cultural design for industry projects.

We are realised for our capability and technical skills too.

16. There is stronger collaboration and partnership.

To see stronger collaboration between engineering professionals and Māori communities. I hope to see the day in engineering projects that Māori communities and impacts on mana whenua are not just an afterthought.

17. Project incorporate te ao Māori and mātauranga

Our project are designed in alignment with te ao Māori principles. When I worked as a site engineer, we were working on a project to extend a side of a road, and there was a lot of harakeke flax there, I had asked management how it was going to be removed or if there were cultural practices in the way its removed, if it could go to the community or schools to be used. I was told to dig it up with the excavator and put it in the skip. That broke my heart. I hope to see the day where cultural practices are considered in the way we build.

18. **Whenua and te taiao are cared for, there are sustainable and environmentally friendly practices at the heart of projects**.

Taking into account the interconnection between our people, land and culture. For our industry to prioritise sustainability, environmental protection, and long-term wellbeing of our communities.

19. **For engineering projects to contribute to economics and social development of our communities.**

For projects to create employment opportunities, support in addressing social inequities and enhance wellbeing of Māori. In our role as engineers, it is not just about thinking about how things work and how they are designed but considering the impacts and the legacy left from a project. I hope to see the day were our people have jobs created for us and fair reliable pay for us as a result from our projects.

20. **Our culture is not made fun of.**

Engineering has a level of racism which has existed for years, events like when Auckland university engineering students would perform mock haka annually as a part of their pranks – healing is still going on I hope to never see a day where an event like this takes place again.

21. **We are not there to help projects superficially.**

“To gain access to Māori communities and knowledge when your intentions are ambiguous. Have you heard of the Tohunga Suppression Act (1907)? Do you know whose stolen land you are standing on? Have you read Decolonising methodologies?” (McAllister T. , 2022).

22. **Marginalisation is non-existent.**

We are not burdened and marginalised due to balancing of our traditional beliefs and the institutionalism of engineering.

23. **We work in an environment where we are respected.**

We deserve to not carry the colonial burden of being the first and the only Māori in a space that was never designed for us. I hope to see the day where my grandchildren will not be the only Māori in their team or organisation.

24. To see Māori retained in our workforce.

Ensuring our peoples wairua and hauora are protected.

25. There are stronger support networks for us as there will be an abundance of us.

26. To see more Māori in the engineering industry.

There have been so many times I have been told "*wow, you're going to be snapped up so quickly, I have only met two wahine Māori engineers*" this should not be a shock and something that is praised. Māori make up 1% of charted engineers.

27. Engineering is a space for whānau.

The profession respects whānua concepts; you can be an engineer and an active member of your marae.

28. The stereotypes surrounding engineering are removed.

It is understanding that every journey into engineering can look different, we are not bound by our high school grades or qualification type.

29. That young Māori believe they can be engineers.

30. That Māori can have a louder voice in engineering.

It is my dream, that these hopes can be achieved in my lifetime, although understanding there have been many generations and incidences which have impacted on the engineering space, to allow for the space to not being set up for Māori. I believe the content which we are delivering to our engineering students will assist in rebuilding the partnership, and breaking down some of the institutional barriers which prevent the industry being inclusive for Māori and to work with Māori.

Purpose of the Kaupapa

Engineering consists of mathematical and scientific problem-solving skills and design to provide creative solutions for industrial and societal problems. Engineering has been described as "engineers … apply science and mathematics … to build products to meet the needs of mankind" (Engineers, 2006) or "engineers create products and processes … to enhance … our everyday lives" (Martin & Schinzinger, 2005). Although more often than not, the engineering profession tends to draw in particular types of people whose personalities exhibit organisation and methodical traits (Alperin, 2023), these people often focus on the 'things' in engineering rather than the bigger picture such as the impacts on communities. Although these personality traits aren't representative of all engineers, the profession has historically been dominated by Pākehā men, that legacy remains (Walker S. , 2015). Engineering needs to consider a pipeline of talent coming through the system. There is a high demand for engineers in the workforce to meet the growing needs of the changing economy, there is a current skills shortage of engineers, diversity may be the key to locking this (Wilkinson & Cameron, 2022).

Engineering places Pākehā knowledge at the forefront, until it requires 'cultural perspectives' or 'cultural support'. There is increasing demand for te ao Māori capability in Aotearoa across a range of industry sectors, including engineering. While, Engineering New Zealand realises the growth of the Māori economy and population, they focus their effort on advertising engineering to attract rangatahi Māori to the profession (Engineering New Zealand - Te Ao Rangahau, 2021). This rangahau gathered insights from non-Māori and Māori, in various stages of their engineering journey, while, ensuring the experiences of Māori in their journey through engineering and their engagement with the institutionalism forming education, academia and industry is at the forefront of the reader's mind.

Engineering New Zealand now rebranded to Te Ao Rangahau note "Employers need to look at how they attract candidates with te ao Māori capability", so perhaps engineering education, academia and industry need to reflect the skills and requirements needed for modern day Aotearoa (Engineering New Zealand - Te Ao Rangahau, 2021). Engineering New Zealand are on a journey to embrace te ao Māori, both within their organisation and throughout the wider

engineering profession (Engineeirng New Zealand - Te Ao Rangahau, 2022). With the addition of the Government's aim for "Māori to be successful" in STEM (Science, Technology, Engineering, and Mathematics), and in particular in engineering, to encourage Māori to choose to participate in the engineering field; for the industry to draw upon Māori knowledge; and build partnerships with iwi, hapū, and marae, some investigation of what is happening for Māori and indigenous engineers within the system of engineering is needed (Ministry of Business, innovation and Employment, 2007).

Māori are under-represented in the engineering profession, they are often 'lumped' with Pasifika, where combined they account for approximately 2% of the industry (DiversityWorks, 2021; Engineering New Zealand – Te Ao Rangahau, 2023) and make up approximately 1% of chartered professional engineers (Engineering New Zealand, 2019). The journey to engineering requires a qualification and a specified engineering discipline. The number of Māori enrolled in engineering from certificates to doctoral degrees in 2022 was approximately 9.5% of all students enrolled in engineering and related technology degrees in New Zealand (Figure New Zealand, 2022). In universities, 15% of academic staff across all qualifications identified as Māori in the same year (Ministry of Education, 2022). Acknowledging Māori engineering professors are likely extremely underrepresented. The journey through the engineering system can be lonely and isolating when the proportion of Māori in the engineering system is not reflective of the general population of Māori. In 2022, 17.4% of the national population identified their selves as Māori (Statistics New Zealand, 2022) and in the next 20 years the Māori population is expected to increase to 33% of the total national population by 2043 (Statistics New Zealand, 2022). This is particularly important because Māori have expectations placed on them to serve a series of unresolved and often competing demands between their cultural knowledge and their technical knowledge (Jenkins & Pihama, 2001; Mercier, Asmar, & Page, 2011; Nikora, 2021).

These matters have emerged from recent work in similar fields of science, architecture, and Māori academia, in addition to my own experience through the engineering system. Māori experience a form of unique challenges which differ from Pākehā and Tauiwi engineers.

If Māori are desired in the engineering industry, and the future holds high population growth of Māori, they then could provide value in filling skills and labour shortages in engineering. Therefore a better understanding is needed to determine the methods of building mana of Māori in engineering. In addition, support for non-Māori to understand their role in mana enhancement for Māori in engineering.

This rangahau aims to shed light on these small communities of Māori students and professionals through their everyday studies and working lives within the wider engineering community. This study also explored the appetite of te ao Māori education to support the development of space where Māori can feel like they belong in engineering as a whole. Many of our Māori participants shared that they frequently carried the heaviness of emotional labour that comes with being 'the only Māori in the room', often inflicted by other engineers. This has led to the role of an engineer who identifies as Māori holding more responsibilities than other engineers, to provide cultural understanding. This study looks directly at the institutionalism which oppresses Māori in engineering.

While the focus of this thesis is on Māori in engineering and enhancing their mana within the profession, it is understood that engineering is a profession in which many indigenous people are not well represented. I hope this thesis can provide insights which could be transferable or exchangeable for other indigenous and first nation peoples tikanga and world view. This thesis does not speak on behalf of all Māori, rather it is an opportunity for the author to share her whakaaro and journey, while outlining similarities in experiences shared between participants and the author.

Chapter breakdown

This rangahau thesis cannot provide all answers and solutions, if any, for engineering in Aotearoa. I acknowledge that there is plenty of work to be done to support Māori engineers on their journey, and in understanding this, it may take generations. This postgraduate and academic journey has been a difficult rangahau to navigate with very little information in the engineering space. I hope this provides an opening for future Māori engineers to continue my mahi. This thesis consists of the following chapters:

Chapter Two: **Māori were and still are engineers.**

This chapter speaks to the concept that as Māori we were always engineers, through sharing our pūrākau, our inventions, and the roles we hold and have held in our societies. To support in decolonising and redefining engineering to be reflective of te ao Māori.

Chapter Three: **Why isn't my Engineer Māori** – **Literature Review**

This chapter sets the scene describing the journey an individual must embark on to become and engineering, and why Māori aren't in engineering, by outlining historic activities. It also provides insights of initiatives and Māori Rangatira that have contributed to the inclusion of our people in engineering.

Chapter Four: **Research Framework**

This chapter outlines the Research framework – He Waka Hourua utilised in collecting quantitative and qualitative results from the methodologies of Surveys and whakawhiti kōrero. The approach harnessed both Māori and Pākēha voices.

Chapter Five: **Chartering the moana** – **Results.**

This chapter highlights key findings from the Surveys and whakawhiti kōrero, which inform the discussion.

Chapter Six: **The Voyage of Engineering** – **Discussion**

This chapter expands of findings in chapter five, in three particular areas, speaking te reo Māori in the engineering workplace, creating safe spaces for Māori and the invisible cultural labour held by Māori engineers. This chapter also addresses limitations in the study.

Chapter Seven: **He kupu taurangi**

This chapter is a personal koha to future Māori Engineering Rangatira, in the form of a letter, where I share my experience and advice in undertaking this Kaupapa.

Chapter Eight: **Kōrero Whakapi – Conclusion**

This chapter summarises the thesis.

Chapter Two: Māori were and still are engineers

We understand that in the future of Aotearoa the Māori population is going to increase to 33% of the total population, therefore Māori are a potential option to support in addressing skills shortages in engineering. However, in understanding how to support Māori in the engineering system, we must understand what the te ao Māori perspective of engineering could be, as we understand the current system privileges Pākehā knowledge. I also mentioned in my introduction, I consider my tīpuna were engineers. This chapter will explore the concept recognising Māori were engineers and still are engineers, through pūrākau, Māori engineering design practices, and characteristics held in Māori societies. This chapter depicts the narrative of our first Māori engineers.

Engineers long before anything; our pūrākau tells us that

“He pūrākau, is passed down from the lips of our tīpuna to the ears of our mokopuna” (Doyle, 2023). Pūrākau or Māori creation legends, are most commonly used to refer to Māori ‘myths and legends’, transmitting ideas and share meaning, as a part of mātauranga Māori. Pūrākau should not be referred to as a fiction of the past, rather it should be used to acknowledge Māori narratives containing thoughts, epistemological constructs, cultural codes, and worldviews that are fundamental to our identity as Māori (Lee J. , 2009). Pūrākau and whakapapa are entwined, pūrākau has once been used as a tool to speak to whakapapa, although it is also whakapapa referring to genealogy and translating into the process of layering ideas (Ngata, 2011). Everything has a whakapapa, there is a genealogy for every word, thought, object, place and person (Roberts, 2015), and is known as the “skeletal structure of Māori knowledge” (Keenan, 2000). Whakapapa is fundamental to Māori identity (O'Regan, 1987), situating a thing in a particular place, in a specific time (Mahuika N. , 2019). The ancient history, whakapapa is told and shared in a variety of ways. And so, this story will be shared once again.

The story began before time and place, when everything was potential. All things were in total darkness, Te Pō, while in the constant state of pure black and nothingness, our primal parents, Ranginui and Papatūanuku laid in a tight embrace of love, holding their celestial offspring, Ngā Atua tightly between them for eternity (Doyle, 2023). One of their sons, Uepoto, was accidently

washed to the extremity of his mother through her urine There he saw a glimmer of light called te kitea (Phillips, Jackson, & Hakopa, 2016). Uepoto returned to his brothers and told them what he saw, and so the brothers began discussions to separate their parents. Tūmatauenga, the fiercest of the children, suggested the drastic measure of ending the lives of their parents (Grey, 1956). Tāne suggested to push them apart; "one would be beneath them as a parent and the other above them as a stranger" (Reilly, 2004). Tāne successfully pushed Ranginui and Papatūanuku apart, bringing into existence Te Ao Mārama, and releasing the atua, causing the emergence of the world of light and day (Grey, 1956; Reilly, 2004; Phillips, Jackson, & Hakopa, 2016.)

This narrative depicts Māori atua, the children of Ranginui and Papatūanuku as problem solvers, who iteratively designed solutions to separate their parents, showing characteristics and traits similar to those of engineers. The children did not stop at one attempt, but a variety of solutions were applied to their problem. Tāne pushed Ranginui and Papatūanuku using a fundamental concept of physics, newtons first law. Newtons first law states "that every object will remain at rest or in uniform motion in a straight line unless compelled to change its state by the action of an external force" (Newton, 1999). Tāne acted as the external force to bring change in the state of Ranginui and Papatūanuku, altering their direction of motion, introducing light. This pūrākau shares the Māori creation story, the beginning of everything from nothingness, while shedding light on engineering principles and ideas which existed well before this world, suggesting Ngā Atua shared similar characteristics and traits to engineers. Whakapapa provides the "genealogical descent of all living things from the gods to the present time" (Barlow, Tikanga Whakaaro: Key Concepts in Māori Culture, 1991). As Māori, we use whakapapa as a way of ordering, thinking, storing, debating, and acquiring new knowledge which links the past, present and future (Rameka, Whakapapa: Culturally valid assessment in early childhood, 2012). Whakapapa examines the origin of all things and their connectedness across time and space (Phillips, Jackson, & Hakopa, 2016). All aspects within te ao Māori are viewed as having spiritual origins and direct links to the gods (Berryman, 2008). At the moment of conception, the physical and spiritual potentials of a person unite, forming a distinct entity imbued with spiritual qualities (Rameka, 2015). The child inherits essential spiritual traits from their ancestors, including atua,

contributing to their overall well-being in spiritual, psychological, and social aspects. These traits encompass, among others, concepts such as tapu, mana, mauri, and wairua, influencing a person's attributes, traits, and perception of the world (Mead, Tikanga Māori: Living by Māori Values, 2003). As Māori we trace our genealogy or whakapapa back to our atua, Tāne, to the world of the gods and to the creation of the universe (Barlow, Tikanga Whakaaro: Key Concepts in Māori Culture, 1991). And inherently those engineering characteristics Tāne possessed are passed from atua to us Māori. Thus, through whakapapa, Māori could be considered the first engineers which existed in Aotearoa.

Through pūrākau, the narrative of Māori as engineers was shared orally, acknowledging engineering and innovative thinking is deeply entrenched in our Māori culture. Although Tāne exhibited engineering traits, there are many other stories similar to his, which highlight our atua as engineers, like the story of Tūmatauenga. Tūmatauenga constructed snares and spears to trap and kill the children of Tāne, then continued to build canoes and nets to catch the children of Tangaroa (Keegan & Sciascia, 2018). Another engineering story is Kupe and his innovation. Kupe used kelp to make containers for food storage and used pounamu making tools in his travels, as depicted in the legend of the great battle between Kupe, his warriors, and the giant wheke (octopus) (Ministry of Eductaion, 2023). In the legend of Rata, he fashioned a canoe from a trunk of a tree to sail across the sea (Ngāi Tūhoe, 2023).

Perhaps one of the most commonly known engineers, Māui, who was an innovator, used his grandmother's jawbone to construct a weapon and a fishhook. Māui's stories also speak of his inventions involving the weaving of the strongest ropes which he used to capture the sun and fish up the North Island of Aotearoa (Keegan & Sciacia, 2018; Ministry of Education, 2023).

Pūrākau forms part of mātauranga Māori, which is a body of knowledge that seeks to explore phenomena by drawing on concepts handed from one generation of Māori to another. (Kaumoana, 2021). Accordingly, mātauranga Māori has no beginning and is without end. It is constantly being enhanced and refined. Each Māori makes their own contributions to mātauranga Māori. The theory, or collection of theories, with associated values and practices, has accumulated mai i te ao Māori / from Māori beginnings and will continue to accumulate,

providing the whakapapa of mātauranga Māori is unbroken (Kaumoana, 2021). This definition of mātauranga Māori conveys that Māori knowledge is an iterative and evolving process, having similar features to an engineering design process, with constraints defined by tikanga (Asunda & Hill, 2007). While it must be acknowledged mātauranga Māori is much more complex than solely comparing it to an engineering design process, the knowledge base does provide kete or pockets of engineering aspects which have contributed to the narrative of Māori as engineers.

Māori have a long history, yet it goes mostly unrecognised, of being innovative and adaptive of new technologies and problem solving (Keegan & Sciascia, 2018). As Māori, our tīpuna have a long and successful history of navigation through oceans, and bush, which supported the rationale behind the development of my research framework (Kaumoana, 2021), in addition to supporting the theory Māori were and still are engineers. Māori knowledge is built upon tikanga which is deeply embedded into mātauranga Māori. Winata's definition of mātauranga shares insights of Māori navigation and extends to our tīpuna's engineering knowledge (Mead, 2013). The origins of tikanga and mātauranga is handed down from Atua in the spiritual realms to tīpuna to the present (Mead, 2003). The values Māori hold, are linked to their normal behaviour, underpinned by Atua (Gallagher, 2016).

Māori engineering design practices

Māori rely on engineering and technology advances that underpin our governing structures. Mana Rangatira held the responsibility of protecting and sustaining the iwi. This section explores the engineering practices and technology developed and utilised by Māori which have been developed from the application of Māori engineering knowledge (Keegan & Sciascia, 2018).

Māori developed and made use of engineering principles that extended further than European technology. An example of Māori engineering practices is the waka. The waka has three key engineering design features, the hull, the sails, the hoe/ paddle.

To solve the problem of building a waka which moved quickly, Māori designed the hull intentionally to not be levelled smoothly but "the toki umarua (double-shouldered adze) was

especially made to parengarungaru (make small wave like patterns on the hull on the exterior of the canoe) - kei piri te wai kite waka (to prevent the water from clinging to the canoe, and so impeding its progress)". This produced rotating eddies reducing drag on the hull leading to a faster moving waka. In engineering today, this principle is also exhibited in golf ball dimples, where the surface of the ball also creates small eddies when the golf ball travels in the air, allowing for the ball to travel further and reduces drag (Keegan & Sciascia, 2018)..

Other features of engineering in the waka, are the design of the sails used on waka. The sails were a triangular shape, referred to as a lateen sail, which had many more advantages such as the ability to be effective in light winds, creating less drag in comparison to a square shaped sail used by European sailors (Keegan & Sciascia, 2018).

Another waka design feature which exhibited engineering practices is the hoe (paddle) of the waka. The hoe represents that Māori understood a level of physics. The hoe was a length of 1.5 metres, increasing its flexibility and allowed for energy to be stored at the beginning of a stroke, releasing kinetic energy as the handle is straightened. The blade was a V shape creating two counter-rotating vortices over the convex upper surface, allowing for extra thrust when the hoe is in the water. The use of a 5-degree angle of the blade permits a greater stroke length over a longer time duration, when force is applied (Keegan & Sciascia, 2018).

Māori applied many engineering design principles in their practices, besides their waka. Other concepts including solar heating and cooling, ventilation, insulation, hygiene, and water proofing in their architecture (Keegan & Sciascia, 2018).

Engineering practices were used in defence to protect people and land assets, and over 7000 pā were constructed. The advantage of building strong pā enabled Mana Rangatira to support their people (Cooke, 2014).

Māori used other mechanical concepts such as the development of levers, wedges, and inclined planes in construction, while in tool and weapon development, they utilised heat-tempering processes (Keegan & Sciascia, 2018) to change the mechanical properties of the materials.

Māori practiced engineering through hunting and gathering food storage methods, through the construction of fish traps, seine nets, roofed storage pits and above-ground pātaka, larders (Cooke, 2014).

Māori engineering practices are not only translated in the form of mechanical and civil engineering, but also exists in software engineering. This is observed in weaving of harakeke. There are two weaving patterns takitahi and whakatutu, that can be described as binary arrays (Figure 1 and 2) (Mckendry, 2020; Mere Te Kanawa, Robertson & Engels-Schwarzpaul, 2009).

Takitahi	*Whakatutu*
General: 1 0 1 0 1 0 … 0 1 0 1 0 1 … repeat	General: 1 0 0 1 1 0 0 1 … 0 0 1 1 0 0 1 1 … 0 1 1 0 0 1 1 0 1 1 0 0 1 1 0 0 … repeat
Test strip: 1 0 1 0 1 0 1 0 1 0 repeat	Test strip: 1 0 0 1 1 0 0 1 1 0 0 1 1 0 0 1 1 0 0 1 repeat

Figure 1 Takitahi and Whakatutu weaves described using binary array.

Figure 2 Takitahi and Whakatutu weaves.

By observing weaving as a mathematical expression, we can acknowledge Māori had design processes and patterns which enabled them to repeat a design process. Weaving was used to

construct a wide range of tools for everyday use, which required a certain level of structural integrity. Some of the tools constructed include kupenga, kete, whāriki, kākahu and cordage for building and waka lashings (Mckendry, 2020). Mathematical patterns in Māori weaving are similar to how industrial weaving patterns are used for modern day composites (Philps, 2022).

There are many features of everyday Māori life in which are engineering practices, or incorporate engineering principles, and while these practices have been handed down from generation to generation, these features are clear examples of te ao Māori in engineering. While there are many engineering designs which Māori have developed, they would not necessarily be considered as engineering in te ao Māori. The majority of the examples of Māori engineering listed before are examples which would be considered toi Māori in te ao Māori. In te ao Pākehā, they would be considered Māori art. Toi has been defined as knowledge, skill, excellence, source, origin or mastery, and is a vehicle of expression employed by Māori (Aperahama, 2018). Toi is the concept of ideas brought into the physical realm by Māori (Wilson J. K., 2017). The forms of toi which were outlined as examples of Māori engineering would include whakairo (carving), and raranga (weaving). Whakairo are created by tohunga whakairo (master carvers), can be developed from a multitude of materials and used to make waka and weapons. Raranga are used in baskets, mats and ropes (Christchurch City Council Libraries, 2023). However, considering all the inventions that were described before as engineering, there appears some overlap between te ao Māori and engineering. Further work is required to understand the interface between the two worlds and redefine what we consider engineering in te ao Māori, perhaps this will also support in understanding our people in the engineering system.

Engineering characteristics in our societies

It is evident Māori possessed engineering skills based on their scientific practices, from their needs at the time and leveraging their problem-solving skills for solutions (Keegan & Sciascia, 2018). Not only did Māori have the capability and skills required to be an engineer, but there were also roles within Māori society which could be considered an engineer, the role of tohunga, the tribal expert. Whakapapa and knowledge of mātauranga Māori was learnt under the tutorage of well-respected elders and tohunga (Smith T. , 2008). Colonial interpretations of tohunga

misinterpreted the role of tohunga, mistaking them as priests, healers, or wizards (Smith T. , 2008). In pre-colonial Māori societies, tohunga had specialist fields of knowledge; a tohunga whakairo, for example, was an expert in interpreting and dealing with tohu relating to whakairo (sculpted or scribed markings, signs, symbols, and images, generally in wood). A tohunga tārai waka was a canoe building expert, tohunga hanga whare was a house building expert. Tohunga were able to interpret a potential outcome or outcomes based upon previous knowledge from prior experience or from the teachings of another tohunga (Smith T. , 2008), which enabled iwi and Māori to navigate and function in the world.

As a Māori engineer, I believe we as Māori could be considered tohunga in our specific discipline, having a specific knowledge set amongst our communities, seeking outcomes which enable our communities to thrive. As an environmental engineer my expertise and skill set allow for the design and construction of infrastructure for roads to be built to support our people to have access to health care, education, and jobs.

Whakarāpopoto: Chapter Summary

As Māori, it is evident that our tīpuna have been engineers through our pūrākau, our inventions, and the roles we hold and have held in our societies. Mātauranga Māori forms the body of our Māori engineering knowledge and is ever evolving and never-ending, which means that our rangatahi have the opportunity to shape mātauranga Māori and engineering. If we, as Māori, were traditionally engineers, why are our people not in the engineering profession? Perhaps, we need to decolonise and redefine engineering to be reflective of te ao Māori, then maybe we will see more of our Māori people in the profession.

The following chapter is going to provide insights into 'Why isn't my engineer Māori,' detailing colonial histories involving engineering and providing an overview of the engineering journey.

Chapter Three: Why isn't my Engineer Māori – Literature Review

While our tīpuna were engineers, today the engineering profession has very few Māori, and we are not represented well.

To understand 'why my engineer isn't Māori', we first must understand the journey an individual must travel and set the scene of the current state of engineering. Then we will explore the whakapapa and hītori of engineering, and what has contributed to our Māori identity not being well reflected in the education, research, and the industry of engineering. When I talk about the whakapapa of engineering, I am referring to the journey into engineering and becoming an engineer, the history and all the compounding events which has led to the prevention of Māori in being seen in the engineering space. This chapter of the rangahau will build the whakapapa of engineering to understand the history of engineering in a te ao Māori context.

Navigating the journey to become an engineer.

The voyage of becoming an engineer is a challenging one. An individual and must navigate different study pathways, ranging from diplomas, bachelors, and bachelors with honours, leading to employment options (Setefano, 2023). The journey through engineering and tertiary education is often an approach which reflects the majority, specifically white males. The engineering journey is not reflective of ethnic or racial differences, implying for those who do not present as a white male, there are extensive factors which impact on their success in engineering (Huanga, Taddese, & Walter, 2000). Similarly, for experiences of Māori engineers, Māori are a collective, and dominated by their roles held in their whānau, with whānau being a core cultural value, this highlights that indigenous employees could be influenced by roles different from the predominantly western employees that dominate the literature (Haar & Martin, 2022). Currently, there is no direct translation for engineer in te reo Māori, which could be contributing to the impact of limited Māori cultural social awareness of the engineering profession. However, as written in the previous chapter, Māori were and still are engineers, so perhaps the way we depict engineers at primary school and high school lessen the chance of Māori choosing an engineering career path (Setefano, 2023).

Setting the scene and the current state of engineering

Historically, the Canterbury School of Engineering estimated 1% of students identified as Māori in the 1980's, which was significantly lower than the 5-9% proportion of Māori in the general population in the same age group (Cooke, 2014). As of 2022, across all qualification levels in engineering, Māori account for 9.5% of those enrolled in engineering schools across the country (Figure New Zealand, 2022), while the proportion of Māori in the general population was 17.4% (Statistics New Zealand, 2022). Māori are underrepresented in the engineering profession, they are often 'lumped' with Pasifika, where combined they account for approximately 3% of the industry (Diversity Works NZ, 2019; Engineering New Zealand – Te Ao Rangahau, 2023) and make up approximately 1% of chartered professional engineers (Engineering New Zealand - Te Ao Rangahau, 2021). In universities, 15% of academic staff across all qualifications, not solely engineering, identified as Māori in 2022 (Education Counts NZ, 2023).

Overall, since 2012, Māori participation in engineering tertiary education had increased at a much faster rate than other ethnic groups (Te Waihanga - New Zealand Infrastructure, 2023). Between 2012 and 2021, the proportion of highly skilled Māori workers in the engineering sector fell slightly from 20% to 18%. Among engineering graduates, other ethnic groups transition into employment at higher rates than Māori. The proportion of graduates who went into employment was roughly 10% less for Māori and Pacific graduates compared to other ethnic groups, regardless of the number of years post-graduation (Te Waihanga - New Zealand Infrastructure, 2023).

The journey through the engineering system can be lonely and isolating when the proportion of Māori in the engineering system is not reflective of the general population of Māori. In the next 20 years the Māori population is expected to increase to 33% of the total national population by 2043. There is going to be a high proportion of young Māori coming through, therefore engineering needs to reflect the values of Māori to assist in helping Māori belong and feel seen in the engineering profession.

Hītori of Engineering

Engineering has a long and complex history entwined with colonial histories. This section will set the scene as to 'why my engineering isn't Māori', in understanding a profession which has oppressed and impacted Māori.

Engineering in Aotearoa

The history of New Zealand saw European settlers migrating to New Zealand in search for profits (Te Ara - The Encyclopedia of New Zealand, 2005). Māori and diversity conversations in Aotearoa must be understood in the context of the colonial theories which were aimed in eradicating and dispossessing Māori. While He Whakaputanga o te Rangatiratanga o Nu Tireni (The Declaration of Independence 1835), and Te Tiriti o Waitangi (the Treaty of Waitangi 1840) recognised Māori independence, the Crown has used the English version of the treaty to claim Māori sovereignty was ceded. In the four decades following the signing of the Treaty, the Crown's presumed sovereignty was asserted through unscrupulous land dealings, legislation, demographic swamping, colonial violence, land confiscation and forced relocation. The early history of New Zealand has played a part in the colonisation, monoculturalism, exclusion of groups, including in engineering (Pool, 2015). Engineering in the early years started with the confiscation and sale of land, alienating Māori before the Treaty was signed (Tupu New Zealand, 2023). European settlers saw the need to lands to be drained, for roads and bridges to be constructed. Railways and ports built for the exportation of goods. Forests and minerals were thought to be there for extraction and exploitation. This same vision was seen by New Zealand colonisers was also shared with the New Zealand Company, which developed the first towns in Nelson, Wellington, and New Plymouth. The development progressed quickly from 1870 to the 1890s, where networks were laid out, agriculture production, the development of water works, and opening the way to hydroelectricity power generation.

One of the earliest professions to be involved in the colonisation project was surveying, which provided skills in mapping and boundary setting, similar skills recognised in the current engineering profession. Prior to this, the land was considered seamless (Cooke, 2014). This view contradicted the values of Māori, where no one person had ownership and rights over the land,

it was shared, and Māori were collective kaitiaki for the whenua. There were also instances where hapū or whānau shared the land, working with it for different purposes, where one group may use the land for fishing, while the other group was using it for growing food (Tupu New Zealand, 2023).

Boundary setting practices were placed on my hapū by surveyors and engineers. All of Tūhoe, Ngati Awa and Ngati Pukeko of the Rangitaiki area lost land through the confiscations of the 1860's. In my hapū, the lands of Waiohau were positioned on the borderlands of the Urewera, where fertile lands caught the attention of Pākehā. The lands were confiscated and sold for Pākehā settlement, agriculture and roading. The alienation of the rohe resulted in relocation of Ngati Haka to Te Putere, on the coast. Issues arose when the lands were hard to cultivate, and Ngati Haka sought permission to return to Waiohau. Although, Ngati Haka relocated to their whenua and they were required to lease it from the crown. The crown further imposed colonisation on Ngati Haka by excluding road construction into the area, continuing to isolate Ngati Haka from the rest of Aotearoa (Arepere, 2022).

The Crown acknowledges their decisions in land confiscations resulted in accumulated unpaid survey costs for Māori in 1907, without inquiring the appropriateness of these costs, resulting in Ngāti Haka Patuheuheu losing large quantities of land in the Matahina and Tuararangaia blocks. The Crown acknowledges that its failure to protect Ngāi Tūhoe from the burden of these excessive costs was a breach of the Treaty of Waitangi and its principles (Arepere, 2022):

> The crown broke a promise to construct arterial roads in Te Urewera, which had been the key reason for Tūhoe consenting to this scheme; and it misled Tūhoe into thinking they were obligated to contribute nearly 40 000 acres for construction of the roads, land which was not returned despite Tūhoe requests, and for which they were only belatedly and partly compensated 37 years later; and notwithstanding Tūhoe's interest in the lakebed, the Crown did not consult Tūhoe before commencing the construction of Kaitawa power station, which ultimately led to some of the lakebed becoming dry land and the degradation of fishing stocks; and it constructed roads and significant structures on the exposed lakebed without the consent of its owners; and due to Crown policies, from 1930

> Tūhoe retained insufficient land to support their recovering population and that many iwi members had to leave Te Urewera in search of employment; and Tūhoe economic development was further hindered by lack of access to finance and the inaccessibility of some of their remaining land due to the lack of roads.

This instance is the first interaction with engineering for my iwi. Surveying, used in the purchase and confiscation of the lands, was a profession which required skills, such as measurement, calculations, and draughting. Many of those skills are taught in engineering, leading to surveyors being considered the first engineers (Cooke, 2014).

The transition to Māori in Engineering

Engineering has always been a predominately a monocultural face, a Pākehā space, through the industry and the education institutions, where Māori in engineering were not recognised or heard. It was not until the 1960's and 70's that Māori had a voice in engineering alongside feminists and environmentalists (Cooke, 2014).

Engineering, Māori and the Environment

While there were very few Māori engineering members, Māori issues started arising into the engineering institution's consciousness. The Water and Soil Conservation Act of 1967 provoked objections from Māori due to its inappropriate water usage provision, and the arguments continued into the "Think Big" projects (Cooke, 2014). Some of these projects included the planned aluminium smelter at Aramoana, and a synthetic fuels plant which opened in 1986 in Taranaki but closed in 1999 (RNZ, 2020). These projects were controversial amongst environmental groups and Māori who were in the middle of fighting for their coastal rights under the Treaty of Waitangi (Boshier, 2023). Ian Gunn had noted the evolution of engineering processes which had incorporated Māori values including the connection to nature for Māori, importance of guardianship, sustainable practices, and respect for water, in 1983. As a result of two wastewater disposal projects, Motunui outfall in Taranaki and the Kailuna River pipeline in Rotorua (Gunn, 1983; Cooke, 2014). Gunn had highlighted concerns regarding the health and wellbeing of water bodies in effluent disposal, and the consideration of waterbodies being taonga to Māori (Gunn, 1983).

A High Court case in 1974 increased the significance given to value judgements over the loss of resources against other requirements, where an engineer might advance. This shift also led to an increased focus on Māori issues in subsequent legal cases and legislative developments. However, these issues were under the responsibility of planners or project commissioners and were not yet fully considered to be under the responsibility of an engineer (Cooke, 2014). For example, the consideration of how an engineer could respond to a taniwha, which involves making greater effort in working with the environment rather than exploiting it. The changing engineering environment led to engineers recognising they need to make greater effort in not dominating and exploiting the land, rather living in harmony with it (Cooke, 2014).

In engineering, the Māori voice started to be heard primarily in water related engineering issues. In the 1990's, the IPENZ (Institution of Professional Engineers New Zealand) conference was one of the first times "Māori Issues and Engineering" were discussed. The implementation of consultation with iwi and mana whenua was built into the Resource Management Act 1991 (Cooke, 2014). While there was some consideration in engineering about the use of land, there were events in engineering discussed below which alienated Māori culture.

The Haka Party Incident

An event surrounding Māori in engineering was 'the Haka Party Incident'. Pākehā engineering students at Auckland University participated in a parody of the haka during capping week. There were many complaints over years from Māori students and the Auckland University Students Association. Auckland University claimed, "it's just a bit of fun" and refused to take action. In 1979, a group of Māori students labelled as He Taua had confronted the mock haka participants, since then, the mock haka has not been performed. He Taua members were detained and beaten by authorities, being labelled as a gang. This piece of history was not as common in the mainstream consciousness, although it is an example of 'casual' racism in which existed in New Zealand and the engineering system (Yates, 2023).

In my own experience, while at work, a conversation about the Haka Party Incident was brought up, however the majority of the engineers present in the conversation were not aware of the incident. The Haka Party Incident is an example of the cultural insensitivity. Katie Wolfe, a

filmmaker, and theatre director had crafted this historic event into a play in 2017. It is clear that this event is still topical and there is still an ongoing issue. Many reviewers of the play thank Wolfe regarding the play due to the play contributing bringing back our cultural consciousness (Muru-Lanning, 2021).

To contribute to righting the wrongs committed by engineering students at the Auckland University, another haka was commissioned for the opening of the engineering building in 2020, titled Me Hoki Whakamuri Kia Anga Whakamua : "Look to the past to move Boldly to the future".

The shift for Māori in Engineering

Aspirations for our people are to see Māori in a range of high skilled jobs, and engineering being one of those. We are starting to see a shift in organisations and government agencies enabling Māori to have a voice in the industry and recognising Māori aspirations, particularly in research which they are commissioning to be conducted to support in their journey to become Tiriti partners.

In 2021 Tonkin + Taylor undertook research into Māori aspirations for the transport sector which included interviews with Waka Kotahi representatives (Sweeney, Breitenmoser, & Dickson, 2022). Tonkin + Taylor undertook a review based on inclusive transport planning with Māori, they highlighted the importance of "not assuming what Māori want or providing a single solution for all Māori" (Sweeney, Breitenmoser, & Dickson, 2022). The research, also noted "a notable shift", where Māori are focusing on upskilling iwi, hapū and whānau to fill roles across the full suite of roles in an infrastructure project, "it was highlighted that one high paying job within an iwi could have a far greater positive impact on a whānau, hapū and iwi than many lower paid jobs" (Sweeney, Breitenmoser, & Dickson, 2022). They referred to a trend of Māori aspirations in relation to Waka Kotahi projects moving from an environmental focus to a focus on leveraging those projects to facilitate longer-term economic interests, such as upskilling Māori whānau so they could fill transport project roles (Te Waihanga - New Zealand Infrastructure, 2023).

A key finding Te Waihanga highlighted for the industry was the value of educating Waka Kotahi staff on matters such as pronunciation, relevant kupu and Māori history. They noted that education should also address contemporary Māori interests, such as cultural building capability

(Te Waihanga - New Zealand Infrastructure, 2023). In 2022, Maarama Consulting undertook research on the relationship Waka Kotahi has with Māori, finding multifaceted approaches are needed, including cultural staff inductions, cultural training, and showing staff how to bring these skills into their specific roles(Maarama Consulting, 2022). In 2022, KPMG released Māui Rau, a report regarding the evolution of post Te Tiriti settlement governance entities (PSGEs). Māui Rau was informed by discussion with almost 30 current and former tribal governors and managers, as well as the insights of authors described as having "more than 20 years of lived experience working, serving and living within Māori communities" (KPMG, 2022). Tangata whenua representatives on collaborative groups were said to feel strong pressure to compromise - particularly if Māori values and perspectives are not well understood, and their desired policy outcomes are difficult to translate to plain language (KPMG, 2022).

The agencies who are commissioning engineering work such as Waka Kotahi, seek to work effectively with Māori, however, few changes have enabled progression in supporting Māori within the engineering spaces, which might support these agencies with their Kaupapa. Although, some of the decisions are under the responsibility of Engineering New Zealand, who has their own challenges in their history and cultural journey.

Engineering New Zealand, the professional body

Engineering New Zealand is the professional body, responsible for promoting the interests of engineers in Aotearoa (Cooke, 2014). Engineering New Zealand has made decisions which have contributed to a history impacting Māori.

In the early days of engineering, local government was New Zealand's largest employer, due to the number of roads, river, and harbour projects. Surveyors served in elementary engineering roles, including road formation, water and drainage works. There was often cross over between "City Surveyor" and "City Engineering" titles and overlapping services offered. In 1892, associate membership of the New Zealand Institute of Surveyors was extended to include the engineering diploma, and engineers with three years working experience. In 1905 engineers were under the umbrella organisation of New Zealand Institute of Architects (NZIA) and the New Zealand Institute of Draughtsmen (founded in 1908), although engineers felt that they were not well

represented in either of these bodies. A series of poorly lead and ill qualified engineering projects lead to the development of the Institute of Local Government Engineers of New Zealand (ILGENZ), which was formed in 1912. This was a body formed for the promotion of engineering knowledge and practice, and was influenced by similar groups formed in Australia, and the UK. The body consisted of engineers who came from drainage and roading backgrounds. The body further developed to become the New Zealand Society of Civil engineers. By 1927, electrical and mechanical engineers felt the name of the body did not reflect their specification. In 1937 the body was renamed to the New Zealand Institution of Engineers. The merger with Professional Engineers Association of New Zealand in 1959 led to a restructure, which led to regional branches. In the early 1980's NZIE became IPENZ (Institute of Professional Engineers New Zealand). Later on many New Zealand bodies adopted Māori names, but IPENZ did not immediately follow suit in changing its name or incorporating token Māori elements (Cooke, 2014).

In the 2000's, the Chartered Professional Engineer (CPEng) was introduced to encourage accountability and transparency. The CPEng was awarded to engineers who "agree to a clear code of ethics, discipline and practices with regard to safety, the environment and financial integrity". In 2002, the CPEng Act became law. In addition, IPENZ became more involved in engineering education to attract young engineers into the profession.

In 2017, IPENZ changed its name to Engineering New Zealand (Cooke, 2014). Engineering New Zealand – Te Ao Rangahau, had been embarking on a journey to change their name, however there was point where IPENZ quietly accepted the name Pūtahi Kaiwetepanga Ngaio o Aotearoa introduced in 2004. Pūtahi Kaiwetepanga Ngaio o Aotearoa was a Māori translation of IPENZ from the Māori Language Commission. The name did not stick, as it was considered the translation did not capture the intent of the organisation (Engineering New Zealand - Te Ao Rangahau, 2020), and others say the organisation did not seek advice from Māori within the institution and did not follow proper tikanga, which had been discovered through kōrero with Māori engineers. This name change appears to be an attempt of the organisation to consider Māori, when looking at it at face value. Although, a trend at the time naming organisations with Māori titles and was considered "good for companies", it is considered tokenistic (De Bres, 2022).

It is a slap in the face for Māori, with organisations now wanting to rebrand in te reo, when the Native Schools Act emphasised the use of English in 1867 (New Zealand Parliament, 2022) and speaking te reo Māori resulted in punishment. There was a sense of desire for Māori communities to encourage their children to succeed in a Pākehā world, and this was encouraged through speaking English (Te Ara, 2012). The use of loan words or transliterating, where Pākehā words were exchanged for te reo Māori have been said to cause a negative impact, and it indicated the Māori language was still developing, minimising and diluting te reo Māori. This process of transliterating stuck and changed the way te reo Māori progressed, where people thought transliteration would lead to the loss of authentic understandings embedded in the Māori language (Tawhara, 2014).

Soon after renaming IPENZ to Engineering New Zealand, in 2018 Engineering New Zealand was gifted the name Te Ao Rangahau' by Sir Tamati Reedy from Ngāti Porou. Te Ao Rangahau translates in English to 'The engineering universe', which was said to capture the vision of "bring[ing] engineering to life" (Cooke, 2014). This Māori name was more widely accepted due to the naming process following tikanga, and the recognition of the naming as a taonga.

In 2019 Engineering New Zealand included explicit reference to "promoting the Treaty principles of partnership, protection and participation", in the organisation's Rules. Although, those changes are yet to be materialised.

In August 2020, Chantelle Bailey (Te Rarawa, Ngāpuhi), Lincoln Timoteo (Ngāti Raukawa), Warner Cowin (Ngāti Porou) and Troy Brockbank (Te Rarawa, Ngāpuhi, Ngāti Hine) formed a group based from a panel discussion to set a wero, a challenge to Te Ao Rangahau to do more for Māori. That wero supported challenges in the organisation, where Te Ao Rangahau invited that panel to form a formalised group named 'Papaki Parihau', which translates to 'flapping wings as a butterfly does when it wants to begin flying'.

Engineering New Zealand elected Wharehuia Dixon, a Māori engineer, to the board of Te Ao Rangahau in 2021 to progress mātauranga Māori and Te Ao Māori in the engineering profession (Engineering New Zealand - Te Ao Rangahau, 2020). Te Ao Rangahau acknowledge,

> "Every engineer has a right to feel part of a profession that is welcoming, safe and inclusive of their cultural concepts and perspectives. Sadly, there have been instances within the profession, including at the tertiary education level, where this has not been the case. Racism and a general lack of understanding of te reo Māori and the importance of Te Ao Māori to engineering continues.
>
> Perceptions and definitions of engineers and engineering have been dominated by Western concepts and approaches that have not always adequately considered the environmental, cultural, and social contexts of Aotearoa. While there have been attempts to embed Te Ao Māori in relevant legislation, such as the Resource Management Act 1991 (RMA), in practice this has fallen short of delivering the protections that are promised in Te Tiriti o Waitangi, despite some exemplary projects. This results in poor outcomes, especially for Māori."

Te Ao Rangahau recognise they need to embed te ao Māori and Te Tiriti o Waitangi principles, and they are on a mission to, (Engineering New Zealand - Te Ao Rangahau, 2020):

- value cultural competency as a core skill for Aotearoa's engineers.
- support our members and the wider profession to develop these skills.
- make engineering a profession where Māori can thrive.
- recognise and celebrate stories of Māori engineering.
- promote the use of te reo Māori.

Engineering New Zealand acknowledge they are on their journey to embrace Te Ao Māori in their organisation and bringing that to the wider profession. In 2023, the called upon the engineering community for those who identified as Māori to attend Kanohi ki te kanohi hui across the motu to understand our peoples experience in engineering to contribute to the strategy which they have titled "Te Ao Māori into our work, our organisation, and the engineering profession". Engineering New Zealand acknowledge it has been a journey and taken a long time to get to the point they are at now and know there is plenty of work still required (Engineering New Zealand - Te Ao Rangahau, 2020).

I had attended a Kanohi ki te kanohi session hosted in Kirikiriroa (Hamilton). Although it was facilitated by Māori engineering leaders that I look up to, and it was an opportunity to have a space to connect to and kōrero with other Māori in engineering, it felt like the session was prescribed, almost as if the senior leadership team had already decided what information they wanted to exact from us, making it difficult for the kōrero to authentically reflect that change that we believed is needed and to truly listen to our Māori experiences and why we would not encourage our rangatahi to enter the profession.

As a continuation of Engineering New Zealands' cultural journey, they now offer a two-hour interactive learning module on Te Tiriti o Waitangi and the Treaty of Waitangi (Engineering New Zealand - Te Ao Rangahau, 2020).

Engineering Rangatira

'He manako te koura I kore ai'

'Wishing for the crayfish won't bring it'

The whakatauki arose through an incident, where the chief Hikairo took refuge in his Pā and a member of a raiding party exclaimed "there goes a fat meal for us". The proverb was the reply of Hikairo. The whakatauki represents the idea of you have to go out and work for something if you want it. We have many of our Māori navigate the voyage of engineering in the modern day. This section sheds light on those warriors fought and continue to fight for change in the engineering industry, to protect Māori people and the whenua in the profession and industry of engineering. This section outlines the rangatira of engineering, and representing Māori in an industry which has not always considered our people.

Some of the key Māori engineers who are rangatira and pioneered the way for Māori in engineering included Morris Love from Te Āti Awa. Love worked to bridge the gap between engineering and cultural consulting. Love wrote a series of articles that covered topics such as kaitiakitanga, tino rangatiratanga, waahi tapu, and Māori claims to intellectual property and other taonga. The narrative uncovered the grievance experienced by Māori, and the need for collaboration in the industry (Cooke, 2014).

Kepa Morgan, hailing from Te Arawa, was an engineer who advocated for collaboration with Māori communities. He asserted that the field of engineering was perceived as "environmental and cultural terrorists" from the perspective of Māori. He actively promoted this viewpoint in the year 2000. Kepa Morgan advocated for engineering to "change its ethnic make-up from within" due to the low numbers of Māori entering the field. This was in light of the Haka incident (Cooke, 2014). Kepa Morgan also went on and developed the Mauri-o-meter, a method of measuring and holistically evaluating the environment in a culturally responsive way.

Troy Brockbank is another leader grounding his engineering view in te ao Māori and has applied and embedded mātauranga Māori and kaitiakitanga throughout the water engineering industry.

While there are rangatira who have had years of experience, Alyce Lysaght is considered to be another upcoming Māori engineering leader, through her interview series showcasing Māori who elevate the engineering world on her podcast 'Māori in engineering'. The podcast provides a platform which enables Māori to see their selves reflected in the engineering profession.

While there are individuals advocating for Māori in engineering, there are also groups such as SPIES, SPEEX, Pūhoro STEMM Academy which support and connect Māori in navigating the engineering space, through education and industry. SPIES (association for Polynesian engineering students) was founded by Tyrone Newson in 1993 (Engineering New Zealand - Te Ao Rangahau, 2020). SPEEX (South pacific Professional Engineering Excellence) was formed to promote Māori and Pasifika entry into the engineering profession and support them through their ongoing career (South Pacific Professional Engineeirng Excellence , 2004). Pūhoro STEMM Academy recognised Māori need to be in professions like engineering and sought to improve equitable access into STEMM education and pathways for Māori into careers. Pūhoro leverages on both knowledge systems: Mātauranga Māori and western science, supporting Māori to think in ways that suit them (Pūhoro, 2023).

These leaders and group initiatives have the same vision for Māori as people, Mātauranga Māori and Māori whānua to exist and succeed in the engineering profession.

Engineering Education

Early in an engineer's journey, education shapes and carves the skills which makes an individual an engineer. However, engineering education could also be used as a tool in enabling Māori in engineering. The engineering curriculum is driven by the Washington Accord, which is an agreement between engineering tertiary degree providers regarding 12 key attributes graduates should have to be a good professional engineer (International Engineering Alliance, 2022). There are five graduate attributes listed in Table 1 which consist of soft skills required to be an engineering professional. The cultural component of these skills is often overlooked or addressed superficially, and technical skills have higher importance (International Engineering Alliance, 1989).

Table 1 Washington Accord Graduate Attributes that highlight soft skills.

Washington Accord Graduate Attributes	**Description**
WA3: Design/ development of solutions	Problem solving of complex engineering problems which can consider specific cultural, societal and environmental considerations.
WA6: The engineer and society	Use reasoning informed by contextual knowledge to assist in societal, legal and cultural issues impacting on engineering problems.
WA7: Environment and sustainability	Understand and evaluate the sustainability and impact of the professional engineering work.
WA8: Ethics	Apply ethical principles and commit to professional ethics and responsibilities.
WA10: Communication	Communicate effectively on complex engineering activities with the engineering community and with society.

In New Zealand, Te Ao Rangahau (Engineering New Zealand) monitors and assesses the tertiary institutes offering engineering programmes. Engineering New Zealand recognises the importance of engaging with Iwi and Māori and letting the voices of the Māori community be heard. However, there is a lack of representation of Māori in the industry (Poli, Lay, Owen, & Boston, 2022). Recently, Engineering New Zealand had proposed building Te Ao Māori capabilities into their governing board by appointing a Māori Board member (Poli, Lay, Owen, & Boston, 2022). Engineering NZ did note that it is not ideal to solely rely on one member to speak

for the Māori community, therefore the governing board is required to build Te Ao Māori capability amongst the full team (Engineering New Zealand - Te Ao Rangahau, 2021).

When the chartered pathways in our industry are examined, there are no competencies around anything cultural. A small step could be to make it compulsory that engineers have an understanding of te ao Māori, te reo, tikanga and mātauranga Māori as part of the competency framework. This has been successful in the planning profession (Te Kōkiringa Taumata – New Zealand Planning Institute, 2020; Association of Consulting and Engineering 2020).

The absence of mātauranga Māori in the education system has ensured a racial hierarchy where western concepts of academia are valued above indigenous peoples. As Leonie Pihama has said, "For generations the stories of how we have come to this context have been made invisible and continue to be invisibilised in our education system across the country" (Pihama L. , Te Toka Tūmoana : supporting the navigation of indigenous wellbeing in colonised waters, 2018).

Knowledge gaps

The literature review has brought attention to various colonial contributions and institutional changes needed in the engineering profession to embrace te ao Māori. However, there are several knowledge gaps regarding the reasons behind the underrepresentation of Māori engineers, which were not addressed in the literature. Some of the identified knowledge gaps that will not be further investigated include the disconnect between engineering education and industry. This gap is particularly noticeable in the disparity between what is taught in education and the actual requirements of the industry. While engineering education emphasises technical skills, there is a neglect of soft skills, demanding an exploration of these in the engineering context. Te ao Māori perspectives in engineering and the decolonisation of engineering could be a potential avenue in supporting Māori entry into the industry.

Further exploration is needed into the use of te reo in contributing to Māori empowerment in engineering. While data supports the finding that Māori are underrepresented in engineering, there is limited research on the retention of Māori in the profession and their destinations upon leaving. Additionally, research on Māori engineering academics and their journeys is lacking.

However, this thesis aims to investigate and concentrate on enhancing the mana of Māori in Engineering and the engineering system. This will involve understanding the concept of safe spaces for Māori in engineering and on their journey.

Whakarāpopoto: Chapter Summary

Though historic events in engineering like land confiscations and boundary setting; the 'Haka Party Incident'; and the monocultural bodies who governed the engineering profession; the education standards, likely contributed to the colonisation of engineering. Activities which diminished the sacredness of Māori tradition, demoralised and disempowered Māori from participating in engineering. Did those acts of our Pākehā peers impact on our people in wanting to study engineering? The number of Māori in engineering education and in the industry remain low. However, although engineering contributed to the oppression of Māori, there were few Māori leaders who arose to take action and support change in Te Ao Rangahau- Engineering New Zealand and the profession. There are changes on the horizon for the professional body. There is little literature readily available in understanding the full picture of Māori in engineering. This thesis will focus on enhancing the mana of Māori in engineering. The following chapter will outline the research framework applied to this rangahau.

Chapter Four: Research Framework

Chapter Four: Research Framework

In Chapter Three, a gap in the literature was identified, for further investigation into enhancing the mana of Māori in engineering. The purpose of this chapter is to outline the research approach and design of this Kaupapa. The chapter will explore the framework, methodology, method approaches and processes involved in the collection and analysis of the information and data. Ethical practices were involved in the Kaupapa to ensure the data collected is protected following the University of Waikato ethic guidelines and tikanga Māori.

Framework

Cultural theoretical frameworks serve as a guide in indigenous methodology approaches, in information and data gathering, and analysis. In academia, they do not need to be integrated with western methods to be considered rigorous. These frameworks can also act as metaphors, directing the incorporation of qualitative methodologies like grounded theory or narrative inquiry for data collection and analysis (Fraser & O'Neil, 2021). Indigenous theorists explain "Indigenous theorizing is contextual, connected to a specific cultural location and site, tested in practice, organically connected, and made with the people not just in the academy" (Smith G. H., 2005).

To propose a "theory", the person must have cultural skills and the ability to connect to knowledge, language and culture relating to the people to whom the theory is relevant to (Fraser & O'Neil, 2021). Research approaches match a problem with an 'appropriate' set of investigative strategies (Smith & Smith, 2012). Metaphors and analogies can guide the integration of qualitative approaches serving as a form of framework to build the theory. "The important point for academia is that indigenous methodology of cultural frameworks stands alone, and they do not need to be integrated with Western approaches in order to be considered rigorous, respected and relevant research approaches" (Fraser & O'Neil, 2021). For my research, He Waka Hourua research framework was used to capture my cultural background, and enable safe research approaches to working with Māori, in understanding mana enhancement within the engineering journey.

He Waka Hourua

Waka Hourua or double hull sailing canoes are voyaging waka designed and built by early Māori and Polynesian ancestors to carry many people and enough supplies on long open ocean voyages to discover new places and opportunities (Anderson, 2017; Pokapū Akoranga Pūtaiao, 2020).

Inter-generational transfer of knowledge through oral traditions enabled the development of a sophisticated method of navigation. By using the environment around them, the stars, moon, sun as navigational waypoints, ocean voyages of epic proportions throughout the entire Pacific and beyond were possible (Anderson, 2017). From a Māori worldview the Waka Hourua are a physical manifestation of excellence and symbolise of every aspect of te ao Māori philosophy, principles, and practice (Rata, Hutchings, & Liu, The Waka Hourua Research Framework: A dynamic approach to research with urban Māori communities, 2012).

A design feature of Waka Hourua is two identical hulls of equal size and length secured together with planks and lashings to strengthen, balance, and stabilise the waka structure for swift performance and manoeuvrability on the open ocean under full sail and in high seas (Pokapū Akoranga Pūtaiao, 2020).

The waka encapsulates the long history of Māori as ocean voyagers, navigators, and innovators, noted in Chapter Two. Building a waka, carving a waka, and paddling a waka requires a group working in collaboration to be able to do these things successfully. Not only does the waka need to be balanced and structurally stable, there also needs to be stability and unity among the people on board moving in the same direction, harnessing each other's strengths, to ensure their safe arrival at every destination with the wellbeing of all intact (Pokapū Akoranga Pūtaiao, 2020).

Ko te waka o te kotahitanga, he waka ngāwari te rere

A waka of unity is a waka that glides easily.

He Waka Hourua framework selected reflects the identity of the researcher from cultural connection, knowledge and language through the depiction of a cultural analogy. The theorising framework acknowledges the technological and engineering practices tailored to audience of the

engineering system, emphasising the recognition, and honouring for Māori who once were and still are engineers. Indigenous theorising frameworks can contradict and challenge existing accepted ways of knowing, doing, and understanding within institutions (Fraser & O'Neil, 2021). The theorising framework in this rangahau of He Waka Hourua is selected to challenge engineering accepted ways of knowing and seeks to develop a contemporary and cultural perspective of engineering and engineering research. Engineering is a complex field for cultural integration, whether it is in education, industry or in research, where the literature review revealed historic colonisation which exists in engineering. The initial intention of this rangahau was to be completed and accepted as Kaupapa Māori methodology as the theoretical framework. However, it was challenging to accept this rangahau as Kaupapa Māori methodology due to listening to the voice of Pākehā, the same people who continue to colonise Māori in the engineering system.

For the purpose of this research, the analogy of a He Waka Hourua, a double-hulled canoe, navigating across an ocean is the theoretical framework which will inform this rangahau, while drawing from Kaupapa Māori methodology. This metaphor permits the view of non-Māori to be present, with the assumption allies are on this journey with Māori in engineering. Similarly, He Waka Hourua has been applied as the cultural framework in other research fields of health and psychology, which has also informed the application of this framework to this rangahau in engineering (Rata, Hutchings, & Liu, 2012; Mullane, Harwood, & Warbrick, 2022).

The hulls, represent each body of knowledge that informs this rangahau. One hull representing Kaupapa Māori as epitomised by mātauranga Māori, while the other hull represents Western Engineering knowledge and perspectives. In this rangahau both bodies of knowledge are drawn upon when appropriate. The papa noho, the platform deck joining each hull is the values of this rangahau. The kiato, crossbeams support the deck representing the principles this rangahau has adopted. Ethics and tikanga are illustrated as Hoe tere, the steering paddle. The identity of the researcher is seen as the captain who is responsible for the safety and steering of the rangahau, while directed by the navigator represented as participants - Māori in engineering voices. The methods and analysis are depicted as the sails, which catch the wind to move, where Māori aspirations embody the winds. Without the wind interacting with the sails the rangahau cannot

move or get traction. The destination is the vision and future where Māori feel like they belong in engineering. All parts of the Waka Hourua are required for the effective functioning of the waka. An illustration of He Waka Hourua theoretical framework has been developed in He Waka Hourua Framework diagram (Figure 2) (Mobilising for Action, 2022).

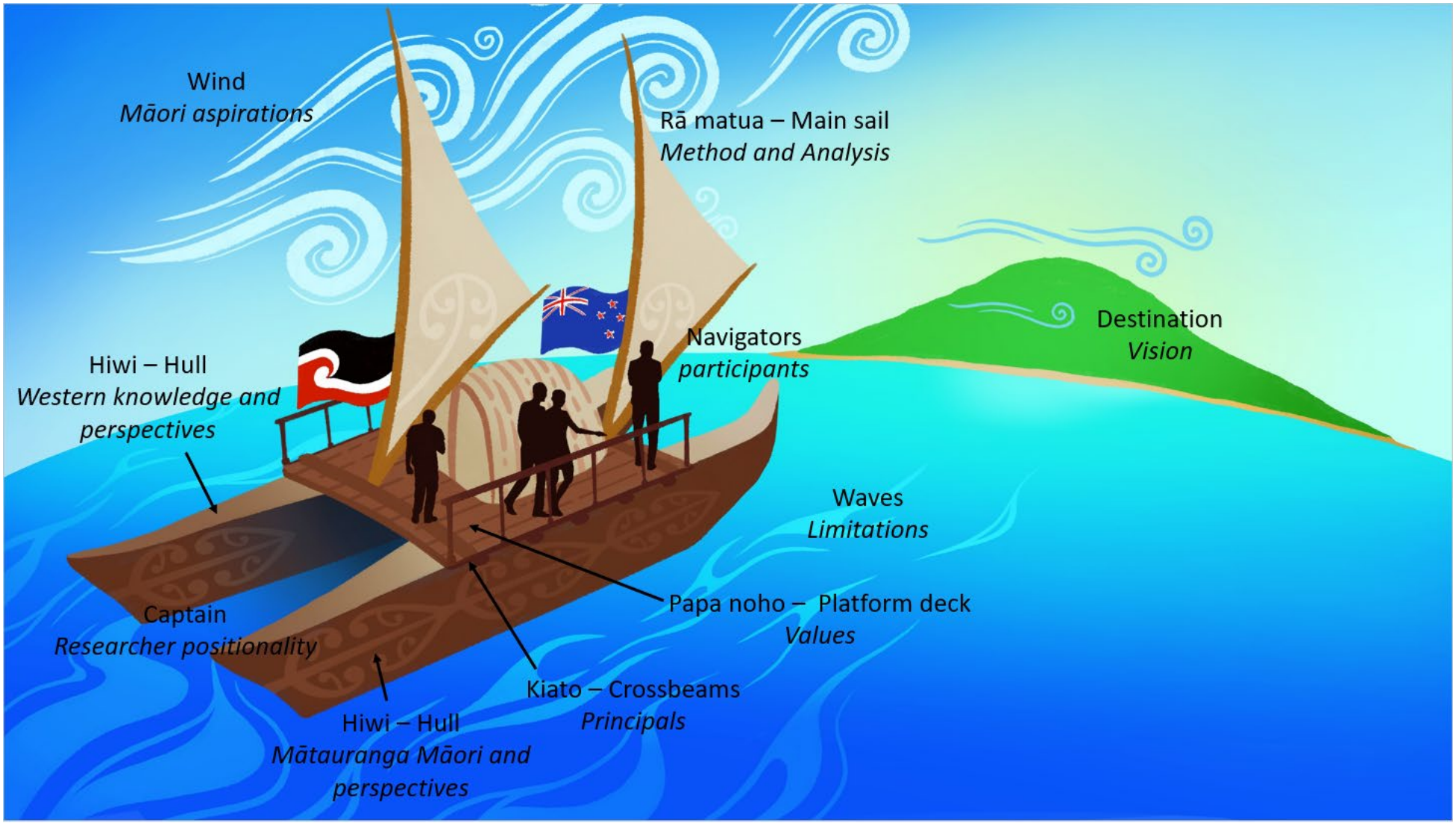

Figure 2 He Waka Hourua Framework diagram.

Kaupapa Māori methodology

Kaupapa Māori methodology anchors this Waka Hourua framework. Kaupapa Māori methodology is a theoretical framework used to challenge the current discourse through awareness of perspectives surrounding colonisation and oppression (Archibald & Lee- Morgan, 2019). The intention of this research was to use Kaupapa Māori methodology. Kaupapa Māori is a methodology which can be used as a theory and in application to supporting in meeting the aspirations of our people, Māori people (Rua, Hodgetts, Groot, Blake, & Karapu, 2023).

Kaupapa Māori methodology is still in early adoption in science and computer science fields research fields, more often than not, scientific research fails to explore history and events that determine experiences of indigenous peoples, similarly to engineering (Wilson, Mikahere-Hall, & Sherwood, 2022).

Kaupapa Māori methodology is not prevalent in engineering literature and there are limited studies which utilise this methodology. This posed difficulty in selecting a methodology which was reflective of te ao Māori and engineering, which was practicable.

Kaupapa Māori methodology centres Māori ideas and thinking of the world, in addition to including approaches to decolonise and break systems which inhibit Māori from succeeding. Kaupapa Māori methodology is grounded in the principles of relationships, connections, accountability and reciprocity in Māori knowledge and understandings of ethics. Smith believes principles are key in decolonising theory so there are several principles, discussed in detail below, that have been adopted from Kaupapa Māori methodology for this rangahau (Smith L. , 2012).

There is still debate as to what defines Kaupapa Māori, although for most Māori, it is agreed a key feature of Kaupapa Māori appears to be the opportunity for control and ownership, which has been adopted in the values and principles of this framework (Moewaka- Barnes, 2000).

Papa noho, the platform deck – Values

In this rangahau the values adopted are described as papa noho, the platform deck joining each hull or each set of knowledge between engineering knowledge and Kaupapa Māori and mātauranga Māori. Values in this waka hauora are the qualities and standards that governs the

behaviour of the author and how they undertake the rangahau. Three values underpin this rangahau, rangatiratanga, manakitanga and Aroha ki te Tangata. These values have an important role in safeguarding the research process, any knowledge produced, in addition to researchers, participants and communities and are discussed below (Jones, Crengle, & McCreanor, How Tikanga Guides and Protects the Research Process: Insights from the Hauora Tāne Project, 2006).

Rangatiratanga

Rangatiratanga - which is the execution of self-determination (Tino Rangatiratanga) by Māori people. There is still debate as to what defines kaupapa Māori, although for most Māori, it is agreed a key feature of kaupapa Māori appears to be the opportunity for control and ownership (Moewaka- Barnes, 2000). The concerns around control of research extend further than developing an understanding of an issue in research (Moewaka- Barnes, 2000). Control is not only held by the researcher but is also held by participants involved in the research (Durmush, 2021). The use of Rangatiratanga in research requires researchers to identity how the aims and outcomes of the research contribute to the aspirations of Māori (Smith G. , The development of Kaupapa Māori theory and praxis [Unpublished doctoral dissertation, 1997) . Rangatiratanga in the context of this rangahau permits Māori experiences, views, ideas to be recognised. The role of the researcher in kaupapa Māori is to challenge the privileging of western culture, by upholding this value (Moewaka- Barnes, 2000).

Manaakitanga

Manaakitanga is the concept of “nurturing relationships, looking after people, and being careful about how others are treated” (Mead, 2003).

The application of manaakitanga is to ensure that “guest” participants who are invited to engage with the rangahau feel that they are worked with appropriately. Manaaki ki te tangata has been discussed in research to build a collaborative and reciprocal method (Pipi, et al., 2004). Typically, the research structure reflects a one-sided arrangement where research receive and take information from participants (Jones, Crengle, & McCreanor, How Tikanga Guides and Protects the Research Process: Insights from the Hauora Tāne Project, 2006). Manaakitanga is a value

used in this rangahau to work with participants to allow them to choose the direction of their kōrero, in addition to thanking them for choosing to be a part of the rangahau.

Aroha ki te Tangata

Aroha ki te Tangata has been described as 'aroha to other people', which is how it will be defined in this rangahau as it is a complex concept when it comes to research as it is challenging to ensure all those involved have their best interests cared for, although compromises are often needed (Jones, Crengle, & McCreanor, How Tikanga Guides and Protects the Research Process: Insights from the Hauora Tāne Project, 2006). Aroha ki te Tangata has been expressed as "A person who has aroha for another expresses genuine concern towards them and acts with their welfare in mind, no matter what their state of health or wealth" (Barlow, 1991).

In the context of this rangahau Aroha ki te Tangata will be having participants in the forefront of the mind of the author to ensure protection, as it is necessary to safeguard against the continued exploitation of Māori knowledge (Bishop & Glynn, 1992; Jones, Crengle, & McCreanor, 2006).

The definition of Aroha ki te Tangata for this rangahau has been adopted "allowing people to define their own space and meet on their own terms" (Pipi, et al., 2004).

Kiato, crossbeams – Principles

In a Waka Hourua, the kiato, crossbeams, hold up the deck, so similarly the depiction of kiato as principles in this framework are used to uphold the values discussed above. Principles are the rules and beliefs that govern the protocols of this rangahau, which are informed by the values. There are three principles which set out the practices within this waka hourua framework, the principles are drawn from kaupapa Māori Methodology, and include Tikanga, kanohi ki te kanohi and whakawhanaungatanga (Pipi, et al., 2004).

The Principle of Tikanga Māori

Tikanga is embedding the way people act and believe (Smith L. , Kaupapa Māori Research- Some Kaupapa Māori Principles, 2015). Tikanga is considered the Māori practice of knowledge (Tikanga maori Hirini moko mead - pg9), informs kaupapa Māori methodology, and has been used to guide

this research, where ‘tika’ means ‘to be right’, with the focus of doing things in a correct manner (Smith L. , Decolonizing Methodologies, 2012). Tikanga is underpinned by the value of manaakitanga, where the mana of participants involved in the rangahau is maintained (Tipene-Matua, Philips, Cram, Parsons, & Taupo, 2009). The role of implementing this principle is to lend a process of how to do things aligned to kaupapa Māori methodology and traditional practices of Māori (Tipene-Matua, Philips, Cram, Parsons, & Taupo, 2009).

The principle of kanohi ki te kanohi

Another important principle in Māori society is kanohi ki te kanohi (face to face). In the context of this framework and rangahau, kanohi ki te kanohi refers to the accountability of researchers when engaging with Māori. This includes the physical presence, relating to mana tangata and a person’s credibility in words, actions, and intentions. This concept of fronting up, face to face, provides people with the sense of honesty and truth and gives a sense of mana to the words spoken. In terms of this rangahau it is acknowledged that kōrero can be intimidating and challenging, however applying this principle sets the expectation that the author will stand by their words to maintain integrity.

Kanohi ki te kanohi is regarded within Māori communities as critical when one has an important “task” or purpose. This form of consultation allows the people in the community to use all their senses as complementary sources of information for assessing and evaluating the advantages and disadvantages of becoming involved (Cram & Pipi, 2000). This in turn, provides an opportunity to practise the values which have been established in the waka hourua framework, for the author to seek to form relationships and trust to enable the communities to feel free to interrogate, challenge, and criticize, if the communities feel they should (Edwards, Mcmanus, & McCreanor, 2005).

The Principle of whakawhanaungatanga

Whakawhanaungatanga (the process of making connections) requires time and space for relationships to be established, as consequence, the interviewer builds a genuine connection with the participants. In building these relations, there is a bond which each party commits to in

upholding the mana of each other (Jones, Crengle, & McCreanor, How Tikanga Guides and Protects the Research Process: Insights from the Hauora Tāne Project, 2006).

These values were implemented into this research in a number of different ways which formed the participant recruitment framework. Whakawhanaungatanga is an approach used in Māori engagement that has existed in Māori society and culture for generations (Bishop R. , 1995).

Captain – Researcher positionality

A good captain ensures the safety of all through that are onboard of the waka, they must be confident, strong, and capable of their role. The captain of this waka is the author. The beginning of this thesis explains the whakapapa and origins of the authors positionality in relation to this rangahau. The positionality of the author is wahine Māori and an engineer. The positionality was purposely described as wahine Māori first, and an engineer second, due to the identity the author brings into this rangahau and in the engineering system. The author is anchored deeply to her Tūhoetanga and well-practised in her field of engineering. The propulsion, the cause, of this rangahau is the authors own lived experiences, and with a positive sense of momentum is the energy and hopes for engineering system changes.

A captain often has a team behind them, to lean on when challenges arise. The team of engineering professors, representing the co-governance of this rangahu, consisting of Mark lay (Pākehā) and Mahonri Owen (Ngāti Hine and Ngāti Tūwharetoa).

Māori academics often share the voice of their thesis to be able to be read by their whānau and the wider Māori community because “if it cannot then its potential for offering information and knowledge is, in their minds, diminished”. This can often be challenging for Māori academics when working in the confines of the universities (Pihama L. , Kaupapa Māori Theory: Transforming Theory in Aotearoa, 2015). This experience is also shared by the author, where engineering is prescriptive. Although this thesis is intended to support Māori in engineering, it is ultimately to enable engineering to be presented with the ‘facts’ of Māori in engineering. This rangahau is intended for Māori in engineering to have their voices and calls heard and acknowledged to prompt transformation in engineering, to ensure Māori do not feel alone, which is how the author has felt in the engineering system (Smith G. , 2017).

Navigator – Participants

The Waka Hourua framework draws from kaupapa Māori methodologies, where Māori participants are to lead the research (Smith L. , et al., 2019). In this rangahau Māori participants are considered the navigators guiding the direction through the way they kōrero and in the kōrero itself. Māori have been navigators, where the skills had been handed down for generations.

This rangahau involves the study of experiences of a number of participants. A solution for Māori in the engineering space will only come from a Māori cultural context by using approaches within Māori control (Bishop A. , 1995).

Table 2 Number of participants in rangahau

Participants	**Number**	**Method applied to their kōrero**
Māori in the engineering industry	3	Whakawhiti kōrero/ interviewing
Māori students in the engineering education	9	Surveys
Students in in the engineering education	38	Surveys

To design an engineering curriculum and engineering industry which is inclusive for Māori and reflective of modern-day Aotearoa, it had to involve the use of participant recruitment frameworks which aligned with Māori values. Māori in the engineering industry participants were sourced through whakawhanaungatanga and pre-established industry relationships with the author. There is literature that suggests to achieve active Māori participation, having Māori leadership central to the study is integral, in addition to aligning participant recruitment approaches to a kaupapa Māori methodology (Fink, Paine, Gander, Harris, & Purdie, 2011). Those participants which took part in the survey volunteered. There were some criteria established which participants must have met prior to engaging with this rangahau.

Table 3 Criteria to participate.

Participants	**Criteria to participate**
Māori in the engineering industry	• Had to identity as Māori. • Had to be working in the engineering industry. • Had to be aged under 30 years of age
Māori students in the engineering education	• Had to identity as Māori. • Had to be enrolled at the University of Waikato. • Enrolled between the years 2021 and 2023. • Undertook any of the following papers ENGENX70 papers and are titled Engineering and Society (ENGEN170), Engineering and Business (ENGEN270), Engineering and the Environment (ENGEN370), and Engineering and the Profession (ENGEN570). • Had to be exposed to te ao Māori Engineering lectures
Students in in the engineering education	• Had to be enrolled at the University of Waikato. • Enrolled between the years 2021 and 2023. • Undertook any of the following papers ENGENX70 papers and are titled Engineering and Society (ENGEN170), Engineering and Business (ENGEN270), Engineering and the Environment (ENGEN370), and Engineering and the Profession (ENGEN570). • Had to be exposed to te ao Māori Engineering lectures

Adhering to He Waka Hourua framework meant giving effect to the values established in this rangahau. The values had to be implemented in both methods. Kanohi ki te kanohi (face to face) and whakawhanaungatanga (the process of making connections) were used in the form of the survey component consultation. The survey was shared and discussed by the lecturer in person,

who had already built the trust with the participants over duration of the teaching period. By sharing the survey link in person, it promoted discussion with the potential participants where they had the opportunity to question the data collection method and the research. The survey allowed for anonymized information to be collected where there was no direct relationship between the researcher and the participants.

Alternatively, the other way kanohi ki te kanohi and whakawhanaungatanga connections were used to recruit participants through relationships already established in the engineering industry, between the researcher and the participants. This approach provided rangatahi Māori engineers, participants with a sense of safety of who they were sharing information with and how the information shared from participants, would be protected.

Whilst non-Māori were involved in the rangahau as participants, Māori voices were prioritised. There have been questions in academia about the non-indigenous involvement in kaupapa Māori, Smith writes about leaving space for non-indigenous involvement to support Māori outcomes. It has been highlighted for the support of Māori outcomes; it is necessary for non-Māori to be treaty partners. If non-Māori have the desire and correct intentions to uplift Māori, then those voices should also be raised, as they can be allies (Smith L. , Decolonizing Methodologies, 2012). There is the benefit in bringing in non-Māori perceptions to further understand the 'truth' where "multiple and different interpretations can be valuable simultaneously" (Brayboy & Deyhle, 2010). While it is not standard practice or tikanga to include the view of non-Māori in kaupapa Māori methodology, engineering is a space which has limited representation of Māori, therefore those voices must be included. It was difficult to find literature in engineering where kaupapa Māori methodology was successfully integrated with western methodology. Therefore the conjunction of Māori and non-Māori voices were reflected in this and embraced rather than denying the diversity in engineering (Smith G. , 1997).

Sails -Methods & Analysis

To assist a waka hourua to move, the sails must catch the wind, but only when the boat is sailing directly downwind. This rangahau depicts methods and analysis as the sails in supporting the waka hourua to move in a direction closer to the destination.

Method

The research used a mixture of quantitative and qualitative methods of collecting information. There is not a singular method used in kaupapa Māori research. To achieve high quality research, appropriate methods were used to fulfil the purposes of this study, it involved repurposing western methods.

The use of quantitative data can provide insights into concerns and areas of interests of a community or group, but it is the groups, their selves who are the experts in determining their own solutions (Smith G. , 1997).

There were two study methods conducted simultaneously to form the focus of this thesis. This rangahau method used the survey method to evaluate engineering students' perceptions and teaching practices of te ao Māori content delivered in engineering lecturers. Whereas, the other study method analysed Māori views of engineering, which involved methods of whakawhiti kōrero/ interviewing rangatahi Māori engineers and their perceptions and experiences as Māori in engineering and education. Both methods were important in understanding the different points an engineer must go through during their journey. The rangahau also analysed non- Māori perceptions, as their relationship with Māori culture at all points in the engineering journey is important to include as they have the potential to support or dismiss Māori in engineering further in their careers. Throughout the rangahau pūrākau was used in aligning the research to kaupapa Māori methodology. The methods are centred in aims to strengthen the confidence of Māori in engineering and the contribution engineering education can play in enabling this.

Survey method on te ao Māori content delivered in engineering lectures

This rangahau utilised survey methods in attempts to understand student perceptions of responding to and including Māori perspectives within engineering and evaluating how effective the implementation of te ao Māori education in engineering was. The overview of questions asked in the survey are seen below, and the specific questions asked are seen in the Appendix C.

- What are the engineering student's familiarity in current education with regards to Māori culture and beliefs?
- What are the student perceptions of the necessity of including te ao Māori?

- Do students understand the connection of Te Tiriti o Waitangi (The Treaty of Waitangi) and engineering.
- What were students' perceptions of the course, and any suggested improvements.

The survey was delivered via Surveymonkey and was advertised to students at the end of the course delivery for students to voluntarily participate. The consenting process was explained at the beginning of the survey. The surveys were designed to be quick, taking an estimate of eight minutes to complete.

Kaupapa Māori methodology: Pūrākau

This rangahau invited participants to share in pūrākau related to experience in engineering and education in accordance to our cultural values and beliefs. An integral component of this research is the use of pūrākau. Unlike traditional western research, pūrākau encourages our cultural ways of reviewing, relating and researching traditional and contemporary knowledge and beliefs (Pihama, Campbell, & Greensill, 2019). Unlike other studies where pūrākau has been used in a historic sense, this research uses pūrākau methodology as an analysis and method (Morrison & Kaio, 2021).

The history of engineering with Māori has caused conflict in the past and is likely a contribution for fewer Māori being in the engineering space. The literature review highlighted the limited views of te ao Māori in engineering, and even less literature for Māori in engineering education. It is for this reason pūrākau methodology has been chosen to elevate and reposition the voices of Māori that are in engineering, whose voices have been marginalised and oppressed by the dominate culture historically (Lee J. , 2009). Pūrākau is a process of Māori narration, which connects stories from Māori oral literature, histories, and experiences. In this thesis pūrākau is used to explain some of the experiences of Māori engineering and theories of how to achieve te ao Māori effectively in engineering education (Smith L. , 2012; Cavino, 2019).

Whakawhiti Kōrero

To achieve the aim of this study, it was important to explore the experiences, views, and perceptions of Māori engineers. Whakawhiti kōrero was used as an additional method in this

study. Where whakawhiti Kōrero is the exchange of ideas and discussion, or in traditional western research its semi structured interviews (Elder & Kersten, 2015).

This method, in addition to cultural practices were to prompt a culturally safe environment to invite participants to share their whakaaro and prompt more conversation. The practices involved opening the whakawhiti kōrero with karakia, prayer which supports the opening of the conversation. Introductions in the form of whakawhanaungatanga were used, where there was an emphasis on the linkages of connection between participants and researcher. The consenting process occurred through a kōrero about the research, and the reasoning for the interviews. Information sheets and consent forms were shared with the participants. Ideally, the whakawhiti kōrero would be kanohi ki te kanohi the interviews were held on MS Teams (online). Although, due recruitment of participants through whakawhanaungatanga, and prior connections in the engineering industry, participants preferred online interviews. Participants had the option of recording the kōrero. The whakawhiti kōrero took place individually to ensure each participant could speak freely and were not influenced by others. This was important as the conversations needed to be about their lived experiences, a list of prompt question scan be seen in Appendix B. Due to interviews being unable to take place kanohi ki te kanohi, this impacted on the tikanga of sharing kai. Alternatively, participants and researcher were invited to a shared kai as a group, where participants received their koha in the form of vouchers and transcriptions were returned as a taonga to show appreciation of their whakairo. Returning the transcriptions provided the participants the opportunity to review and correct any of the kōrero. Once participants made any necessary changes, data analysis was able to begin.

Analysis - Content Analysis

Due to their being a mixture of results collected from surveys and whakawhiti kōrero/ interviews, there was a mixture of data which had to be analysed. Content analysis uses coding to determine patterns and trends as a way of disseminating data. Content analysis is a dissemination approach which can be applied to qualitative and quantitative data (Franzosi, 2008).

In this research, key ideas were themed, however it was important to value the narrative of all participants involved in the research. This was done by ensuring the kōrero shared by the

participants were not deconstructed to maintain the mana of what was being said. As a result, the kōrero results were not compared between participants, rather the analysis took place on the individual kōrero. Therefore, content analysis in this research was influenced by pūrākau. Traditional scientific research often fails to contextualise historical and contemporary events and experiences that determine indigenous realities and experiences so it was important this kōrero was not lost (Wilson, Mikahere-Hall, & Sherwood, 2021).

Through the research, the themed ideas were not compared rather supplemented each other to elevate the whakairo. This was influenced by the principle of whakapapa, and in this context 'the process of layering one thing upon another', where history and experiences were able to be acknowledged (Mahuika N. , 2019).

Hoe tere, the steering paddle – Ethics and Tikanga

Prior to the starting this research, it was important to ensure the ethics and tikanga was aligned with kaupapa Māori methodology. The research tikanga and ethical practices which have been upheld in this research include:

- Aroha ki te tangata: A respect for people—allow people to define their own space and meet on their own terms.
- He kanohi kitea: It is important to meet people face-to-face, and to also be a face that is known to and seen within a community.
- Titiro, whakarong kōrero: Looking and listening (and then maybe speaking)—develop understanding to find a place from which to speak.
- Manaaki ki te tangata: Sharing, hosting, being generous.
- Kia tupato: Be cautious—be politically astute, culturally safe, and reflective about insider/outsider status.
- Kaua e takahia te mana o te tangata: Do not trample on the “mana” or dignity of a person.
- Kia mahaki: Be kind and humble—do not flaunt your knowledge; find ways of sharing it (Pipi, et al., 2004)

These ethical practices summarise an approach reflective of te ao Māori engagement with people and knowledge and forms the basis of this research (Awekotuku, 1991).

These practices required the research to reflect on the research methods which hold power imbalances for indigenous. By actioning the principles, to attempt to mitigate and minimise the imbalances and strengthen Māori, in the methodology in addition to the research itself.

There have been generations of distrust built between Māori and academic research; many indigenous research have highlighted this (Smith L. , Decolonizing Methodologies, 2012).

Taking into consideration the power imbalance of Māori in research, and the layer of Māori in engineering, I attempted to break down some of these preconceived ideas through whakawhiti kōrero, by leveraging on the established values of this rangahau, mainly whanaungatanga. Whanaungatanga used to building rapport and connection between the author and the participants and allowed space to share aspirations of this rangahau while understanding what the participants would have like achieved in this rangahau. The aim was to elevate Māori voice in engineering and engineering education.

Tikanga of the research was not only held in the investigation, but also is in the leadership of the research. A component which was important to consider was representation of Māori in the supervisory team, this permitted the researcher to embed cultural safety into the research for myself, participants and for seeking cultural guidance. Cultural guidance was also provided outside the supervisory team, though whānau and whanaunga connections.

Another consideration that was adhered during the writing and research of this thesis was the practice of karakia by the researcher prior to commencing any work involving this thesis and before moving onto other tasks outside this research. This was advised by whanaunga to protect the researcher and the hauora of researcher, due to the significance and toll this research could had taken on the researcher, this research could had been very isolating if adequate practices and support were not implemented.

In following the University's guidance participants were provided with information sheets and consent forms, where participation was voluntary. All information from participants were anonymised and with removal of any identifying features. The study was approved by the Human Research Ethics Committee of the University of Waikato under HREC (HECS)2022#10.

Waves – Limitations

When confronted with heavy waves in the ocean act as challenges, the waka must flex and move with the wave. Wave formations can offer insights into proximity of island destinations. Similarly, understanding the limitations of this rangahau can support other kaupapa and provide insights of this kaupapa to explore in their voyages (Pokapū Akoranga Pūtaiao, 2020).

This rangahau had limitations which must be acknowledged, the most prominent limitation is the number of participants both in the survey, and through the semi-structured interviews. Not only was there a lack of Māori participation in the study, which was partly due to the method of data collection, but also due to the lack of Māori representation in engineering. There are numerous articles which explain the long decline of Māori participation in surveys and questionnaires as a result of the historic distrust held towards those involved in forming the surveys. Historically, Māori have been counted and classified in data, leading to ownership issues around the data and information misuse and used inappropriately (Te Ara, 1966).

Māori representation is low in engineering, therefore resulting in access to a small sample pool, this is due to Māori being discouraged from fields like engineering and pushed into trades or menial work. This stems from colonisation of Māori where mission schools were to provide industrial training and labouring on the land for the objective of “prepar[ing] Māori for a future as a labouring underclass” (Walker R. , 2016).

Participants of this study were voluntary, and likely a contributing factor as to the number of participants who were involved in the survey. For surveys to achieve equal explanatory power for Māori and non-Māori, it is necessary to be able to recruit equal numbers of Māori and non-Māori participants, with representative samples of both groups (Fink, Paine, Gander, Harris, & Purdie, 2011).

Wind - Māori aspirations

Wind in this Waka Hourua framework represents the aspirations Māori have in Aoetaroa which carriers some of the motives and reasoning for this rangahau to exist.

While whānau-centred processes recognise the importance of maintaining the wellbeing of the collective whilst meeting the needs of its individuals. This framework considers the wider Māori

community aspirations, in considering the wellbeing of the Māori engineering community. A study conducted with Māori across the motu, to understand the desired outcomes over the next 20 years including (Te Puni Kōkiri, 2023):

- Ko Au – identity and culture
- Rangatiratanga
- Language
- Identity
- Treaty of Waitangi
- Cultural connectedness
- Mana motuhake
- Nga Rawa – strengths and resources
    - Stable career pathway
    - Skill development
- Whenua and Te Taiao
    - Technological innovation
    - Information
    - Data
    - Financial security
- Ngā Hiahia o te Oranga- Essentials of wellbeing
    - Education
    - Health
    - Housing

These outcomes are the aspirations that will move the waka hourua with help of the navigators in a direction of the destination. Although not all these aspirations will apply to this rangahau, this rangahau is a part of the wider kaupapa in realising these aspirations in Aotearoa to support Māori culturally, socially, and economically.

Destination – vision

The destination or the vision of this kaupapa and reason for this rangahau is to promote Māori education in engineering to ensure the journey of te ao Māori engineering brings everyone on the waka, which in turn can support in building the engineering system for Māori, when previously the system has not.

Whakarāpopoto: Chapter Summary

This thesis research prioritises Māori in its questions, methods, processes, and dissemination. This rangahau follows He Waka Hourua framework anchored by Kaupapa Māori methodology. The research is controlled by Māori, conducted by a Māori researcher, with support from a co-governed supervisory team and with Māori participants. The research does consider te ao Pākehā, however the way the research has negotiated te ao Māori as the priority, in a space and industry where Māori haven't been well represented. It is understood to navigate some of the findings, there is the requirement to have te ao Pākehā views in understanding how these impacts on Māori in engineering and their mana. The method and methodology were not a prescribed set of methods but rather about how research was framed; It focuses on generating solutions and aspirations from within Māori experiences. The following chapter outlines the findings and results.

Chapter Five: Chartering the moana - Results

He Waka Hourua was the selected research framework which guides the rangahau in its navigation of enhancing mana of Māori in engineering. When charting the oceans or moana is a waka, its fundamental to understand to understand what's below the water's surface. With this analogy it is applied to the findings of the rangahau.

This rangahau study draws upon data gathered collected from 47 participant surveys from engineering students and three in-depth whakawhiti kōrero with Māori engineers in industry aimed at gaining a comprehensive understanding what the experiences of Māori in engineering.

Section One: Survey Results

The surveys were designed to capture a wide range of perspectives and experiences from engineering students with their interaction with te ao Māori. Participants included engineering students enrolled at the university of Waikato in any of the offered papers (courses) in the ENGENX70 series, which had an added component of Māori education facilitated by a Māori engineering lecturer, comprising of approximately 3 lectures. The ENGENX70 series provide engineering students with development of soft skills required for the engineering profession. The papers are considered for students to partake in the survey were required to be enrolled in the ENGENX70 papers. They are titled Engineering and Society (ENGEN170), Engineering and Business (ENGEN270), Engineering and the Environment (ENGEN370), and Engineering and the Profession (ENGEN570).

This section of this rangahau presents the key findings to understand engineering students' appetite of te ao Māori education, this would later support findings from Māori engineering experiences to paint the picture of what it's really like to be Māori in engineering. The survey questions and responses addressed:

- Engineering student familiarity with regards to Māori culture and beliefs
- Student perceptions regarding the relevance between Te Ao Māori and engineering
- Student experience in te ao Māori education in engineering

- Student perceptions regarding the necessity of including Te Ao Māori in engineering education.

To understand the participants, the survey presented questions to understand the profiles of participants involved in the rangahau. Approximately 12% of the students enrolled in the course (47 participants out of 390 students) participated in the survey. Of those 47 participants, seven identified as female, and 39 identified their selves as male, while one participant elected to not say.

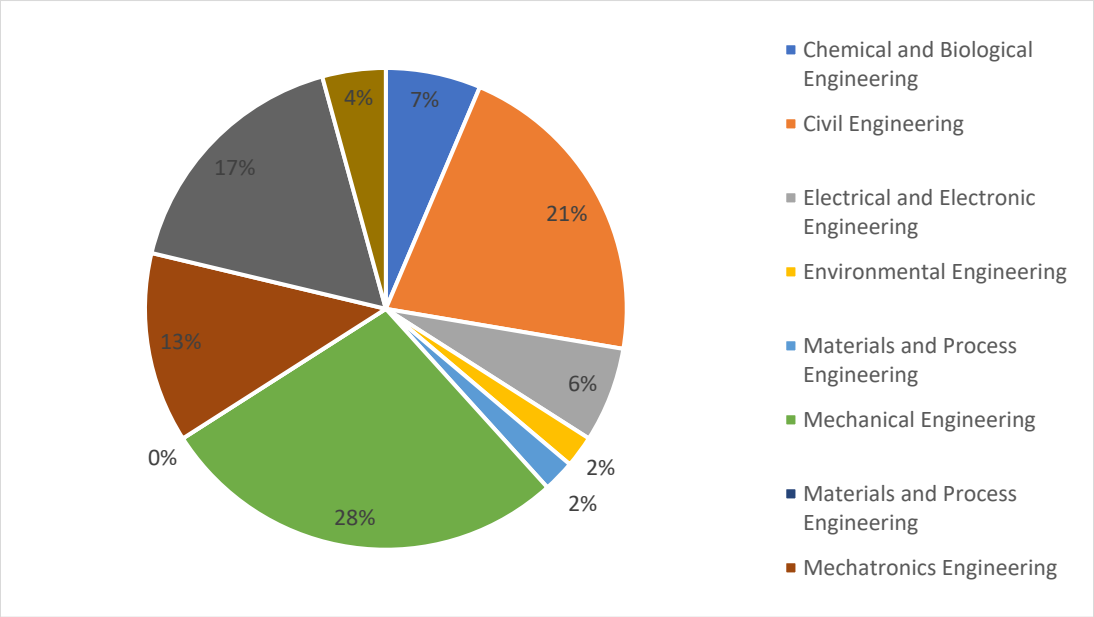

Figure 3 Survey participant engineering disciplines

The survey exhibited a range of participants who study in a variety of engineering disciplines, mechanical engineering being the most popular (28%), followed by civil engineering (21%).

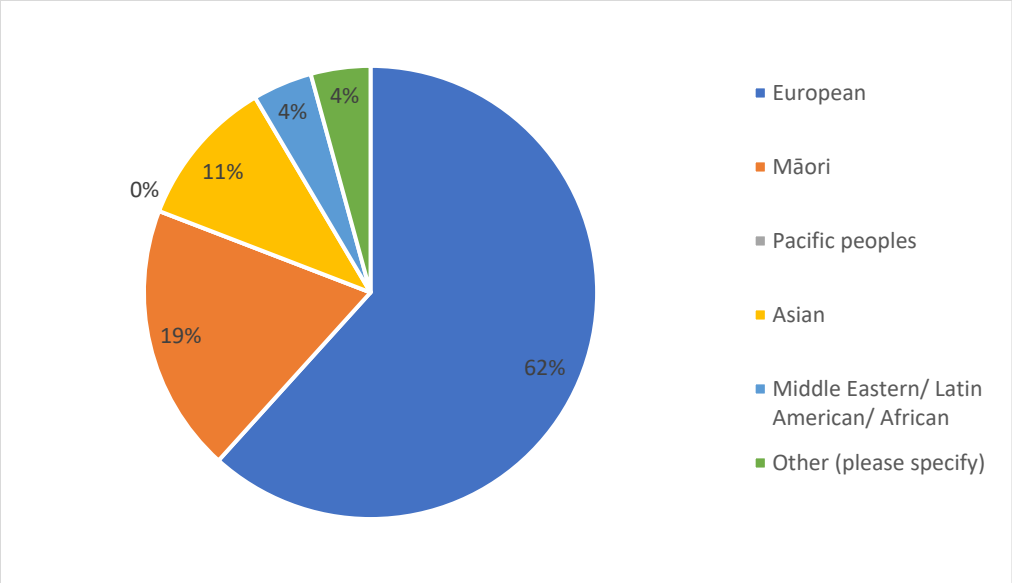

Figure 4 Engineering student main ethnic identities

It was observed majority of the participants identified as European (62%), Māori participants made up (19%), which is higher than the average percentage of Māori which participate in engineering. The responses from the survey were themed, to understand the general consensus of the students' perceptions.

Engineering student familiarity with regards to Māori culture and beliefs

To understand the student's familiarity with te ao Māori, it was essential to understand previous educational institutions where students have had access to these learnings.

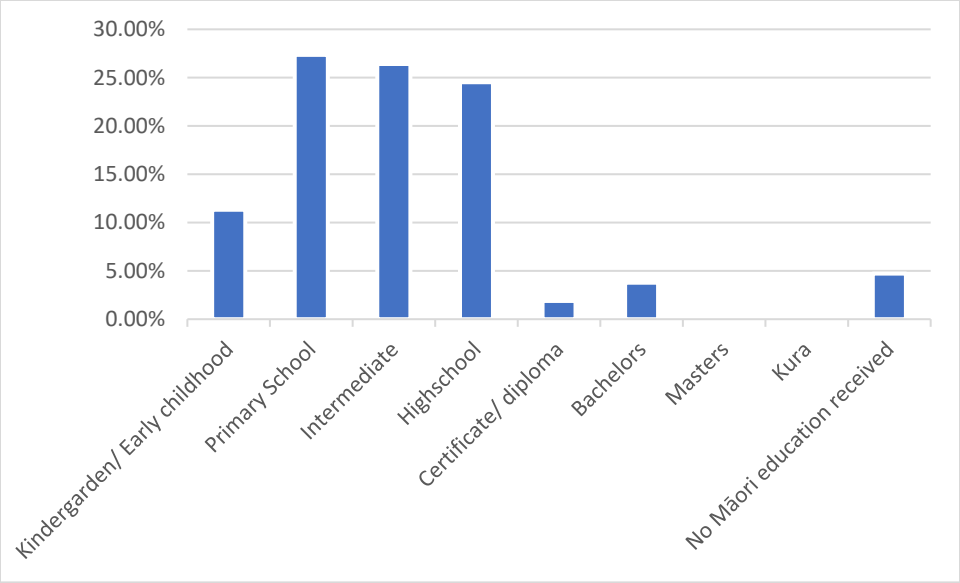

Figure 5 Engineering students previous Māori education sources

Figure 5, suggests the most prominent learning opportunity in te ao Māori education is in primary school (27.4%) and intermediate school (26.45%), followed by high school (24.5%). The history of te ao Māori in the education has a long-standing history, from the 1970's to today (Berryman, Kerr, Macfarlane, Penetito, & Smith, 2012). A particular policy which would have had implications on the participants who were involved in this survey world be the Ministry of Education Māori education strategy in the 2000's, which brought about policies such as te reo Māori professional development for primary school teachers. In 2005, for te reo Māori professional development, programmes were implemented to enable primary school teachers to increase their understanding and respect of Māori culture, and support teachers in second language teaching and learning strategies. The programmes improved the confidence of teachers in tikanga and te reo Māori, which also extended to achieve wider school implications, which were likely experienced by the survey participants in their primary school education curriculum (Murrow, Kalafatelis, Fryer, Hammond, & Edwards, 2007). This assumes the students undertook New Zealand education learning, however 4.7% of students noted that they never received te ao Māori education. However, the survey did not examine whether or not students had undertaken their studies in New Zealand or overseas prior to enrolment in engineering at the University of Waikato. This leaves the question open as to whether the participants studied overseas or the schooling which they undertook in New Zealand did not include te ao Māori education, but given

a proportion of engineering students are international students or arrived here partway through high school it is likely to be the former.

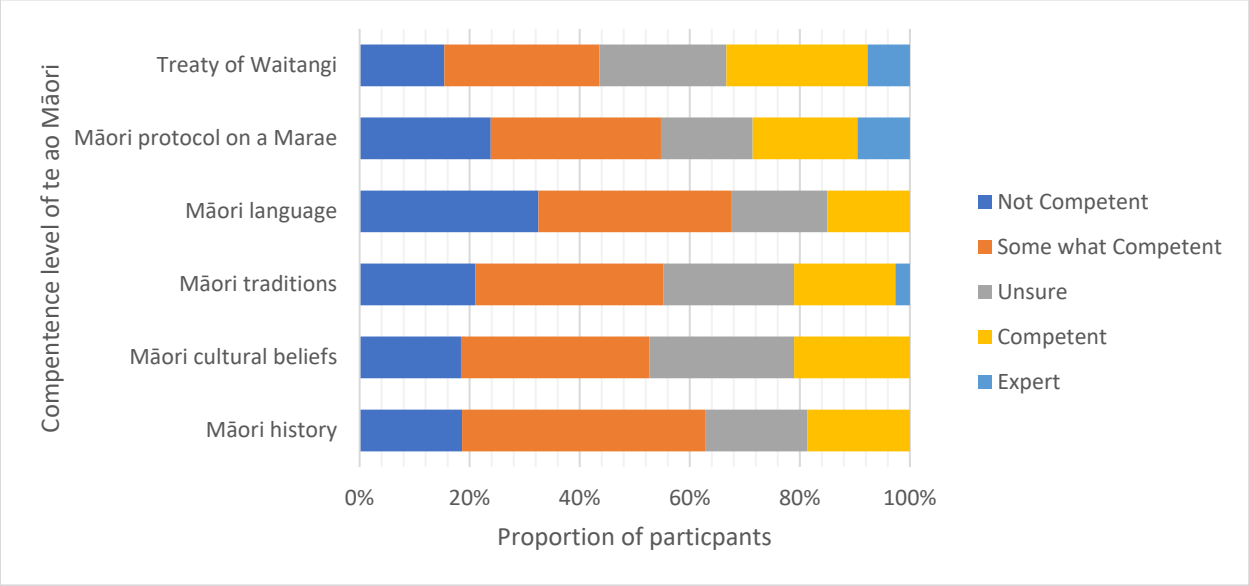

Figure 6 Māori topics included in previous education.

The students self-evaluated their level of understanding of te ao Māori (Figure 6). The majority of the students did not feel that they were an expert in te ao Māori content, although 26% of the participants believed they were competent in Treaty of Waitangi and 28% thought they were somewhat competent. Similarly, 31% and 35% of participants felt they were somewhat competent in protocol on a marae and Māori language. The topic of Māori language had the highest rate of students feeling they were not competent at 33%. There were 10% of participants that evaluated themselves as having an expert level of understanding on marae protocol. Many of the participants had evaluated themselves with high competency, however there were many responses noting:

> *"I knew barely anything, so pretty much everything was new."*

Student perceptions regarding the relevance between Te Ao Māori and engineering

The survey provided areas for students to respond to in their understanding of the relevance and connection of te ao Māori in engineering (Figure 7).

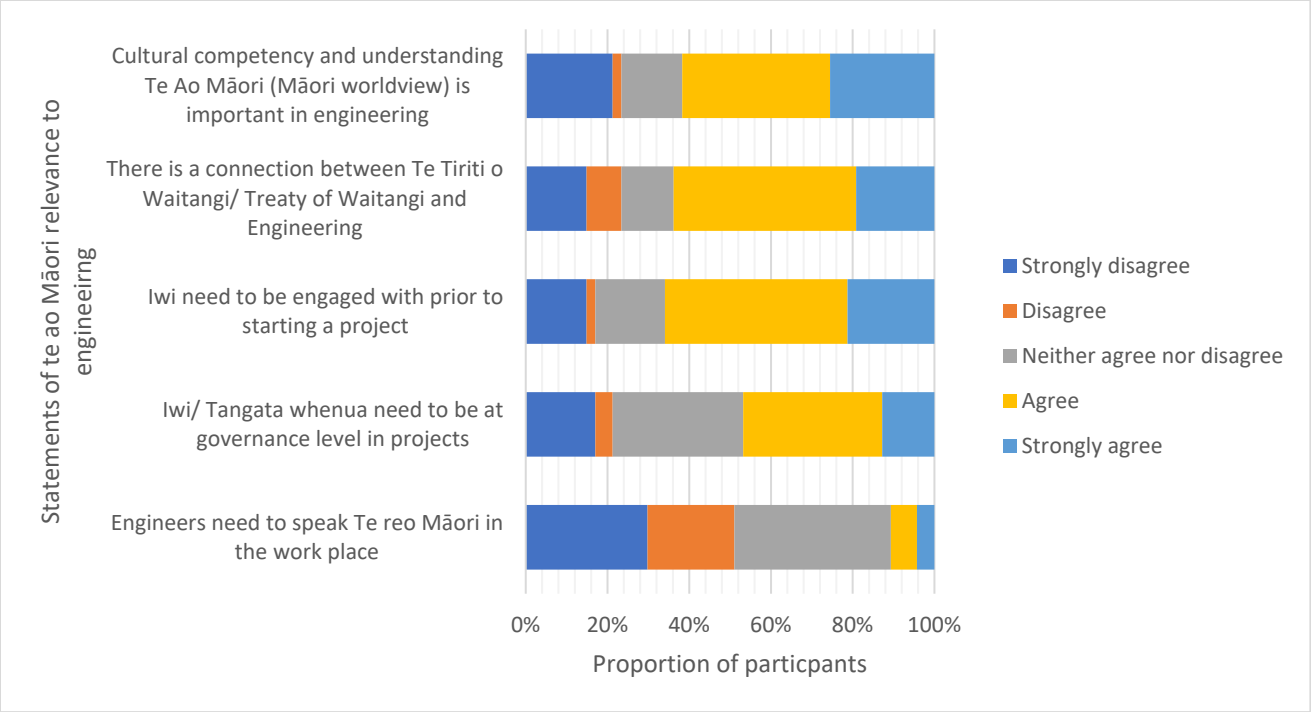

Figure 7 Engineering students' perceptions regarding statements about te ao Māori in engineering.

The survey results suggest that participants mostly agree with all the statements, however the statement 'Engineers need to speak te reo Māori in the workplace' appears to have the most variability, where 38% of participants neither agree nor disagree, while having the highest strongly disagree response rate of (30%). Whilst some of the feedback received noted

"Include more vocabulary that can be used in official engagements".

There were four similar statements regarding the use of te reo Māori for curriculum improvements. The statement 'Cultural competency and understanding te ao Māori (Māori worldview) is important in engineering' exhibited the highest response rate for strongly agree of (26%), this view also came through in suggestions for curriculum improvements,

"Extend on the current protocols needed especially in the Waikato with new projects."

The statement 'There is a connection between Te Tiriti o Waitangi/ Treaty of Waitangi and Engineering' saw (45%) of the participants agree. Students understood the history of Te Tiriti o Waitangi, however comments similar to,

> *"Spoke on impacts of Māori relationships, outside directly land related issues and examples (i.e. examples are only truly useful for civil, and environmental engineering. The software, mechanical, mechatronics engineering left a bit confused as to why this was completely relevant to projects, they may work on)"*

The respondents appeared unable to grasp the connection of Te Tiriti o Waitangi specifically to their engineering discipline. The figure shows (45%) of respondents agree with the statement 'Iwi need to be engaged with prior to starting a project'. Participants detailed iwi engagement as significant factor of enjoyment in the course while seeing the relevance to the role in engineering. Participants shared comments such as

> *"The levels of engagement, and why consultation is an undesirable alternative to engagement".*

> *"The full importance of engagement to Māori on a personal and official level and the effect of Māori beliefs on everyday things including engineering practices".*

> Few participants commented that they have the desire to further learn more regarding iwi and Māori engagement.

> *"The diversity across iwi. How protocols, beliefs, and history have shaped iwi into what they are today and how they operate."*

and

> *"Workplace interaction, and relationships."*

Similarly, the statement 'Iwi/ Tangata whenua need to be at governance level in projects' had a high agreement between participants where (35%) agreed and (13%) strongly agreed. Although this statement did not have a distinct defined opinion as (32%) of participants neither agreed nor disagreed.

Student perceptions experience in te ao Māori education in engineering

Student perceptions of the education delivered were evaluated from their experience, specific areas of enjoyment, and improvements to the course (Figure 8). Overall students had a positive

experience, where they really enjoyed (45%) or were satisfied (30%) with the course, while (10%) of students claimed they had a terrible experience.

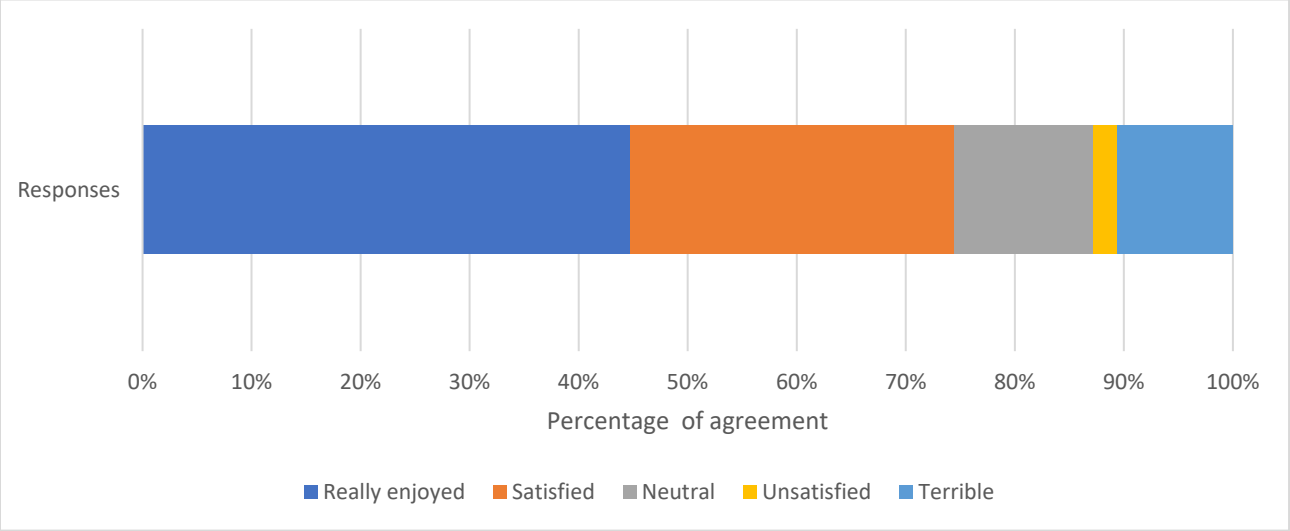

Figure 8 Engineering Students experiences during te ao Māori education in engineering.

There appears to be two features which contributed to the positive experience, the teaching style and content delivered.

Respondents shared the lecturer style was *"chill"* and more relaxed, which promoted conversations.

> *"Enjoyed the engagement, group conversations and open questions. [the lecturer] made us think by actually asking the class and waiting for answers."*

The participants also made mention to the interactive activities which assisted in the facilitation of learning,

> *"I like the way that it's not a lecture, discussions were great, loved the wharenui build."*
>
> *"Really enjoyed how engaging and compassionate [the lecturer] was when taking out lectures as delivery is extremely important. [the lecturer] did an excellent job on delivery as people felt involved and a safe space to ask questions was formed. However, it takes different people different amounts of time to adjust/learn that these can be safe spaces*

so since we only received 1-3 lectures per year, this is very likely not enough time to create a safe space to discuss kaupapa."

The survey indicated interactive activities are important in the students learning experience. A theme indicated by the participants to better the course was furthering interactive activities.

"More Māori interactive games to learn names and words."

Participants mentioned a variety of content topics which they enjoyed throughout the course the main themes were te reo Māori; pūrākau; tikanga and powhiri; iwi engagement; Te Tiriti o Waitangi/ Treaty of Waitangi.

"Speaking/hearing te reo Māori pronounced correctly was a nice change (more importantly, an actual effort to correct where spoken wrong). The doctrine of discovery was quite intriguing."

"The purpose and meaning behind many pūrakau I found quite interesting and insightful."

and

"The foundational principles of Māori are shared across iwi, hapu, and whanau, but how it is practiced and what it looks like varies."

Some of the kōrero shared from participants was that the students struggled with understanding the connection to engineering, or to make the course more aligned to engineering.

"How does this actually relate to anything engineers do?"

"Spend more time focusing on what my future will look like incorporating Māori culture rather than the history of it."

"There is a lot of talk of partnership and engagement in the Māori series, however it feels like the Māori content is separated from the rest of the content rather than being woven into it."

A participant had shared that they would like to understand the impact engineering and had also acknowledged the short time currently dedicated to Māori education in engineering was the result.

> *"A more comprehensive view on the engineering impact and influence on Māori … Maybe a dedicated paper so that there is plenty of time to cover a range of topics early in the degree so that thinking regarding Māori is acknowledged and considered from much earlier."*

The majority of the improvement suggestions of the course was for the course to be longer than the allocated lectures, as students felt rushed, had the desire to learn more, and for the course to be earlier in their degree.

> *"If I wasn't Māori I for sure would need longer than that to feel comfortable to ask questions about a culture other than my own as I would not want to offend anyone by asking inappropriate questions - and I would have a million questions."*

> *"More of it. And I know that's hard cause I wouldn't know where to start / what to include but an annual one-hour lecture is not enough. Incorporate Te Ao Māori / Mātauranga Māori into the X80's design papers would be a good start - similar to what was done for the mechanical 581 students."*

Student perceptions regarding the necessity of including te ao Māori in engineering education.

Many of the participants shared that they would like the course to be longer, allowing the students to get a greater breath of te ao Māori in engineering, in addition participants shared their opinion of this content to be fundamental in the curriculum.

> *"…If anything, I would just like to do more in this space as I think it is such a crucial aspect of engineering in Aotearoa."*

> *"Maybe a dedicated paper so that there is plenty of time to cover a range of topics early in the degree so that thinking regarding Māori is acknowledged and considered from much earlier."*

Students had raised concerns of te ao Māori becoming a tokenistic activity.

> *"Having a set of Māori lectures is nice, but to truly convey te ao Māori and mātauranga Māori I believe a stronger move would be to have papers convened by Māori (engineer) lecturers. That way, rather than a handful of "Māori lessons" in a paper you could have a paper where mātauranga Māori infuses the whole paper. Any of the 70 series papers may be suitable for this. Course material may not necessarily be all that different, but if we are trying to teach a Māori worldview then teach the normal material through that lens. Otherwise, it is merely a check box exercise."*

There were some comments from participants noting,

> *"Not during engineering studies. This should be done at high school."*

In addition to two strong opinions which shared that they were very anti including Māori curriculum in engineering.

Section Two: Whakawhiti kōrero

This rangahau leveraged on whakawhiti kōrero with three Māori engineers in the engineering industry. The key themes of their kōrero were,

- Learning and education
- Perceptions of te ao Māori in engineering
- Experience in engineering
- Suggestions for engineering in te ao Māori

Learning and education

The participants all went through education in the mainstream western system, all sharing they had interests in arts subjects. The participants noted that the learning style which suited them was,

> *"I learn with hands and by doing"*

and

> *"I like seeing how things are done, and understanding the big picture of how things work"*

The participants also said that they work best when they are in a group,

> *"People that think like me and you know that I like me and that I'm not saying that's predominantly mildly people or polys, but it always ends up being Māori. People in Polynesians cause we just work this in the bouncing off each other's space and the support network rather than alone, which a lot of skills make you learn that way as a loan and not having that support network."*

Perceptions of te ao Māori in engineering

Participants were asked about their perceptions of engineering, where many of them didn't have much previous knowledge about engineering, besides 'stereotypes' for engineering,

> *"[I] knew [an engineer] had to be good at maths."*

Similarly, others commented,

> *"I thought engineering was for smart peoples and thought I couldn't do it."*

Although participants shared, they thought it was something they could not do, they believed,

> "*Māori belong in engineering."*

All the participants indicated that they thought Māori are naturally good engineers;

> *"Māori are natural engineers, we are strategist, long-term thinkers, problem solvers, supportive with manaakitanga. I think engineering in an ao Māori context encompasses a holistic view to engineering, we think about the environmental impacts alongside the technical components."*

while, noting they thought the current engineering practices were heavily influenced by western perspectives.

> *"I think the way that we do [engineering] is quite It's heavily influenced by the British of the European way of being."*

The participants pointed out,

> *"[Non- Māori engineers] need to understand the tikanga of engineering."*

One of the participants shared their view of engineering and the purpose of it, from his view as a Māori,

> *"How can we make things for or create things for the community? Because we're not just creating it just for Māori people, we're creating it for all living, all people that inhabit New Zealand and for the land."*

In addition to another participant communicating the responsibility of engineering to

> *"Give back more than it will take away from papatūānuku the earth mother, it's like we borrow the land from our children."*

The participants were asked for their view on the connection between Te Tiriti o Waitangi and engineering. Two of the participants shared that they are on a journey in understanding Te Tiriti o Waitangi and the Treaty of Waitangi, as they had not been exposed to it before. They understood translation losses between the versions, however due to their limited knowledge on this history they found it hard to comprehend and share an opinion. Participants mentioned,

> *"It would be really great if [engineers] would know [*Te *Tiriti o Waitangi]. It would be awesome. That would show true partnership, true understanding."*

Experience in engineering

Participants were asked about their perceptions of engineering, where many of them did not have much previous knowledge about engineering, besides 'stereotypes' for engineering,

> *"[I] knew [an engineer] had to be good at maths".*

Similarly, others commented,

> *"I thought engineering was for smart peoples and thought I couldn't do it."*

The participants all shared they have all had experiences which have been challenging as a result of being the Māori, and shared they found comfort when they were with other Māori,

> *"I don't remember many Māori in the space I worked in."*

> *"…be that brown person."*

A participant had shared where they felt comfortable in the engineering environment,

> *“Bathrooms and, you know, it's a kind of a safe space, no hierarchy and would make friends in those spaces.”*

All participants said they were often called upon for any cultural work, including cultural advisory work, translation work, or for caring for other Māori in their spaces.

> *“It’s not in my job description, only cause I'm Māori I get asked for cultural tasks. Like I'm noticing now, I'm doing a lot more of it. I don't mind it. I love just being involved and stuff, but I have noticed it. I'm slowly starting to do more Māori stuff.”*

One of the participants noted they were often advocating for Mana Whenua, and for other engineers to act in the interests of them.

> *“So I felt like I had a lot of money to do to bring people on board and it was just hard. It was very difficult, and I was the only Māori in my particular space.”*

All participants shared feelings of difficulty while being Māori in engineering,

> *“I felt like I am too much of an activist for these spaces. I cried a lot last year.”*

> *“I agree I am sometimes a bit rogue and a bit intense with being Māori and advocating for this space.”*

> *“I didn't join this to be tick box. I joined it to make an impact.”*

A participant felt engineering,

> *“Strips away my normal way of being.”*

The participants shared that at one point in their engineering journey they have felt they tokenistic or like they are there to tick a box.

> *“My thoughts on ao Māori and te reo Māori in the engineering space is we need more of it. I like to use the term ao Māori rather than te ao Māori because the latter doesn't seem to account for multiple Māori world views. I think we need to be less tick box in our approach to bringing ao Māori and reo Māori into the office.”*

Yet, participants highlighted good experiences in engineering when they can be their selves, have supportive managers, see Māori in the organisation and around them.

> *"What's really helped me is, that I have two managers which I absolutely love. One is Māori. My other manager, she is not Māori, but her husband is Māori. Her kids are Māori, and I think having people who are Māori or think like Māori, helps me."*

Another aspect which participants touched on that have helped them feel like they belong in engineering is when there is access to cultural competency in organisations,

> *"It gives you a sense of belonging as well that people are learning about your culture and wanting to make a change and themselves and wanting to help you as well."*

Suggestions for engineering in te ao Māori

Based on the participants experiences, they gave suggestions for engineering, their opinion and ideas which can help Māori in engineering and the alignment of engineering to te ao Māori,

> *"Cultural competency courses."*
>
> *"Well, I think the um like stuff like [cultural competency training] where it's engaging. Where you have to actually do your own research and stand up and talk about it instead of sitting down listening, not good for a lot of people."*
>
> *"Changes to reflect Māori."*
>
> *"[Engineering] understanding the treaty".*
>
> *"If there isn't a strong Māori lead in projects then [engineers] can sometimes miss the mark. Adding Māori leads into projects, who have a strong understanding of 'whats best for mana whenua and iwi can really elevate the effectiveness of bringing an inclusive space into the industry for Māori."*
>
> *"Look at the past Māori technology and engineering skills."*
>
> *"I think we need to be less tick box in our approach to bringing ao Māori and reo Māori into the office. I think we need to bring Māori core values into the engineering industry,*

like whakawhanaungatanga, maanakitanga, etc. At the moment I am happy with the karakia but we need to do more."

"How can we make [Māori] feel welcome? How can we make [Māori] feel like they wanna do [engineering]? How can we provide a safe space for [Māori]? How can we see more Māori in here? Because this is really important. Māori, we're creating the infrastructure for the country. You know, we need more Māori in these spaces. But yeah, I think we need to create supportive, inclusive spaces for them to come into."

The participants recognised there were few Māori in engineering,

"I also understand like the reality of the world that we're living in right now and that that's gonna take, like, generations and generations of working towards it."

Participants proposed a wero – a challenge to Te Ao Rangahau

"Te Ao Rangahau needs to do more."

"Te Ao Rangahau should be pushing the industry to be culturally competent and show acceptance of Māori culture."

A participant shared their vision of engineering and the environment they want to be a part of

"Facilitating a space so that Māori feel like they don't need to need to be anything else".

The participants also mentioned,

"Universities and organisations need to be set up to enable us to fit in."

Whakarāpopoto: Chapter Summary

The findings from the surveys and Whakawhiti Kōrero found an overall response from both students and engineering professionals, encompassing both Māori and non-Māori individuals, that there is a shared desire to increase representation of te ao Māori in engineering, through the education provided at universities and within the industry.

The results obtained from Māori engineers indicate a clear preference for cultural competency being delivered to support in helping them feel like they belong. However, it is noteworthy that they encounter many challenges daily, particularly in establishing safe spaces within the engineering system. Additionally, Māori participants often bear the burden of invisible cultural labour, which can be emotionally taxing. These perceptions will be further explored in the subsequent chapter.

Chapter Six: The Voyage of Engineering – Discussion

This chapter presents in depth discussions of whakaaro presented from the surveys and whakawhitinga kōrero. This chapter will explore the themes of engineers needing to speak te reo Māori in the workplace; safe spaces in the engineering system; and invisible cultural labour.

It is important to establish that these themes are not exhaustive of the discussions held throughout the surveys and whakawhitinga kōrero, however they explore the knowledge related to the research questions in accordance with content analysis. In understanding that, it does not mean that whakaaro shared was not considered taonga, rather it could not be explored further due to the constraints of this thesis.

The approach used is intentionally focused on how engineering can assist in uplifting the mana of Māori within the engineering system. Thus, the array of themes presented relate to the research questions: ***How to uplift the mana of Māori within engineering? Can engineering education support with this? What is the role of Pākehā and Tauiwi engineers?***

This chapter may not present solutions or answers on how to solve these questions, rather it will explore the whakaaro further.

Section One: Engineers need to speak te reo Māori in the work place

“Our language wasn’t simply ‘lost’, although you will often see this euphemism attached to te reo Māori, implying that we simply misplaced it – how embarrassing for us. ‘It was stolen. Not the same. Not equivalent. Not shame.”- Anahera Gildea (Gildra, 2018).

In rough seas, a captain must warn the boating crew of the dangers ahead, this section of this thesis will be occupying choppy waters and must be navigated cautiously. This section must be read with care and read with the study in context. This section highlights risks for Māori and the possible detrimental impacts of assumptions placed on Māori, if not read with the understanding of these findings. This is to not represent all Māori thinking or perspectives regarding the topic of te reo Māori. If this section is misused or misinterpreted it poses the risk to furthering the colonising narrative and suppression of te reo Māori. As the author and captain, I ask you to tread

with care and aroha around the views of the participants, as I present my thoughts in understanding and unpacking the views of the participants.

In Chapter Five, it showed many participants from the survey disagreed with the statement 'Engineers need to speak te reo Māori in the workplace'. This section is informed by the survey results and supported by the experiences of Māori engineers. As an extension of the findings, this section serves as an investigation in understanding the participants opinions. A comparison was observed from those that identified as Māori and those who identified as another ethnicity other than Māori, who were then grouped as non-Māori.

It was found Māori participants and non- Māori participants had similar views of the statement that 'Engineers need to speak te reo Māori in the workplace' (Figure 9).

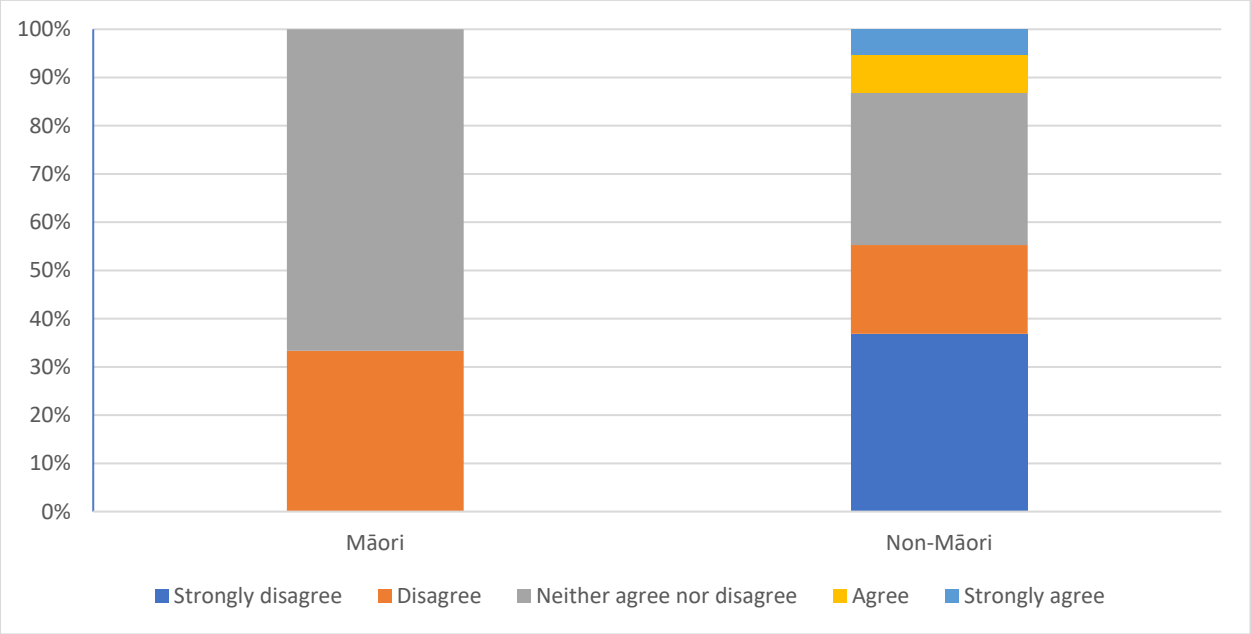

Figure 9 Opinion on 'Engineers need to speak te reo Māori in the workplace' based on identity.

I will first outline the purpose of presenting this particular statement to the participants and express the reasoning behind such an approach. The statement was posed, as a result of the increased use of te reo Māori I have noticed throughout the engineering industry since entering it, myself. Many engineering organisations are promoting engineering staff to participate in te reo Māori classes during work hours. There is evidence of the hiring decisions showing that individuals possessing te reo Māori skills is of significant advantage (Jackson & Fischer, 2007).

Engineering New Zealand adopting a Māori name - Te Ao Rangahau; Association of Consulting and Engineering (ACE) sharing articles like “10 Māori kupu every consultant and engineer should know” (Association of Consulting and Engineering , 2020); and engineering offices incorporating te reo Māori signage (Figure 10).

Figure 10 Māori signage in Engineering office

The engineering industry has moved in a direction of realising the importance of iwi engagement, and in honouring Te Tiriti of Waitangi obligations. (Te Waihanga- New Zealand Infrastructure Commission, 2023). Engagement with iwi and mana whenua has seen those with te reo skills highly valued and sought after (O'Rorke, 2022).

In New Zealand history there were major impacts of colonisation on Māori, where each event had its own ramification for the state of the Māori language including changing demographic of Aotearoa and how the majority of Māori language quickly became a minority language by the mid-1800’s. Legislation and law then cemented the suppression of the Māori, with a plethora of laws passed to actively disadvantage Māori. The Native Schools Act 1867 proposed ‘assimilating [of Māori] as speedily as possible’. The act led to active discouragement of using Māori language within school grounds and corporal punishment for speaking te reo Māori was enforced (Warren, 2017).

Te reo was continually supressed until approximately the 1970’s, where a group of Māori university students, Ngā Tama Toa, who themselves were denied opportunities to learn te reo Māori, petitioned to government to reintroduce te reo Māori into schools (Jahnke & Warren, 2023).

If it were a group of university students which advocated for this change, it was important to understand the view of engineering students and their appetite of te reo Māori alongside Māori education in engineering.

The survey indicated non-Māori participants had view of strongly disagreeing with the statement. It is evident the survey suggest Māori participants disagree (33%) or neither agree nor disagree (67%) with the statement of 'Engineers need to speak te reo Māori in the workplace'. There were no Māori participants which agreed with the statement which was an interesting finding. As there were only interviews with engineering professionals, I will have to make assumptions as to why Māori participants might have this view. There are two conflicting theories that may shed in supporting this view. Remnants of colonisation and te reo Māori being a taonga.

Remnants of colonisation

The remnants of colonisation of Māori language may be a reason for Māori participants to believe engineers should not speak te reo Māori in the workplace. Colonisation efforts were concentrated on oppressing Māori language. Te reo Māori faced many challenges, to the point of the threat of extinction. In the 1900's 95% of Māori were fluent in te reo Māori by 1960, that proportion decreased to 25%. This 70% decrease in such a short span of time was catastrophic for the language and has generational impact that can be seen today (Ministry for Culture and Heritage, 2023).

Furthermore, legislation and urbanisation were major factors leading the continued and perpetual disconnection of Māori to their language (Ministry for Culture and Heritage, 2023).

As a result, many whānau turned away from their language and encouraged their children to speak English because it was thought that 'they needed it for the workplace' reinforcing the idea that 'Kōrero Pākehā' (Speaking English) was seen as essential for progression. This disconnection to the language is all too common. (Ministry for Culture and Heritage, 2023). As a result, there currently exists a low proportion of people who kōrero Māori, about 7.9%, whilst a quarter of Māori can speak te reo (Statistics New Zealand, 2022).

The state of te reo Māori is a result of colonisation, its decline reflects the existing power structures of New Zealand (Warren, 2017). There are many generations of Māori who have felt

an immense disconnection to their culture due to the language being stripped from their genealogy (Tangatatai, Reclaim Te Reo (so our Tamariki don't have to), 2021).

In my immediate whānau, we cannot kōrero Māori. My nana was in the generation where the language was beaten out of them, my father never had the opportunity to learn, as my nana discouraged it. I have been in situations and experienced emotions while on my own cultural and te reo journey, where I have made mistakes or had an awkward conversation surrounding te reo. These experiences have often left me feeling ashamed that I cannot kōrero Māori - speak te reo Māori. There are a multitude of articles which expose the whakamā or shame Māori have felt when they cannot speak their native tongue (Burne-Field, 2021).

The inability to converse in te reo can exclude participation and belonging in Māori settings, 'The sense of shame experienced by those who are non-speakers is very real' (McIntosh, New Zealand).

Upon reflection of the survey results, perhaps Māori participants are one of those who feel whakamā, or maybe they still carry the generational trauma that te reo Māori is not going to serve Māori in being engineers. However, another view as to why the Māori participants might disagree with the statement is in relation to te reo Māori being taonga. Resulting in the participants view that sharing this with non-Māori may dilute the mana te reo Māori holds.

He taonga te reo Māori – Language is a taonga

In te ao Māori 'He taonga te reo Māori – Māori language is valued like a treasure', where the language is considered the lifeline and sustenance of a culture according to Pere (Pere, Nicholson, & Ao Ako Learning New Zealand, 1997). Te reo is recognised as taonga of iwi and Māori according to Te Ture mō Te Reo Māori 2016, Māori Language Act 2016, under section 16(2)(b). (New Zealand Parliament , 2016)

In addition to arguments acknowledging te reo as a taonga under Article II of Te Tiriti o Waitangi, where the expression "O ratou taonga katoa" covers both tangible and intangible things, all valued customs, and traditions. Although, Love (2004) notes te reo Māori is an aspect of wairua which stems from and is integral to the spiritual realm. It has a life force, a living vitality, and a spirit, suggesting te reo is much more than just a language. (Love, 2004). Crown agencies

of New Zealand acknowledge the language contains Māori identity and wellbeing (Hudson, et al., 2020).

The Māori language is both a communication tool and a transmitter of values and beliefs. Language is also a vessel for transmitting customs, valued beliefs, knowledge, and skills from one person to the next and from one generation to the next. It reflects the cultural environment and ways of viewing the world. It is a source of power and a means for expressing identity (Barlow, 1991). 'Language is the window to a culture and transmits the values and beliefs of its people' (Reedy, 2003). The phrase Taonga tuku iho refers to treasures handed down from ancestors, and similar phrases are said about te reo Māori. Barlow regards the Māori language as sacred as it was given to the ancestors by the gods, and so is a means to know the gods (Barlow, 1991). (Barlow, 1991; Ellis, 2016). "In time, such taonga do not just represent ancestors, they become those ancestors", where taonga are considered as living beings, part of the history and whakapapa of the whenua, land, and communities associated with them, similarly the same beliefs are applied to te reo Māori. Māori communities are considered fluid, as is the movement of taonga and te reo are passed from person to person, shared during ceremonial and occasions. As kaitiaki Māori do not consider taonga to be able to be owned, like our relationship with the whenua, we are here to look after them until we can pass them on to the next generation (Ellis, 2016).

As kaitiaki, Māori are obligated to oversee the use of taonga have and have the right to be consulted, where appropriate, to give consent for the use. Under a Waitangi Tribunal claim Māori are "entitled to prevent offensive and derogatory public uses of mātauranga Māori" (Waitangi Tribunal, 2011, p. 48).

To add, whakawhiti kōrero with a participant shared a finding,

> *"Te reo is a taonga and shouldn't be spoken in the engineering profession as it would lose its diversity."*

Essentially, the utilisation of our native tongue reflects our desire to be Māori and affirms our deep-rooted connection to our unique world and creation narrative (Warren, 2017).

It is important to remember that our deep and profound histories are entrenched in our language, and that Māori language institutions are sites of resistance to colonisation (Warren, 2017). Upon reflection of this deeper understanding of the Māori language, this poses the question should something so special be shared in the engineering space?

This is not very kaupapa Māori of me

This thesis draws from kaupapa Māori methodology, while considering this the theorising framework, upon reflection there was some pressure from supervisors to analyse the survey statement 'Engineers need to speak te reo Māori in the workplace', in terms of evaluating results by ethnicity. Kaupapa Māori methodology operates with the threads of inquiry, the first is based on self-determination and indigenous sovereignty, and the second is decolonizing knowledge and systems (Smith L. , et al., 2019). Self-determination and sovereignty focus on indigenous knowledges, methodologies, language and cultural revitalization, governance, wellbeing, philosophies, visions, aspirations and exercising indigenous rights. Decolonizing knowledge and systems focus on reframing the systems, engagement, and participation with systems with the crown, recognising indigenous rights, reconciliation strategies, social justice and wider social and economic transformations.

Kaupapa Māori assessment works to challenge, critique, and transform dominant educational perceptions of non-Māori (Rameka, 2021). The statement was posed to challenge the thinking of engineers in considering reconciliation strategies, and for Māori to exercise their rights of decisions in engineering and cultural revitalisation (Bishop R. , 1995). However, upon reflection there are several concerns that have arisen from the discussion including the system in which the statement was posed to Māori; and whether non-Māori should have a say in cultural topics related to decolonising engineering.

The system in which the statement was posed to Māori was an inappropriate method, through survey, which I shared limitations of survey methods in Chapter 4, in addition to the comparison of Māori versus non-Māori opinions of the statement, as kaupapa Māori methodologies acknowledge that the information shared must be accepted and valid, where in this case

comparing Māori to non-Māori could be suggested that once again non-Māori opinions are being privileged, diluting and weakening the argument which Māori hold.

The results of the survey also lay in preference of a non-Māori view, the method privileges Western methodology. In this case, the ethnicity comparison took place between Māori and non-Māori participants. Comparative studies offer a deeper understanding in conclusions drawn from results (Earl, Eckert, Bucciarelli, & Whitney, 2005). Comparative studies are a common practice in engineering stemming from Western science, as engineering is essentially applied science, although this is not seen in kaupapa Māori methodology (Eekels & Roozenburg, 1991). I was conflicted between whether it was correct practice in dissecting the evaluation results between Māori and non-Māori, as kaupapa Māori methodology is rights-based evidence, and comparative studies are evidence-based research. Comparing Māori to Pākehā or non-Māori are more often than not made in such a way that Pākehā appear 'better' or 'more correct' than Māori (Moewaka-Barnes, et al., 2012). It could be concerning if the author and researcher were not embedded in kaupapa Māori, to be able to further extrapolate reasoning for Māori to have the view of disagreement with the statement (Haig & Marie, 2006). It is crucial for protocols in assessing the results are to cover identifying people as being Māori as relevant to the telling of a particular narrative (Moewaka-Barnes, et al., 2012).

The survey results lend themselves to serve non- Māori, which could damage and undo progress which has been made in New Zealand society, where the potential of the results may be read and mistaken in a way which outlines, 'Māori don't want to speak their language in engineering, therefore we shouldn't make changes in engineering'. By comparing the two groups, leads to grievances which continues the divide, rather than providing Māori to have the power to make these decisions. Non-Māori norms are considered naturalised, when Māori people, institutions, and practices are constantly compared to these norms without considering their context, it seems to reinforce the idea that Māori are seen as weak, dependent, and inferior by non-Māori (Moewaka-Barnes, et al., 2012). Kaupapa Māori methodology is undertaken to benefit Māori and makes a positive contribution to Māori aspirations (Smith L. , Decolonizing Methodologies, 2012). The risk with these results without proper interpretation could compromise a positive outcome for Māori.

Can engineering contribute to reclaiming and the revitalisation of te reo

Language revitalisation requires increased access and exposure to a language throughout all areas of life, including education, academia and industry (Higgins, 2018). People who are not Māori should first recognize the importance of te reo Māori in the world, especially for the Māori people whose heritage is closely connected to it through whakapapa, specifically the iwi Māori (Higgins, 2018). There is thinking to suggest New Zealand engineers have a role to play in revitalisation of the language, even if the engineers do not agree with it, however there are concerns regarding non- Māori accessing the language which require further examination.

Nicola Bright, a descent of Tūhoe and Ngāti Awa, shares that "Māori should benefit first from the revitalisation of te reo Māori" (Tweed & Te Maro, 2023). "Non-Māori people must first acknowledge the right for te reo to emerge in the world along with the people whose own emergence is intimately entwined with it through whakapapa. That's iwi Māori" (Higgins, 2018).

There are claims that Māori are often more successful in systems which are founded on the Māori language and culture, and in spaces which embrace and allow their identity and reconnect them (Warren, 2017). Perhaps if engineering participated in the te reo revitalisation there would be more Māori entering and being retained in the engineering industry.

A question I have asked myself while writing this is "am I doing Māori justice in writing this thesis, should I be writing this thesis in te reo Māori and contributing to the revitalisation of the language?" Adding to this view from Gracewood, highlights her concerns of glossaries for Māori words, or italicising them, the Māori words then become separate, as if they are abnormal, foreign and not a part of our literary landscape, making them almost secondary to English (Makereti, 2015).

There are academics like Patricia Grace who purposely refuse to explain or highlight Māori words in English. Although does that mean non- Māori speaking readers feel excluded when Māori words are not translated. It has been observed does perform the function or discomforting the reader enough to act or complain (Graham-McLay, 2020).

Gracewood proposes the question "If a New Zealander reader cannot understand simple words or phrases in one of the official languages of his or her country, should he or she not attempt to

learn?" also highlighting that often translating from te reo to English lessens the meaning (Makereti, 2015).

Similarly in engineering, if we pose the question 'If a New Zealand Engineer cannot understand simple words or phrases in one of the official language of their country which they work in, should he or she not attempt to learn?' as this might transform our understanding of Māori and the land by a deeper understanding of the indigenous language of Aotearoa. Perhaps, learning the language will increase the understanding of the colonisation and alienation engineering has contributed to in the histories of New Zealand for those students which still struggle to comprehend the connection of engineering with Te Tiriti o Waitangi, which was highlighted in Chapter Five.

There are concerns among Māori who share the view where non-Māori having access to te reo could lead to commodification of the language, where there is the potential for 'customers to buy various products "off the shelf", allowing non-Māori to learn any language they like (Higgins, 2018). While others note non-Māori need to accept limits of the ability to know in relation to Māori knowledge (Tweed & Te Maro, 2023).

"This is a difficult task because many non-Māori are so used to believing that, in theory at least, they can know and possess anything (if they want to and put in the effort). Respecting whakapapa then involves non-Māori in a necessary self-limitation which runs counter to their own cultural development in a capitalist, exploitative and predatory culture. Non-Māori must figure out how to acquire te reo Māori without possessing it. It might help to return to our idea of two countries overlapping in time and space – New Zealand and Aotearoa. Honouring Te Tiriti then asks those of us who live in New Zealand to honour what happens in another country, Aotearoa" (Higgins, 2018). Māori are actively sharing the taonga of te reo with New Zealanders of all backgrounds. Te reo Māori is becoming more of a defining part of our identity as citizens and those living in New Zealand, as Ngāi Aotearoa celebrating our Aotearoatanga (Higgins, 2018).

In this process of sharing the language, neither Māori nor non-Māori lose. Māori get to keep continuing and enjoying the use of their ancestral language in our country. While other New Zealanders get to learn from the literature, insights, and culture of the first people who named

and described the land and environment. Collectively, we all gain a new perspective and understanding of ourselves and our place (Hayden, 2021).

The revitalisation of te reo is important, and engineering may have a place to contribute to it, there are two levels to revitalisation:

1. The need to ensure tangata whenua can learn as tangata whenua.

2. The need to provide opportunities for everyone else to access te reo resources.

By providing opportunities in learning our language and reclaiming it as the social norm, it does not only service Māori today, but also bettering a future for the next generation (Tangatatai, 2021).

Engineering can contribute to reclaiming the language; however, Māori need to have control over it, and how it is implemented. Engineering can play a part in normalising te reo and providing opportunity for Māori to not only connect to the language but the extension of the language of supporting a Māori sense of belonging and identity. By reclaiming this for our whānau, we can remove this whakamā, this guilt, that face modern Māori. Moreover, education is not just about producing efficient automaton engineers; it is about nurturing and growing well-rounded individuals, who have value beyond their economic worth. Teaching a comprehensive understanding of cultural context and of the history of Aotearoa, including often overlooked events like the land wars, would help create more informed and considerate engineers (Rowe, 2017).

A message to reo-speaking non-Māori.

I want to live in an Aotearoa and work in an industry where all tauiwi understand te reo Māori, and therefore understand us better. However, I have been in many situations with the expectation understanding the language. Hearing the kōrero shared by some of the participants indicate they have felt the same.

> *"It's not in my job description, only cause I'm Māori I get asked for te reo translations or cultural tasks, it's pretty shame when I have to say no, because I can't speak it."*

I have also been in situations where I have watched as some (very few) of my Pākehā workmates kōrero with confidence while some of us (Māori) remain hesitant. It is something which is not often talked about. There have been several times when I have been greeted in Māori, or in situations been invited to share my pepeha, and I failed. I have failed to do the only thing required of me in this moment. I have not shown my appreciation the teaching and my whakapapa. I have not put into practice all that I have learnt. I felt a lot of shame.

We have given each other permission to struggle through this language journey together. So, I would say that if you are a reo-speaking Pākehā, wait for an indication that the other person wants to kōrero Māori with you, or talk about it in English. Do not assume that your Māori workmate has the language, even if you have just heard them deliver a beautiful karakia. In your excitement to practise, you may unwittingly bring shame on them.

Remember that time is a privilege. Time in learning the language, and all that is involved in that journey is a privilege. If you are lucky enough to have had that opportunity as a non-Māori, please think long and hard about the gifts you have been given and to whom they have been denied (Hayden, 2021).

Multiple avenues to revitalise the Māori language are required and there is continuing debate about the best method to strengthen the Māori language and increase the number of Māori language speakers (Benton, 2015).

A glossary for Engineers

A modern-day engineer required several ways to communicate. It is clear that an engineer requires technical languages to communicate and translate their ideas often in the form of software languages such as python or C++; Mathematics languages such as calculus, trigonometry, and statistics. However, an engineer also must communicate and use language in way which is usable by their listener, such as when communicating with a team engaged on a project; communicating with the community and stakeholders in which the project in placed or with clients which commissioned the project in the first place (Strevens, 2008).

Language is essentially a means of communication. Language is a tool that conveys traditions and values of a group's identity. Communication leads to occurrence and development of language

and becomes stronger when on has someone to communicate with. Society acquires self-awareness through the contact and communication between its members (Sirbu, 2015). Language is an essential skill in the engineering profession, this poses the question of should te reo Māori be utilised into an everyday work? By the incorporation of te reo, this is a method an organisation can show their inclusion practices and embrace the language and te ao Māori (Association of Consulting and Engineering , 2020).

It is clear there is the desire for engineers to hear and understand te reo, through comments shared during the surveys.

> *"More language learning like phrases/sentences"*
>
> *"More vocabulary that can be used in official engagements".*
>
> *"Proper definitions of important Māori words explained".*

A participant who identified as Māori noted,

> *"Speaking/hearing te reo Māori pronounced correctly was a nice change (more importantly, an actual effort to correct where spoken wrong)."*

Other Māori engineering participants also shared their desire for the engineering profession to pronounce kupu correctly, and their aspirations for the language and culture to be embedded into their jobs daily, to ensure they are not the only ones continually correcting others for mispronunciation or providing 'cultural advice' to engineers.

If engineering has the desire for inclusivity and bringing Māori into the engineering profession, then Māori need to have the ability to see themselves as a part of the industry.

Kura Kaupapa, Māori immersion schools and bi-lingual schools are taught in te reo Māori, if the engineering industry continues to further promote the language, then this poses the risk of restricting the interest of those pupils from entering the engineering profession. There are many more Māori tamariki and rangatahi, a new generation emersed in the Māori culture, and they will be seeking employment opportunities which embrace indigenous culture and language (Association of Consulting and Engineering , 2020). The Ministry of Employment, Innovation and

Enterprise developed a list of Māori kupu to encourage the construction industry to include te reo in their building glossary (Building Performance New Zealand, 2023).

In addition, in an article, Troy Brockbank shared 10 kupu every engineer needs to know. Brockbank notes tekau (ten) kupu Māori including whakapapa, kaitiakitanga, manaakitanga, whānaungatanga, mātauranga, kaipūkaha, Mana, Mauri, Tutū, and Wero. I will be expanding on this glossary based on what I have seen in the engineering industry, and what Māori participants had shared during their kōrero.

Additional kupu I would like to add to the glossary list for engineers include the following:

1. **Pūrākau** – The stories and narratives of the land in which iwi or Mana Whenua share when upon designing. Pūrākau comprises of codified knowledge and include a suite of techniques based in nature for investigating phenomena, acquiring new knowledge, and updating and integrating previous knowledge (Hikuroa, 2016). Understanding and hearing pūrākau permits access to another knowledge base to acknowledge in our engineering deigns and to inform decisions.
2. **Maramataka** - The maramataka is a calendar that divides the Māori year into lunar months. The word marama means both moon and lunar month. The maramataka is a framework which denotes the natural rhythms of a lunar cycle, and is a predictive tool used to schedule activities (Hikuroa, 2016). Maramataka is an important concept for engineers to consider when Mana Whenua may want certain construction activities to occur based on how they could impact the hapū and iwi.
3. **Mana Whenua** – Mana Whenua is often used to refer to the ‘customary authority exercised by the iwi or hapū in an identified area’. Mana whenua is often confused with Tangata whenua which is defined as the iwi or hapū in that area which holds Mana Whenua (Ministry for the Environment, 2022). Something, which had been prevalent in my journey as an engineer is ensuring the spelling is consistent and checked with the iwi or hapū as to which letters are capitalised or not, understanding it is different for each iwi.

4. **Wāhi tapu** - sites of significance or sacred sites and according to legislation it means a place sacred to Māori in the traditional, spiritual, religious, ritual, or mythological sense (Parlimentary Counsel Office New Zealand, 2014). These sites are important and identified by Mana Whenua to ensure decisions around an engineering design does not impact them, or a design may be used to enhance them and allow for the site to be known. A participant shared that they often felt they had to educate engineers on this concept.
5. **Whenua** - is the country or land in which we stand on, but also denoted as placenta or afterbirth. For Māori the whenua is not property, the whenua is fundamental to being Māori and building a sense of belonging (Moewaka-Barnes & McCreanor, 2019). To be an engineer, we must understand the interconnected relationship which Māori hold with the environment, and try to make decisions which are mana enhancing, to allow Māori to continue to have their relationship with the land.
6. **Wānanga** - Wānanga is a traditional method of Māori knowledge transmission, it is a defined in multiple forms, as a place – a school, an act, a form of governance, a pedagogy, and a practice. Wānanga is a practice which draws upon, shaped by local knowledge, place people and tikanga (Mahuika & Mahuika, 2020). In engineering, wānanga is a practice which can be adopted to support in making practices, decisions, and policies reflective of Māori views.
7. **Tikanga** - is the procedure, custom, manner, rule, way, code, plan, meaning, convention, and protocol. It is the customary system of values and practices that have developed over time and are deeply embedded in a social and cultural context. Engineering has tikanga, in the way the profession operates, within its systems and processes. Tikanga can also be used to inform how to appropriately engage with Māori (Jones, Crengle, & McCreanor, 2006).
8. **Tangata tiriti**- Means ‘treaty people’: all people who came to Aotearoa under the authority of the Treaty of Waitangi (Huygens, 2015). To be tangata tiriti is to acknowledge and honour Te Tiriti o Waitangi. To be an effective engineer in Aotearoa, we must act as

tangata tiriti, understanding the histories of our lands, and acting in a way which permits Māori to be Māori. Engineering decisions should reflect the practices of tangata tiriti.

9. **Karakia** – Karakia is to recite ritual chants, pray, incantation. It doesn't have to be a prayer; it can also set intentions for a particular activity. Karakia is reciting and acknowledging traditional language and structures. Karakia for Māori had been used in rituals or in all aspects of life (Te Aka, 2023). It is considered important to Māori engineers who shared their kōrero in this thesis. Karakia can be used to connect to our ancestral engineers and support in restoring the mana and tapu of the modern day. The use of karakia can uplift employee morale and be used as a tool to motivate and develop employees especially in training systems, something the engineering profession can adopt (Jolly, Harris, Macfarlane, & Hikairo, 2015).
10. **Te ao Māori** - Te ao Māori is the Māori world view. For engineering to successfully work with Māori and iwi, to employ Māori, the system must understand Māori have a view which can offer a different knowledge set and promote innovation and address complex problems specific to Aotearoa.

This glossary list is not extensive, there are likely more kupu which engineering can adopt and learn to support our engineers to communicate, engage, interact with the Māori culture. It is important to acknowledge along with the other language which exist in engineering, that te reo Māori is becoming a language more prevalent amongst the new generation, where the profession will require to be adopt if it if engineering plans to progress and honour its responsibilities under Te Tiriti o Waitangi.

Whakarāpopoto: Section Summary

To summarise this chapter, Māori should be the kaitaki of te reo, they should be given the power to decide, and the intent of decisions should be to reflect good Māori aspirations and outcomes. Although there were concerns about the results themselves, reading this section for context is essential. There were also concerns of the way this section dissected the results as it was not done in a way which aligns to kaupapa Māori methodology. Although this waka is powered by both Māori and pakeha the destination had the same result must be read with care, in saying that the participants shared they disagreed with the statement, it does not mean engineering

could not or should not assist in the revitalisation of te reo Māori, and it may not look like 'all engineers speaking te reo', although there are opportunities and resources which hold te reo Māori glossary lists for the engineering profession to utilise. However, engineering does need to consider teaching practices, in creating environments for Māori to thrive, in addition to providing all engineers with the opportunity of understanding of the history and the language for engineers to be better well rounded, in addition of understanding a defining part of the identity of New Zealanders, as Ngāi Aotearoa celebrating our Aotearoatanga.

Section Two: Safe spaces in the engineering system

Chapter 5 outlined findings from surveys and Whakawhiti kōrero. This section is informed by the experiences of Māori engineers, and their suggestions to for engineering in incorporating te ao Māori into the engineering system. Unlike the previous section, which was informed primarily from collected survey results of student engineers, accompanied by opinions from the whakawhiti kōrero; this section will be focused on prioritising the voices of Māori from the whakawhiti kōrero, while supporting the whakaaro from the survey results.

The previous section explored the statement 'Engineers need to speak te reo Māori in the workplace', which highlighted safety concerns for Māori when speaking te reo in engineering, although that section touched on the idea that safe spaces can be contributed through te reo Māori. This section of the rangahau will expand on safe spaces in the engineering system, and cultural safety in engineering.

Attracting Māori into Engineering

It does not take much to look to the news, to see a multitude of articles which are expressing the desire to attract more Māori into STEM and particularly engineering qualifications led by calls from industry. There are initiatives implemented to encourage Māori to actively pursue STEM pathways such as Pūhoro STEMM Academy (Science, technology, engineering, mathematics and Mātauranga), Ngā Puanga Pūtaiao and Te Ara Pōtiki (Diversity Works NZ, 2022). Ngā Puanga Pūtaiao is a short-term fellowship scheme designed to support early-to-mid-career Māori researchers, administered by the Royal Society Te Apārangi. Te Ara Pōtiki is an internship programme being established to support promising, tertiary-qualified, Māori entrepreneurs and

technologists (New Zealand Government, 2023). Groups like the Diversity Agenda are seeking to increase representation and participation in industries under-represented. The Diversity Agenda is a joint venture with Engineering New Zealand, New Zealand Institute of Architects and Association of Consulting and Engineering are committed to increasing participation of Māori (The Diversity Agenda, 2023). It is important to attract Māori into the engineering system, however once the system obtains Māori an important component is ensuring there is cultural safety for these Māori engineers. It was evident from experiences shared by Māori participants from whakawhiti kōrero that they have experienced unsafe spaces while being in the engineering industry. Although there have been opportunities which have allowed Māori participants from both the surveys and whakawhiti kōrero to feel safe and feel like they belong in engineering.

Cultural Safety

A safe space for indigenous people is an environment where they feel culturally safe in an environment, secure in their identity, culture, and community. It is an environment in which there is shared respect, shared meaning, shared knowledge, and experience of learning, living and working together (Hamilton, 2020).

A definition of "safety" suggests from a Māori cultural viewpoint, safety is taken to mean freedom to be who (individually) and what (collectively) Māori are. Cavanagh (2005) learned that Māori students and employees need to feel respected and proud of who and what they are as Māori. Professors, teachers, and employers all need to respect the Māori preferred ways of learning and working, through whānau wisdom, and karakia. Māori preferred ways of learning include acknowledgement, celebration, mentoring, and honouring an individual's Māoritanga (McFarlane, Glynn, Cavanagh, & Bateman, 2007). Culturally safe spaces can be achieved for indigenous people through cultural safety and cultural security imbedded in all aspects of (Hamilton, 2020):

- Physical built spaces
- Governance
- Staffing
- Language

- Policies and procedures
- Training, programmes, and resources
- Agents and representatives
- Community engagement

Whakapapa links between Cultural safety, wellbeing, and Cultural identity

Cultural security is also a secure cultural identity, which acts as a protective measure against psychological distress and adversity, and increases resilience (Durie, 2001; Houkamau & Sibley, 2015; Waiti & Kingi, 2014). Āhurutanga encourages individuals to explore and comprehend their own whakapapa, fostering a profound sense of connection and, consequently, establishing a secure space rooted in their unique epistemological perspectives. This perspective holds significance, as it enables individuals to navigate their surroundings with care and recognise the significance of others' spaces. The foundational values of āhurutanga play a crucial role in te ao Māori, contributing to their cultural purpose and fulfilling their obligations (Chand, 2020). Māori wellbeing is intrinsically connected to a person's connection to cultural heritage and cultural identity (Durie, 2023; Hohepa, Kawharu, Ngaha, & Peri, 2011; McLachlan, Waitoki, Harris, & Jones, 2021). If considering this in te ao Māori, there is a whakapapa connection to a person's cultural identity, influenced by cultural safety and in turn affects a person's wellbeing. It is crucial to acknowledge that Māori identities and self-perception have evolved within the complex context of colonisation and are embedded within a Pākehā (Eurocentric) framework (McLachlan, Waitaoki, Harris, & Jones, 2021).

The impacts of colonisation, acculturation, and assimilation of Western values on Māori, means Māori have to be resilient in maintaining their Māori identity. In this struggle, they have had to navigate while maintaining links to their culture and traditional ways of living. Decreased access to Māori cultural heritage, like tikanga Māori and te reo Māori, is believed to have compounded the impacts of an insecure cultural identity and have repercussions on mental well-being (Baxter, 2008; Baxter et al., 2006; Mark & Lyons, 2010).

Māori engineers & safe spaces

In essence, for Māori or indigenous people to be culturally safe, there need to be spaces in which Māori can be authentically their selves and considers their wellbeing, restoring their mauri ora. Whakawhiti kōrero with Māori engineers highlighted interesting findings of the feelings of being a Māori in the engineering, where the kōrero shared insights to the participants 'safe spaces'.

Participants had shared spaces which are safe for them in the engineering system, the 'safe spaces' to be discusses are spaces with other people from the Pacific, the bathroom, and safe learning environments.

Safe in spaces with people like me

The participants had shared experiences of safe spaces for them in engineering, which all appeared similarly, in working with and alongside other Māori, although they had also mentioned they had felt safe in settings with Pacific peoples. It is believed Māori and Pacific peoples are blood and cultural cousins and have both share histories of colonisation (Ratuva & Brady, 2019).

Participants had shared comments such as,

> "*In Māori spaces you feel that any ideas you have are heard and accepted".*
>
> ***"****Feels safer with other Māori, and don't feel alienated when you bring your ideas to the table."*
>
> *"I feel safe in spaces with people that think like me, that's predominately Māori and Poly[nesians]."*

'Māori friendly' space is a term used by McLachlan, are spaces in which are reflective of te reo Māori and imbedded in te ao Māori (McLachlan, Waitaoki, Harris, & Jones, 2021).

Many Māori and their whānau are disconnected from their wider culture, due to colonisation and limited resources to actively engage in mātauranga Māori including whakapapa and wairua (McLachlan, Waitaoki, Harris, & Jones, 2021). Despite this, many Māori are still able to demonstrate Māori values like manaakitanga and kotahitanga with in their whānau and amongst other Māori (McLachlan, Waitaoki, Harris, & Jones, 2021).

There is literature to support the idea for physical spaces which enable cultural safety for Māori are spaces in which are big enough for the whānau, for all people to come together to eat and gather (McKinley, 2000).

Safe spaces – Physical Places

Kōrero shared by a participant had highlighted the bathroom as a safe space,

> *"Bathrooms and, you know, it's a kind of a safe space, no hierarchy and would make friends in those spaces".*

When unpacking this quote, a key aspect to the bathroom being a physical space the participant felt was safe was the result of *"…no hierarchy…",* when thinking about this in a te ao Māori context, there are several spaces when incorporating tikanga and normalisation of Māori in which there is also no hierarchy, one of those is morning karakia and waiata. The use of karakia and waiata assists to unify or Kotahitanga people of all levels and differences to practice karakia and waiata together—without a hierarchy of power (Motu, Watson, Tai Rātima, Karaka-Clarke, & Stevens, 2023). Studies have suggested that Māori tended to achieve greater success when educational settings and work setting that offer chances to cultivate their identity, enhance their self-worth, and instil confidence and pride in their Māori heritage (Whitinui, 2008).

The utilisation of karakia and waiata are culturally responsive practices to normalise te reo and tikanga supporting Māori to authentically embrace their identity, this had been seen in studies (Motu, Watson, Tai Rātima, Karaka-Clarke, & Stevens, 2023). Ratana's insights share Māori students highlighting spaces in which they liked as they could not be seen or heard. I feel similar emotions reading that in Ratana's rangahau, as I do in hearing kōrero about the bathroom being a safe space. Similarly, to Ratana's findings who Māori who studied subjects with very few other Māori students or staff said that claiming space for Māori was difficult within their discipline and as a result, they felt quite lonely (Ratana, 2020). It is implied through kōrero with Māori participants that they had similar feelings of loneliness.

Another thought as to why the bathroom was deemed a safe space was due to the physical removal of moving into another space, or perhaps the connect through wai, water. Another study found connection to taiao through walking to the ngahere helped with whai ora. The physical

environment enabled the person to work through their thinking and experience. The taiao space has often been used as an opportunity to support the wellbeing of Māori whether it was through Māori medicine or in this case in mental clearing (McLachlan, Waitaoki, Harris, & Jones, 2021).

Studies have highlighted the significance of "incorporating place-based cultural narratives, culturally responsive pedagogy, and bicultural curriculum into the structures and spatial relationships of the built environment within schools" as a pivotal aspect in the design of educational facilities (Haraymchuk, 2015), additionally this same concept could be translated into the engineering work place.

Safe Spaces – Cultural responsive pedagogy

Part of this rangahau involved surveying engineering students after completing a series of te ao Māori lectures. A key feature from some of the findings was the teaching style and the environment created for learning. Pedagogy is a key aspect in creating a safe space and is defined as encompassing a variety of teaching and learning methods and other teacher behaviours and characteristics grounded in theories of student learning and influenced by internal and external socio-political contexts (Stucki, 2012).

Safe spaces for learning te ao Māori and te reo Māori are required for continuation of learning, regardless of skill level; moreover, learners could mitigate their anxiety by redirecting their focus away from their perceptions of how others viewed their language attempts (Te Huia, 2022) .

Many of the survey participants highlighted the wānanga style of learning was effective in creating a space in which students could ask questions without judgement.

> *"… safe space to ask questions was formed".*
>
> *"The more relaxed approach was really good".*

The results showed both Māori and non-Māori felt safe and comfortable in this teaching approach. It was important to be cautious for Māori learning colonisation histories and Māori culture, however there are studies which suggest that Māori feel a sense of belonging, which also often help Māori who might be early on their cultural journey (McLachlan, Waitaoki, Harris, & Jones, 2021). Studies have found that when there is a focus on the quality of the relationship

between teacher and learner, there are better learning outcomes for Māori (Stucki, 2012). There are other studies which urge teachers to use “whānau” as a metaphor for relations in classrooms, while encouraging teachers to interact with students in a way that new knowledge is co-created (Stucki, 2012). Although these examples are based on a learning environment, there is likely parallels which could be integrated into the workplace.

Whakarāpopoto: Section Summary

This section pulls together insights from surveys and whakawhiti kōrero, focusing on the experiences of Māori. The discussion delves into the significance of safe spaces within the engineering system, aligning with efforts to attract Māori into engineering. It underscores the importance of cultural safety and well-being for Māori engineers, exploring the interconnectedness of cultural safety, well-being, and cultural identity.

The concept of cultural safety is examined, encompassing various aspects such as physical built spaces, non-physical spaces, and spaces where individuals identify with themselves. However, it is important to note that this section does not offer solutions to the challenge of creating cultural safety, nor does it consider into the difficulties of implementing it. Instead, it provides an opportunity to shed light on Māori perspectives within the engineering system and its spaces.

Section Three: Invisible Cultural labour

Similarly in section two, this section will be focused on prioritising the voices of Māori from the whakawhiti kōrero, while supporting the whakaaro from the survey results, found in Chapter 5. A prominent theme centred on the experiences of Māori engineers was the notion of being seen as tick box or merely seen as 'that brown person' within the field of engineering. This section will delve deeper into the unseen cultural work and emotional labour expected from Māori engineers.

Experiences highlighted by Māori participants from whakawhiti kōrero, found that they have had experiences which saw Māori as tick boxes, of as a participant shared “…be that brown person”, with the expectations to complete additional work outside their technical role in an engineering organisation.

Comments from participants were,

> *"It's not in my job description, only cause I'm Māori I get asked for cultural tasks…"*

It is evident that excess labour is expected from Māori engineers by the engineering system.

Aronga takirua - Double labour

It is often we see our Māori in many spaces experiencing excess labour, this has been examined in science by McAllister and Haar (McAllister, et al., 2022; Haar & Martin, 2022).

The excess labour means an individual fulfils the dual roles as a Māori and present technical expertise. The excess labour encompasses dealing with issues of racism, meeting expectations of cultural expertise, executing cultural protocols (such as karakia and mihi whakatau), and fulfilling tokenistic diversity roles, such as speaking at events to showcase diversity or to recruit Māori into engineering (McAllister, et al., 2022).

Haar offers the term aronga takirua which refers to Māori working multiple roles from dual foci – western and Māori. Aronga takirua was specifically termed for scientists although it has parallels for engineering. Aronga takirua encapsulates the intricate challenge of wearing multiple hats in various roles, including fulfilling the responsibilities of a Māori engineer. In essence, Aronga takirua is interpreted as undertaking a cultural double-shift, signifying not only the potential for a workload that is twice as demanding but also being rooted in cultural motivation (Haar & Martin, 2022).

Experiences

Stress arises from the assumption the "Māori part" in projects, will be done by us, posing a risk to our cultural integrity. Often, our teams are without another Māori, we then must take the initiative to ensure that cultural protocols are adhered to. While it is not explicitly our responsibility, Pākehā may lack awareness of what they do not know. In the interest of project's cultural safety, the responsibility frequently falls on us to oversee and ensure the smooth progress of things (Naepi, et al., 2019).

Each participant from Whakawhiti kōrero detailed what in effect was the additional cultural labour of kawenga taumaha. The heavy burden and profound sense of responsibility to oversee

and champion for te ao Māori in projects, and often assist in raising the voice of Mana Whenua in decision making. The participants' commitment to kaitiakitanga - the guardianship of the people and land- frequently encountered indifference or a lack of comprehension from their colleagues.

There are other industries which have literature in describing additional cultural labour Māori kaimahi experience, such as nursing, and science academia (Hunter & Cook, 2020). (Hunter & Cook, 2020; RNZ, 2021). In my own experience in the engineering industry, I have felt the pressure to accept a role in a project as the project was seeking someone who had whakapapa to the iwi. Asked to act as that diversity token, I was asked to act as a bridge between my iwi and the design engineers. The assumption was made that I would act as a cultural advisor and educate Māoritanga and tikanga of my iwi to the design engineers. They had also assumed I would be able to support in the cultural design features of the project. This was completely out of my scope of my engineering skills and were additional expectations on top of my technical skills, which, at the time, I was not culturally capable of, something I had highlighted with the team.

This is one example of superficial 'inclusion' of Māori engineers. "Our bodies, names, and whakapapa are misappropriated to fulfil tokenistic roles" (McAllister, et al., 2022). The everyday marginalisation, racism and exclusion experiences held by our Māori engineers, who are underrepresented in engineering, places a heavy burden and added stress on our people, leading to Māori having to stay hypervigilant to protect our minds, bodies, and mātauranga (McAllister, et al., 2022). This experience of mine, in addition to hearing the stories of Māori from whakawhiti kōrero, shows we have all shared similarities.

Token-O-Meter

As a result of hearing the kōrero from Māori, and sharing my own experiences in the engineering industry, it was highlighted that to alleviate some of the excess labour held by Māori in the profession, a tool could be created. In developing the Token-O-Meter, it was important to pull perspectives from Māori participants from their kōrero, which was incorporated were,

> "*More Māori, more Māori values".*
>
> *"…they're viewing us like tick box, and I don't understand why we have to do it".*

"More cultural competency and more history education"

Other key information which was shared from survey participants highlighted the student's interest in further understanding Māori engagement and te ao Māori for their future engineering role.

"Learning about the levels of engagement that engineers will need to consider when interfacing with Te Ao Māori."

"How to fully incorporate Māori design and considerations into projects"

"How to work with Māori in all areas of a project".

The Token-O-Meter has used these views, to frame some of the responsibility to be put back on Pākehā engineering colleagues, to assist in alleviate the burden. From those stories shared by Māori engineers the 'Token-O-Meter' was developed, a flow chart which our Pākehā engineering colleagues can use and adopt to engage internally with Māori in engineering organisations. The Token-O-Meter asks a series of questions to prompt the individual to think about the way they are engaging with Māori when, Māori are required to be a part of an initiative or opportunity. The Token-O-Meter evaluates whether an individual engaging is appropriately engaging and whether the individual has thoroughly thought about a safeguarding mechanism for Māori while acting in a manner which upholds the mana of Māori they want to engage with (Figure 11).

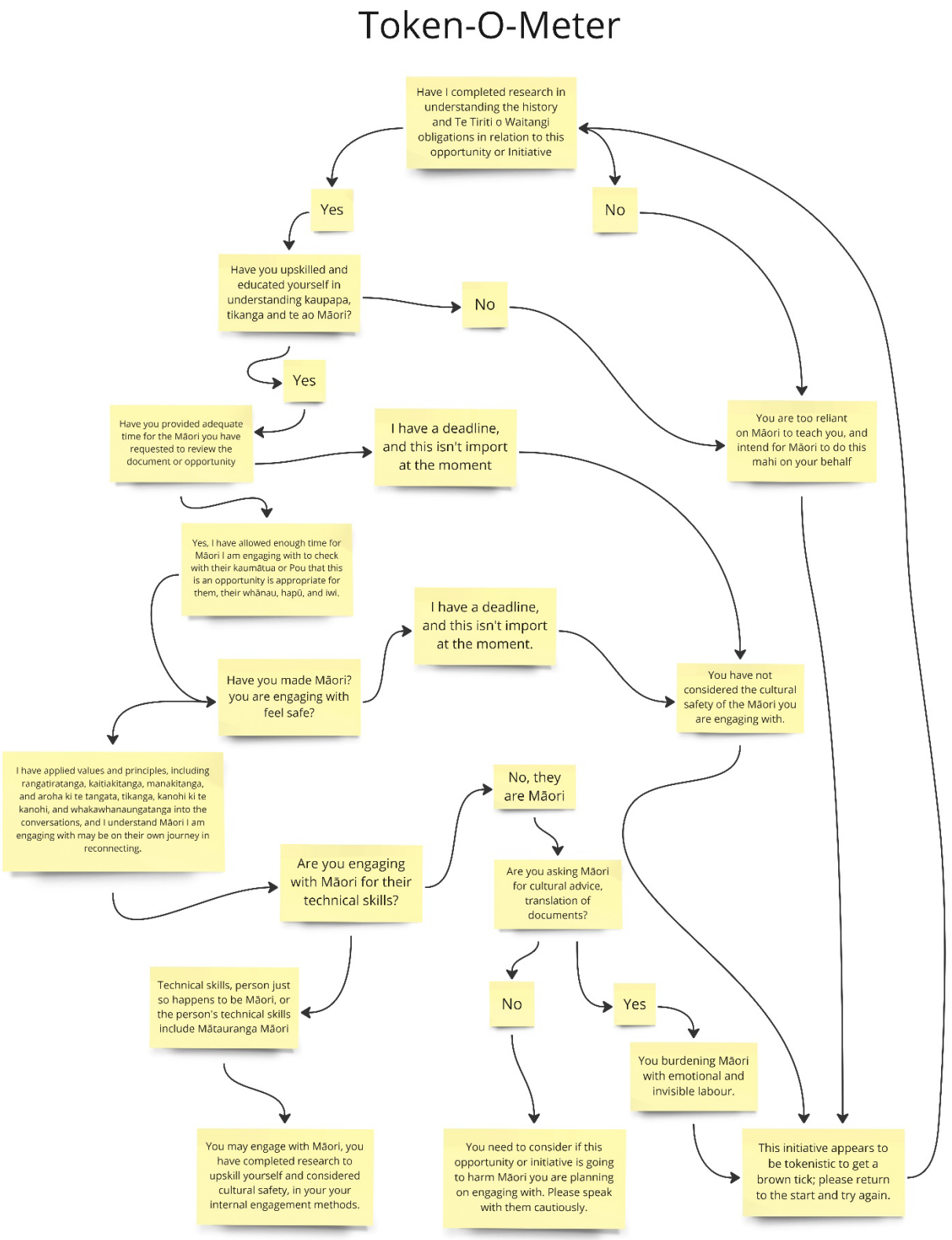

Figure 11 Token-O-Meter Flow chart for a Cultural Safety Assessment

Haar highlights that much of the role of Māori is to engage with Māori stakeholders; it is at least sometimes unpaid (Haar & Martin, 2022). A lot of the unpaid work is also Māori often having to educate and inform non-Māori on the histories, and te ao Māori reasoning. A participant shared,

> *"I'm often the one having to argue with designers about cultural practices of Mana Whenua like why we can't flush stormwater out to sea, why its disrespectful, I'm the one having to educate them."*

Using the Token-O-Meter prompts the engineer to complete research for their selves before asking Māori directly. There are other solutions which could be introduced to support non- Māori to lessen the burden on Māori engineers, such as increasing Māori education in engineering curriculum, to ensure that basics of tikanga and Māori values are taught to every engineer working in Aotearoa.

Consequences & Implications

The excess invisible labour results in our Māori engineers burning out. Some of the participants shared,

> *"I felt like I am too much of an activist for these spaces. I cried a lot last year."*

This is a heavy emotional burden many Māori engineers must carry with them in the engineering profession. In science they have seen turn over or many Māori exiting the science sector (Haar & Martin, 2022). This is a consequence which is assumed to be happening in engineering as well, although further research would need to be conducted to conclude that. This aligns with the role of conflict theory (Greenhaus & Beutell, 1985; Kahn & Quinn, 1964) and extends this to include cultural roles. This offers crucial extensions to ensure the inclusion of all workplace voices, including those of indigenous individuals. It also understands limitations in primarily Western approaches to organisational phenomena, resulting from a lack of involvement with other cultural practices, including indigenous perspectives (Haar & Martin, 2022). It is seen that Māori engineers are facing the struggle of navigating two worlds and resulting in the excess labours, impacting on their wellbeing.

Haar proposed the option for Māori scientists as a collective, perhaps through a Treaty of Waitangi claim. Perhaps the same can be done for Māori engineers,

Other approaches have been undertaken recently such as WAI 262 claim, where Māori are seeking redress for ongoing inequalities for which the government are responsible (Geismar, 2013). More than 170 years after the Treaty, 'We still seem to bear the burden of mutually felt attitudes from our colonial past', with Māori feeling that their culture is marginalised, while non-Māori fear that Māori will acquire undeserved privileges at their expense (Waitangi Tribunal, 2011). Ultimately, policy changes and legislative requirements of engagement between the engineering system – education, academia, industry and Māori are needed. It appears the challenge is taking a toll on Māori engineers and their role as an engineer.

Whakarāpopoto: Section Summary

This section outlines excess labour, or aronga takirua the dual worlds Māori walk in as Māori engineers. The cultural responsibility of projects often falls on the shoulders of Māori, in addition to education for non-Māori and other cultural protocols such as karakia. Wearing both a Māori hat and engineering expert hat takes the toll on our people. To support in elevating some of the burden of Māori the Token-O-Meter was developed to support non-Māori in how they engage with Māori internal for their engineering projects. Our bodies, names, and whakapapa are misappropriated to fulfil tokenistic roles in engineering, ultimately changes within the engineering system are required to reduce the marginalisation of Māori within engineering.

Section four: No voyage is smooth sailing - Limitations and Challenges.

The preceding sections discuss the experiences of Māori individuals in engineering, addressing opinions of the representation of Māori people and the influence of Māori culture in both industry and education. During my exploration of this rangahau, various challenges and limitations emerged. If I were to undertake this research again, I would opt for a different approach. The modifications would involve incorporating kaupapa Māori methodology, expanding the sample pools for information collection, and adopting a more purposeful approach to participant selection. Additionally, I would prioritise considering the audience earlier in my research journey.

One of the primary modifications to this rangahau would be to prioritise Māori engineering voices exclusively. This approach would aim to authentically fulfill a kaupapa Māori methodology, ensuring that the rangahau is deeply embedded in te ao Māori.

The questions shared between the surveys and whakawhiti Kōrero should have aligned more closely. Whakawhiti Kōrero, with its guided questions prompted diverse discussions. This, however, led to challenges in aligning findings between the two methods. Another recommendation in this study would be despite the similarity in experiences among the Māori engineering participants in the small sample pool, a larger number of participants would have been necessary for confirmation.

While I aimed to incorporate more pūrākau in this rangahau, achieving this would have required selecting participants who were kaumātua or well-versed in pūrākau. Additionally, I would have engaged in upskilling in pūrākau for myself and sought guidance from my own iwi. Learning about pūrākau would have provided insights into our thinking and tikanga, offering a more integrated te ao Māori perspective into the challenges faced by Māori engineers.

Although I initially envisioned the audience as Māori, I now realise that this thesis, while valuable for Māori, primarily aims to inform the engineering community. In reflecting on the audience, more attention should have been given to the use of the te reo dialect throughout this rangahau, especially considering that many Tūhoe individuals are actively reclaiming our dialect. This includes dropping the 'g' in 'ng'. Throughout this thesis, I have not incorporated our dialect. Recognising that if the audience were solely Māori, this would be a factor that I will take into account in future rangahau. Earlier decision-making regarding the target audience would have been beneficial.

While this rangahau sheds light on engineering aspects that diminish the mana of Māori in the field, further research is needed to explore the disconnection between industry expectations on cultural skills and what is delivered in education, to ensure graduates meet the cultural requirements of engineers working with iwi Māori clients and Māori colleagues. Additionally, investigating whether Māori engineers leave the profession due to mana-diminishing practices in the industry would be intriguing.

No rangahau is without challenges or potential changes in hindsight. Viewing this as a learning opportunity, I aim to contribute to the literature on a topic that is not widely discussed.

Whakarāpopoto: Section Summary

In summary, key modifications for this rangahau would include a focus on exclusively representing Māori engineering voices to authentically fulfil a Kaupapa Māori methodology. The initial intent to combine interviews and surveys was hindered by time constraints. Whakawhiti Kōrero guided questions posed challenges in aligning findings with surveys. A larger participant pool is essential for validation. Audience considerations should have been clarified earlier, recognising the rangahau primarily informs the engineering community. This rangahau acknowledges challenges and serves as a learning opportunity.

Whakarāpopoto: Chapter Summary for the Voyage of Engineering

This chapter explores survey and whakawhiti kōrero results from Chapter Five, focusing on discussion themes like the significance of te reo Māori in engineering workplaces, the need for safe spaces in the engineering system, and the concept of invisible cultural labour.

The findings emphasised that Māori individuals should hold the role of kaitaki in preserving te reo, making decisions that align with positive Māori aspirations. There are concerns about the result interpretation and the need for careful consideration to prevent potential misinterpretations. While participants may disagree with the idea of all engineers speaking te reo, opportunities exist for incorporating te reo Māori to enhance the understanding of te reo Māori in New Zealand's identity.

The discussion explored the significance of safe spaces, aligning with initiatives to attract Māori to engineering, and emphasises the vital role of cultural safety and well-being for Māori engineers. The concept of cultural safety is analysed, covering physical and non-physical spaces, as well as areas where individuals connect with their own identity. Notably, this chapter does not propose solutions or address the challenges of implementing cultural safety; rather, it illuminates Māori perspectives within the engineering system and its spaces.

The requirements from Māori engineers in dual worlds are culturally taxing, bearing the cultural responsibility of projects and while wearing both Māori and engineering expert hats. The discussion explored the concept of the Token-O-Meter in testing internal Māori engagement in an organisation. The misappropriation of Māori bodies, names, and whakapapa in tokenistic roles resulting for the need of systemic changes in engineering to reduce the marginalisation of Māori.

Recommendations for the conduction of this rangahau involve a differing approach to consider kaupapa Māori, and a Māori audience, as this rangahau as it stands, is better suited for the engineering community rather than Māori, the following chapter is aimed primarily for a Māori audience in the form of a letter to future Māori engineering Rangatira. Overall, this rangahau serves as a valuable learning opportunity and a contribution to a less-explored area in literature. The is a strong desire from all participants to see changes in the engineering system, to embrace inclusion of Māori culture, Māori language and ultimately Māori people, to enhance the mana of Māori in engineering.

Chapter Seven: He kupu taurangi

The previous chapter shared insights of other Māori engineers, and the challenges they face in engineering. Chapter Seven dives deeply into my whakaaro and thoughts throughout my journey of this rangahau. It serves as a reflection and shares what advice future Māori engineering rangatira, and what they might need to know prior to undertaking kaupapa of this nature in the engineering field. This chapter has been inspired by Marama and Ammon Aprata who shared a letter to their future rangatira to serve as their conclusions (Apiata, 2021; Salsano, 2021). I want to share an open letter to future Māori engineers.

Addressed to future Māori Engineers

Teresa Angelina Poli

Ngāti Haka, Ngāi Tūhoe

Waiōhau Valley, Whakatāne

Te Kura Mata-Ao

Te Whare Wānanga o Waikato

Kirikiriroa

Huitanguru 2024

Tēnā koe Rangatira,

I am writing this letter to you, future Māori engineers, as a personal koha to you. Thank you for pulling up a chair and listening to my kōrero, a story similarly shared by many of us in the engineering system. This thesis has been a manifesto in the making, although I would have unlikely called it that at the beginning of my journey. It is something that I wish I had read before I began my engineering journey, I hope that you found this record of, frustrations, challenges, and everything somewhat useful as you embark on your own engineering journey. If I were to offer some guidance, it would be:

- Choose the right waka,
- Kia mau ki to Māoritanga — (Hold on to your Māori heritage),
- Protect yourself,
- Take our people on the journey with you,
- Continue the wero – continue the challenge.

I began this rangahau listing out my 30 hopes for engineering. As I conclude this rangahau, I present a summary in the form of an open letter. I aim for it to be a helpful piece as we navigate towards better representation and protection of our people in the world of engineering, be it in education, academia, or industry.

Choose the right waka

The perspective you gain from standing on your maunga is your advantage. It shapes the way you see problems in a special and unique manner; do not let anyone convince you otherwise! If they do, re-examine the waka you are travelling on, the people on your waka, and where in the Pacific you are heading (Salsano, 2021).

In the initial stages of my thesis, I contemplated integrating te ao Māori into the engineering curriculum. However, my approach and the waka I was travelling on needed recalibration, and it evolved into supporting Māori in finding their place in engineering, because we unquestionably belong in the field. Choosing the right waka, is about surrounding yourself around the right people. Some of those right people include your supervisors or others in the industry.

I have been fortunate to have supervisors who support my vision and have given me the freedom to shape this project. This was particularly valuable while researching a topic for which there is very little available literature. It enabled me to delve deeper into my own cultural identity throughout the process of writing this rangahau. I have been fortunate to have numerous Māori tuākana supporting and guiding me on my journey in the engineering industry.

Find your cultural pou, someone from whom you can seek support while drawing connections between te ao engineering and te ao Māori. This person can help ensure your understanding of mātauranga is accurate. Having a cultural pou is crucial not only in academia but also in the

professional realm. When faced with tasks where you may lack cultural competence or confidence, your cultural pou will be the one to either encourage you to take on the challenge or advise you to step back if you're not ready. Your cultural pou can be a whanaunga, or a respected mātauranga lead in your school or workplace. Someone you are comfortable to seek cultural advice from.

Kia mau ki to Māoritanga — (Hold on to your Māori heritage)

Hold onto your Māori heritage, be authentically Māori. Stay true and be authentic to your Māoritanga in the research and mahi which you undertake. While this rangahau still holds a piece in my heart, and has permitted me to think in ao Māori, there are these parts which I feel I have not been able to be authentically Māori.

If I were repeat this kaupapa again, I would only include the voice of Māori, and work towards using a kaupapa Māori methodology. The approach used in this rangahau heard the voice of Pākehā which made for interesting discussion points, however, it also presents existing thoughts and ideas of our Pākehā classmates and colleagues which do not necessarily align with enhancing the mana of Māori in engineering. My concern is that exposing these negative thoughts may harm our Māori in engineering or prevent our future Māori from engineering pathways. It did also showcase there are many more allies in engineering than I anticipated.

Other adjustments to this kaupapa which I would have made were to cast a wider net, wide enough to look at other indigenous peoples to support my argument. Although the rangahau focused on enhancing mana of Māori in engineering, if more time were available, and constraints surrounding word count would have permitted further investigation into what initiatives and struggles were also shared among indigenous people in engineering, including indigenous programmes throughout the engineering system.

Throughout this rangahau, I wish I had my reo. To support the whakaaro and to ensure it was intended for Māori, and for it to be authentically Māori. As in Chapter Seven, Section One, it outlines the importance te reo is in Māori identity and wellbeing. I also wish I had used and acknowledged Ngāi Tūhoe dialect of te reo through my rangahau.

There were many changes I would have made if I were to repeat this rangahau to connect and reflect my authentic Māori identity better in this kaupapa. Throughout this rangahau and on my hīkoi, I was uncertain if I was the right person to undertake this kaupapa.

I felt like:

I am not Māori enough.

I do not speak te reo Māori.

I do not write in te reo Māori.

I know little of our tikanga.

I do not know enough of our mātauranga.

I did not grow up on the marae.

I do not look like other Māori, so how can our people accept this.

I have not done this rangahau and kaupapa justice.

I am not sure how this kaupapa will be received.

There are other Māori who would have been better suited to undertake this kaupapa.

A friend of mine shared a kōrero with me, 1.) there are not many Māori in engineering, who else will do this kaupapa? 2.) you uphold and live by āhua Māori, whakaaro Māori, and whakapapa Māori. You have the energy and character that is Māori, you think as Māori – and want to do what you can for our people, and you are a descent of Māori.

I share these thoughts with you in case you might encounter these same feelings or challenges, but I also want to share insights of what advice I would want when exploring this kaupapa further. This is a piece of work I want to leave for the next Māori engineer to succeed me. For you to build on this rangahau, and hope that you are able to lead kaupapa you are proud of.

Protect yourself

Protect yourself when embarking on any journey in the engineering field. Equip yourself with karakia and the remembrance of your tīpuna. Advocating for our people in the engineering space involves a considerable amount of invisible and emotional cultural labour, as explored in Chapter Seven, Section Three.

Surround yourself with those who share the same vision, and only take on this kaupapa when you are healthy and supported. Ensure that you engage in activities that nurture and sustain your cultural identity— stay connected to your whānau, visit your marae, haka and kōrero te reo when needed. Look after your wairua.

Protect yourself and be selective of how you plan on undertaking your kaupapa. Upon reflection, I wish I had not utilised a methodology and data collection approach which involved Pākehā, it exposed myself to comments and statements that hurt to read and understand the very real potential that my classmates and colleagues could feel that very way, although most feedback from the surveys were very positive and encouraging a te ao Māori movement amongst engineering.

Take our people on the journey with you

When I had a whānau reunion recently, there was a comment made, “who had met or knew an engineer before meeting Teresa”, the room was silent and still. It was highlighted how I was the first engineer in the hāpū. That really made me think and realise how little of us do not actively choose engineering but how as Māori how poorly connected we are to engineers; this leads to many of us not knowing what engineers do.

My piece of advice, when you are venturing on your journey is to share your learnings with your whānau, share how to apply for scholarships, share what type of work you do, share your experience at university, because without sharing these, how else will we see our people in engineering. Without the whānau connections or the people you know being engineers, our people will not go into engineering.

To have our people see their selves in the engineering profession, we need to decolonise and re-engineer the system. To represent our people and culture in all aspects, through education,

academia, and industry. We need to remind our people that they can be engineers and that we have always been engineers.

Continue the wero – continue the challenge

Continue the wero, it is a hard fight, and with the current political environment we look to our tīpuna and reflect on the fight they have been on for generations.

In a war, we would be teaching our rangatahi at young ages to become warrior, and would train for years to build the strength and skills, that is happening currently, where we are armouring our tamariki with their reo, and mātauranga through kohanga reo and kura kaupapa, strengthening their cultural identity, however we unfortunately are having to teach them how to protect our culture and advocate for these in spaces where we are not well represented.

This rangahau has not answered many questions, rather it has highlighted more questions and areas which need to be investigated if Māori are to feel like we are to belong and have mana in the engineering system. Some things that have not been answered, as I set the wero, include how many Māori are leaving the engineering industry and why; the number of Māori engineering academics are there to support our future rangatira while they are in education institutions; investigations in how to bridge the gap between what is taught in university versus the what cultural knowledge and soft skills are required in the work place; how can engineering specifically build culturally safe spaces in the engineering system, and lessen the invisible culturally labour held by Māori engineers.

As a Māori researcher, it has been difficult to navigate the seas when there are no stars guiding you at night, and the seas are pitch black. I think of this rangahau in a way of navigation, there was very little literature, or Māori engineering academics to help guide me in my directions. I had to rely on my available resources – my supervisors, my experience, my tūhoetanga and the knowledge left to me by my tīpuna in making decisions in this rangahau. I hope this rangahau helps you in your quest, as we start to see even more positive changes and inclusions of Māori n engineering, we are inching closer to achieving my 30 hopes, shared at the beginning of my rangahau.

Our waka hourua has not yet reached the shore of our destination, where our vision of engineering includes embrace of te ao Māori and te reo within the engineering system. In this vision, Māori should not bear the burden of cultural labour, and our whānau are safeguarded to retain our mana. This conclusion is not an ending rather, it signifies the commencement of what comes next.

May the prow of your canoe cleave the waters of life and leave in its wake, mighty deeds. Mā te tauihu o tōu waka, e ū te waiora Kia mahue atu, ngā mea whakahirahira i roto i te koriparipo (Massey University, 2010).

Nāku noa, nā

Teresa Angelina Poli

Wahine Māori Engineer

Chapter Eight: Kōrero Whakakapi | Conclusion

This thesis examines the perspectives of both Māori and non-Māori within the engineering education, academia, and industry, aiming to understand the challenges and experiences faced by Māori engineers. Despite incremental changes in working with iwi Māori, the history of engineering remains entangled with colonial influences that have marginalised Māori. Colonisation, with its repercussions such as the loss of te reo and cultural oppression, has led to a sense of disconnection among Māori engineers. This historical legacy imposes invisible cultural labour on Māori as they strive to rectify past wrongs in the profession.

The research framework, He Waka Hourua, symbolises the journey toward a vision where Māori hold mana and a sense of belonging in engineering. The data collection process, employing Surveys and whakawhiti kōrero methodologies, provided both quantitative and qualitative information shaping the research findings. Woven throughout is the author's personal journey as a wahine Māori engineer, anchored in her Māoritanga, with waka analogies paying homage to Māori engineering feats. Survey and whakawhiti kōrero results, focused on themes like te reo Māori's significance, safe spaces, and invisible cultural labour. It depicts the importance of Māori holding the role of kaitaki in preserving te reo and making decisions aligning with positive Māori aspirations. There has been an increase in initiatives to attract Māori to engineering, however the results depicted few safe spaces currently existing in the engineering system, emphasising the vital role of cultural safety and well-being. Due to the few Māori existing in engineering, Māori often bear cultural tax, lending to systemic changes needed to reduce marginalisation. Although there were challenges in conducting this Kaupapa it was recommended for future Māori engineering Rangatira suggest a shift towards Kaupapa Māori methodology and considering a Māori audience. The current approach presented in this thesis better suits the engineering community, rather than Māori. There is a strong desire from all participants and the next generation of engineers to see changes in the engineering system, embracing the inclusion of Māori culture, Māori language, and, ultimately, Māori people to enhance the mana of Māori in engineering. This acknowledgment recognises that the process may take generations.

Ka pū te ruha ka hao te rankgatahi'

When an old net is worn out it is cast aside, and a new net takes its place.

When the present generation fades away the rising generation will take its place, representing new practices and new knowledge.

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Ngā Āpitihanga | Appendices

Appendix A: Information Sheets

School of Engineering
Faculty of Science and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

INFORMATION SHEET - SURVEY

Title: Māori education in Engineering - an invitation

As a Māori Engineer who is passionate about Te Ao Māori and Kaitiakitanga being incorporated into engineering, I invite you participate in a Survey using SurveyMonkey about your perceptions and experiences of Māori education in engineering, this should only take you 15mins to 30mins. This kōrero will play a large role within a Masters project at the University of Waikato. Here is a little more information about the research and survey process.

What is the purpose of this rangahau?

Māori culture is an integral part of our lives in Aotearoa. The role an engineer plays in society impacts on the economics, social, cultural and environmental components of any engineering activity. The understanding is that Māori are considered some of the most vulnerable to these impacts, and previously the engineering profession has been neglectful of cultural considerations in practice and through education. Policies and legislation are changing the engineering landscape where Te Ao Māori, mātauranga Māori and cultural competency is essential and valued in projects, The aim of this Masters research is to explore Māori education in engineering, and whether students value and understand how its relevant to the engineering profession. The voices collected from the surveys and interviews with assist in shaping the Māori education delivery and content delivered.

We're interested in hearing your voice on the kaupapa. This may include your interpretations, experiences, and understandings of Māori education, your cultural journey, and your experience in Māori education. Further questions may be asked as to how this links to wider aspects of your life and community.

What do I have to do?

We ask for you to complete a survey before the Māori education is delivered in the classes you are enrolled in (ENGEN170, ENGEN270, ENGEN370 and ENGEN570). After the Māori education is delivered a second survey will be asked to be completed also submitted. We also may ask to have ***One korero/ interview*** with you on this kaupapa at a place of your choosing, this is a volunteer process which will be indicated in the second survey. This can include via Zoom if convenient. The kōrero may take approximately 60mins, including time needed for whakawhanaungatanga and formalities. After each interview, your kōrero will be transcribed and returned to you to review and approve to be used in the research.

Who can take part in this research?

If you are currently enrolled in a Bachelors of Engineering at the University of Waikato and taking any of these papers ENGEN170, ENGEN270, ENGEN370 and ENGEN570, then you are eligible to take part in this study.

What are my rights as a kaikōrero/participant?

School of Engineering
Faculty of Science and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

- Your participation in this research project is entirely voluntary, you can withdraw at any point during the survey by not submitting; however, once submitting, withdrawal is not possible due to the anonymous nature of the survey.
- You can review your answers of the survey before selecting to submit.
- Your information will remain confidential, and if indicated, your identity will be anonymised within the research outputs using a pseudonym where necessary.

What will be done with my kōrero / Survey answers?

All of the kōrero data that you share from the survey will be analysed to find common themes or narratives on the kaupapa and will be kept on a password protected computer or a secure drive. Following this project, it will be stored for 5 years within the University of Waikato.

This rangahau will be published in the Masters thesis and will also contribute to the wider research reports, which you will have access to. The information may also be shared in other research conferences

.

Who is conducting this rangahau?

This research is being conducted by Masters of Engineering student Teresa Poi (Ngāi Tūhoe) through the University of Waikato. The Masters project is being supervised by Dr Mahonri Owen (Ngāpuhi, Ngāti Tūwharetoa), and Dr Mark Lay.

If at any time you feel uncomfortable, unsure, or participation in this research raises any concerns, please contact either:

Teresa Poli (Masters student)
Email: tap18@students.waikato.ac.nz
Mahonri Owen (Research supervisor)
Email: mahonri.owen@waikato.ac.nz
Mark Lay (Research supervisor)
Email: mark.lay@waikato.ac.nz

Ethical statement of approval

This research project has been approved by the Human Research Ethics Committee of the University of Waikato under HREC(HECS)2022#10. 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

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Faculty of Science and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

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INFORMATION SHEET - INTERVIEW

Title: Māori education in Engineering - an invitation

As a Māori Engineer who is passionate about Te Ao Māori and Kaitiakitanga being incorporated into engineering, I invite you participate in a kōrero/interview about your perceptions and experiences of Māori education in engineering and Te Ao Māori in engineering. This kōrero will play a large role within a Masters project at the University of Waikato. Here is a little more information about the research and interview process.

What is the purpose of this rangahau?

Māori culture is an integral part of our lives in Aotearoa. The role an engineer plays in society impacts on the economics, social, cultural and environmental components of any engineering activity. The understanding is that Māori are considered some of the most vulnerable to these impacts, and previously the engineering profession has been neglectful of cultural considerations in practice and through education. Policies and legislation are changing the engineering landscape where Te Ao Māori, mātauranga Māori and cultural competency is essential and valued in projects, The aim of this Masters research is to explore Māori education in engineering, and whether students value and understand how its relevant to the engineering profession. The voices collected from the surveys and interviews with assist in shaping the Māori education delivery and content delivered.

We're interested in hearing your voice on the kaupapa. This may include your interpretations, experiences, and understandings of Māori education, your cultural journey, and your experience in Māori education and the industry. Further questions may be asked as to how this links to wider aspects of your life and community.

What do I have to do?

We ask for you to have ***One korero/ interview*** with you on this kaupapa at a place of your choosing, this is a volunteer process which will be indicated in the second survey. This can include via Zoom if convenient. The kōrero may take approximately 60mins, including time needed for whakawhanaungatanga and formalities. After each interview, your kōrero will be transcribed and returned to you to review and approve to be used in the research.

Who can take part in this research?

If you are currently in the Engineering industry and identify as Māori, then you are eligible to take part in this study.

What are my rights as a kaikōrero/participant?

-If you have chosen to participate in the kōrero, you may withdraw within 2 weeks of participating in the interview process once receiving the transcript, the information will be deleted.
- Your information will remain confidential, and if indicated, your identity will be anonymised within the research outputs using a pseudonym where necessary.
- You are welcome to have whanau or a support person present during our kōrero.

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Private Bag 3105
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- You may ask questions about the project at any time.
- You may decline to answer any questions during the kōrero.
- You will receive an overview of the findings at the conclusion of the study.

What will be done with my korero/ interview?
All of the kōrero that you share will be recorded and transcribed and analysed to find common themes or narratives on the kaupapa and will be kept on a password protected computer or a secure drive. Following this project, it will be stored for 5 years within the University of Waikato.
This rangahau will be published in the Masters thesis and will also contribute to the wider research reports, which you will have access to. The information may also be shared in other research conferences
.

Who is conducting this rangahau?
This research is being conducted by Masters of Engineering student Teresa Poi (Ngāi Tūhoe) through the University of Waikato. The Masters project is being supervised by Dr Mahonri Owen (Ngāpuhi, Ngāti Tūwharetoa), and Dr Mark Lay.

If at any time you feel uncomfortable, unsure, or participation in this research raises any concerns, please contact either:
Teresa Poli (Masters student)
Email: tap18@students.waikato.ac.nz
Mahonri Owen (Research supervisor)
Email: mahonri.owen@waikato.ac.nz
Mark Lay (Research supervisor)
Email: mark.lay@waikato.ac.nz

Ethical statement of approval
This research project has been approved by the Human Research Ethics Committee of the University of Waikato under HREC(HECS)2022#10. 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 B: Consent forms

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Faculty of Science and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

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Tēnā koe kaikōrero/ participant

We invite you to participate in a Research to investigate perceptions of current Māori education taught in Engineering.

If you agree to participate, you will be interviewed on:

1) Your cultural journey – if you have one.
2) Your perception of the Māori engineering education

The interview is expected to take up to one hour. We may also invite you to participate in follow up interviews which may take up to, or between one to two hours. The interviews and workshops will be recorded, transcribed, and copies sent to you for validation. All responses will be treated as confidential and participants allocated pseudonyms. The data obtained will be examined for common themes and points of interest and used to prepare a thesis. The findings and conclusions gained will be shared with all participants to provide an opportunity for feedback prior to publication.

The findings will be presented at conferences, in a thesis and journals.

You may withdraw as a participant from this project at any time by advising Teresa Poli (tap18@students.waikato.ac.nz), Mark Lay (mark.lay@waikato.ac.nz), or Mahonri Owen (Cultural Advisor - mahonri.owen@waikato.ac.nz). For any concerns that cannot be resolved, please contact the Chair of the Ethics Committee, Brett Langley (email brett.langley@waikato.ac.nz)

Thank you for helping us with our research.

Yours sincerely,

Teresa Poli

School of Engineering
Faculty of Science and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

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Te Whare Wānanga o Waikato

Participant Consent Form

I agree to participant in this research.

In doing so I understand that:

- I will not be identified in any way in any publication or presentation
- Any interview notes will be provided to me for validation
- The data obtained will be used for publications, presentations and commercial use
- I can withdraw from the project at any time
- If I withdraw from the project, data collected (survey forms, interview notes) and hardcopies will be removed from the database and destroyed

Name:_____

Address:_____

Email:_____

Phone:_____

Signed:_____

Date:_____

Appendix C: Question Guides for Survey & Whakawhitinga Kōrero

Survey Question Guide

*Participants will be provided with Participant Information Sheets and Consent forms.

1. Have you read the Participant Information Sheet and consent to participating in this study?
   - Yes
   - No

2. Gender:

3. Year at university:

4. Degree:

5. Major:

6. What is your ethnic background (e.g. race, culture, tribe, iwi, hapu)?

7. At what level of education have you received Māori education (tick all applicable boxes)
   - Kindergarden/ Early childhood
   - Primary School
   - Intermediate
   - Highschool
   - Certificate/ diploma
   - Bachelors
   - Masters
   - Kura
   - No Māori education received

8. At what level of education have you received Māori education (tick all applicable boxes)
   - Kindergarden/ Early childhood
   - Primary School
   - Intermediate
   - Highschool
   - Certificate/ diploma
   - Bachelors
   - Masters
   - Kura
   - No Māori education received

9. What was included in your Māori education (tick all applicable boxes and indicate your proficiency on a scale of 1 (not proficient) - 5 (expert)
    - Māori history
    - Māori cultural beliefs
    - Māori traditions
    - Māori language
    - Māori protocol on a Marae
    - Treaty of Waitangi

10. Please answer the following statements in engineering
    - Engineers need to speak Te reo Māori in the work place
        - Strongly agree
        - Agree
        - Neither agree nor disagree
        - Disagree
        - Strongly disagree
    - Iwi/ Tangata whenua need to be at governance level in projects
        - Strongly agree
        - Agree
        - Neither agree nor disagree
        - Disagree
        - Strongly disagree
    - Iwi need to be engaged with prior to starting a project
        - Strongly agree
        - Agree
        - Neither agree nor disagree
        - Disagree
        - Strongly disagree
    - There is a connection between te tiriti o Waitangi/ Treaty of Waitangi and Engineering
        - Strongly agree
        - Agree
        - Neither agree nor disagree
        - Disagree
        - Strongly disagree
    - Māori design principles can help with equitable outcomes
        - Strongly agree
        - Agree
        - Neither agree nor disagree
        - Disagree
        - Strongly disagree

11. Cultural competency and understanding Te Ao Māori (Māori worldview) is important in engineering?
    - Strongly agree
    - Agree
    - Neither agree nor disagree
    - Disagree

- Strongly disagree

12. Is there anything you would like to learn about Maori culture?

Secondary survey

*Participants will be provided with Participant Information Sheets and Consent forms.

1. Have you read the Participant Information Sheet and consent to participating in this study?
   - Yes
   - No

2. Gender:

3. Year at university:

4. Degree:

5. Major:

6. What is your ethnic background (e.g. race, culture, tribe, iwi, hapu)?

7. Please answer the following statements in engineering
   - Engineers need to speak Te reo Māori in the work place
     - Strongly agree
     - Agree
     - Neither agree nor disagree
     - Disagree
     - Strongly disagree
   - Iwi/ Tangata whenua need to be at governance level in projects
     - Strongly agree
     - Agree
     - Neither agree nor disagree
     - Disagree
     - Strongly disagree
   - Iwi need to be engaged with prior to starting a project
     - Strongly agree
     - Agree
     - Neither agree nor disagree
     - Disagree
     - Strongly disagree
   - There is a connection between te tiriti o Waitangi/ Treaty of Waitangi and Engineering

    - Strongly agree
    - Agree
    - Neither agree nor disagree
    - Disagree
    - Strongly disagree
- Māori design principles can help with equitable outcomes
    - Strongly agree
    - Agree
    - Neither agree nor disagree
    - Disagree
    - Strongly disagree

8. Cultural competency and understanding Te Ao Māori is important in engineering?
    - Strongly agree
    - Agree
    - Neither agree nor disagree
    - Disagree
    - Strongly disagree

9. Is there anything you enjoyed about the course?

10. Is there anything you wish you had learnt that was not included in the course?

11. Is there anything you would like changed about the delivery style of this course?

12. If you would like to be involved in interviews please submit details
    - Name:
    - Contact Email:

13. Is there anything you wish you had learnt that wasn’t included in the course?

14. Is there anything you would like changed about the delivery style of this course?

Interview – Whakawhiti Kōrero Guide

Consent form

Introduction

- Where are you from
- Your education and where you grew up
- How did you end up here
- Did you study engineering
- What field of engineering in the business are you in?
- Have you got a mentor or someone you look up to, who is it?

What is engineering in a Te Ao Māori context?

- What are you thoughts on Te Ao Maori and Te Reo in the engineering industry?
- What are your thought on iwi engagement in engineering?
- What is the connection between Te tiriti o Waitangi/ Treaty of Waitangi and Engineering?
- How does being Māori come into play in your thinking of what is engineering?

What is engineering education?

- How do you learn best?

What can make this work place amazing and what would make you come here.

- Talk about you experience, what you've seen, heard, and feel in these spaces
- How do you bring your full self to this space?

What do you think helps create a culturally safe space for you?

- Where have you felt safe?
- What happened in occasions that you didn't feel safe

Where do you see the future of the engineering profession?

- What did you want engineers to know to help the engineering profession to be better Titriti o Waitangi partner?
- What would help your peers/ colleagues to participate?

Closing comments

Appendix D: Ethics Approval Letter

The University of Waikato
Private Bag 3105
Hamilton, New Zealand, 3240
0800 WAIKATO (924 528)

HECS Human Ethics Committee
Brett Langley
Telephone +64 77 838 4060
Hecs-ethics@waikato.ac.nz

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

30 March, 2022

Teresa Poli
Mark Lay
Mahonri Owens
Megan Boston

Re: HECS Ethics Approval of Application HREC(HECS)2022#10 "How to incorporate Māori education into Engineering"

Dear Teresa:

Thank you for submitting your amended application HREC(HECS)2022#10 for ethical approval.

We are pleased to provide formal approval for your project, including the following activities:

- Recruitment of up to 400 Engineering student participants for two surveys about their perceptions and experiences of Māori education. Up to 40 of the survey respondents may also recruited for interviews on the same subject.
- Survey participants will complete the two surveys before and after Māori education is delivered in ENGEN170, ENGEN270, ENGEN370 or ENGEN570. The survey is anonymous (Moodle link to Survey Monkey) and should take 15 to 30 minutes to complete. Participants can withdraw at any point during the survey until it is submitted.
- Interviews may be face-to-face or on Zoom and take up to 60 minutes. Participants can withdraw at any point during, and up to two weeks after the interview.

Please contact the committee by email (hecs-ethics@waikato.ac.nz) if you wish to make changes to your project as it unfolds, quoting your application number with your future correspondence. Any minor changes or additions to the approved research activities can be handled outside the monthly application cycle.

We wish you all the best with your research.

Kind regards,

Brett Langley, PhD
Chairperson
HECS Human Ethics Committee
University of Waikato

Appendix E: Published Journal Article

Building the Cultural Capacity of Engineers in Aotearoa, New Zealand: A Students Perspective

33rd Annual Conference of the Australasian Association for Engineering Education (AAEE 2022)
4 - 7 December 2022 – Sydney, NSW

Building the Cultural Capacity of Engineers in Aotearoa, New Zealand: A Students Perspective

Teresa Poli[a] , Mark Lay[b], Mahonri Owen[c] and Megan Boston[d].
Masters Student, University of Waikato[a]; Senior Lecturers, School of Engineering, University of Waikato[b,c,d]
tap18@students.waikato.ac.nz

ABSTRACT

CONTEXT

Like many countries in the world, Aotearoa, New Zealand has a dependence on the engineering profession to add value to the economy, respond to community needs and improve the lives of its inhabitants. However, New Zealand's society is unique in that it houses both "Mātauranga Māori" (the indigenous knowledge system) and a "western knowledge system". As a result New Zealand based engineers require additional skills to navigate and respond to community needs in unique, equitable and innovative ways. One way these skills can be taught is through the accredited engineering programmes New Zealand Universities offer.

PURPOSE

This study investigates Māori education within the School of Engineering at the University of Waikato with respect to building cultural capacity relating to Māori (the indigenous people of New Zealand).

METHODOLOGY

This study uses a teaching intervention in a core engineering subject to investigate and develop student understanding about the Māori and their needs. The intervention was facilitated by a Māori Engineering lecturer from the University of Waikato.

The study attempted to understand student perceptions of responding to and including Māori perspectives within engineering and evaluating how effective the intervention was with regard to the following research questions:

- What are the engineering students familiarity in current education with regards to Māori culture and beliefs
- What are the student perceptions of the necessity of including Te Ao Māori
- Do students understand the connection of Te Tiriti o Waitangi (The Treaty of Waitangi) and engineering
- What were students' perceptions of the course, and any suggested improvements.

CONCLUSION

The study found the engineering students had limited knowledge of Māori cultural beliefs, Māori traditions, and Māori language, however there was a strong desire to learn more. The information provided from the study indicated that there is a need from the student perspective as well as a societal perspective for the engineering curriculum to catch up to other professional degrees in including Mātauranga in their curriculum.

KEYWORDS

Engineering, education, Indigenous, Te Ao Māori, Building cultural capacity, Graduate attributes

Introduction

Engineering consists of mathematical and scientific problem-solving skills and design to provide creative solutions for industrial and societal problems. However, the engineering qualification often overlooks the soft skills required to be an engineering professional. Our engineering qualification is focused heavily on ensuring students are equipped with strong technical backgrounds in mathematics, modelling, and design. As engineers we are so often pigeonholed into the finer technical details that we often forget the bigger picture such as how our project contributes to society and the people it supports. Due to this we need to better prepare our engineering graduates for the workforce, the stakeholders they meet and work that they will complete for communities. Just like in science, there are a multitude of ways to approach an engineering challenge, and looking at it through a cultural or Western lens can often inspire new ways of solving the problem (Cross et al., 2020).

Many companies and organisations are beginning a journey where they are building cultural intelligence through more frequent use of Te Reo Māori (language), tikanga (cultural practices) and Mātauranga Māori (cultural knowledge). It is becoming more common that these skills are required in modern day jobs. This journey is influenced by the following:

- Vision Mātauranga - New Zealand's science policy that requires that Te Ao Māori (world-view) be included in all aspects of the research and innovation sector ("Vision Mātauranga | Ministry of Business, Innovation & Employment", 2022).

- The growing Māori economy. Iwi (Māori tribes) are having a much greater contribution to New Zealand's economy. This has a direct effect on industry and the activities it undertakes ("Te Ao Māori Trends and Insights", 2017).

- The government incorporation of equity, diversity and inclusion into many of its funding structures for science and engineering research and business and enterprise.

- International desire for Māori products, businesses and enterprises as they are unique and innovative (Ruckstuhl et al., 2019).
- Te Tiriti o Waitangi (The Treaty of Waitangi) - the treaty between the Māori and the Crown ceding governance to the Crown, while retaining chieftainship of their land, villages and treasures, and giving Māori full rights and protections as British subjects.

- Development of groups like Taumata Aronui, which provides advice to tertiary education providers on how to better meet the needs of Māori learners and communities.

Building cultural intelligence and competence in students is becoming a necessity in our education curriculum to produce well rounded professionals. However, there must also be a shift in the mindset of the tertiary institutions to work between cultures, instead of just through plans and strategies in a Western manner, as we have seen that does not always work and can marginalise indigenous cultures. In 2020, The University of Waikato underwent an internal review after public claims of racism were made at the university. The findings showed that the university markets itself as having a commitment to Māori, however the internal management structures, world view and knowledge base from it operates embodied Western university culture and practices. A part of the findings were that reconciliation with Māori and mana restoration were required (Satyanand, Gardiner & Parata, 2022).

While New Zealand universities have often operated within a western framework, they have developed plans to support Māori aspirations. The University of Waikato has a strategic planning framework of which a key feature is the Māori Advancement plan. This plan is intended to uphold

the University's charter and their commitments to Te Tiriti o Waitangi (Treaty of Waitangi), as well as to support the university's mana as a leading university for Māori. While there are four goals highlighted in the plan, goal three regarding the integration of kaupapa (Māori policy), tikanga, Te Reo and Mātauranga into the university experience should be highly embraced. The Māori Advancement plan describes how the university will achieve this goal (The University of Waikato, 2014):

> *Explore opportunities to infuse the curriculum with Māori knowledges and perspectives, to ensure graduates of the University have a level of bicultural awareness and capability that enhances their contributions in the workforce and in society generally.*

Often these plans and strategies have not been enough, so Taumata Aronui was established to assist in designing an education system that supports partnership between the Crown and Māori. Some of their recommendations for the tertiary education space included the need for commitment to Mātauranga Māori, Te Reo Māori and Tikanga Māori in practice and in philosophy for the education sector to support and promote cultural revitalisation (Taumata Aronui, 2022).

The engineering curriculum at the University of Waikato has not had an emphasis on integrating Mātauranga Māori. What has been available to students in their learnings regarding cultural capacity was previously a handful of lectures delivered about Te Tiriti o Waitangi (Treaty of Waitangi), the Resource Management act and the consenting processes. These lectures were often taught from staff outside the engineering faculty. This is a shame, as there have been New Zealand engineering projects which have been undertaken which have had poor engagement practices with Māori. When we are not effectively engaged and partnered with Māori in the right way, it can lead to increased project costs, mistrust, and resistance by Māori. Often, these relationships can be seen as a "tick-box exercise", however when engineers really listen and embark on the journey with Māori and have Māori at decision making levels, it can change the way we undertake our projects, for example New Plymouth Airport with local hapū (sub-tribe) Puketapu. The airport project allowed hapū to lead and provide visibility of their culture and creation narrative through the design (Philp, 2021). These partnerships should not be limited just to formal obligations, i.e. a "tick-box exercise", therefore it is an important component to consider in education for engineers.

Understanding the value of and implementing Mātauranga in engineering projects will help broaden our knowledge base. There are several instances where Mātauranga has supported or inhibited infrastructure. An example where appreciating Mātauranga and incorporating it into a project has been successful was the establishment of a marae in Matatā. This marae is sited close to the Waitepuru stream. The stream was blocked with debris as a result of extreme weather in 2005 and its path had shifted. The marae was not affected, as the local Māori had selected locations of the marae away from the shifting path of the Waitepuru stream. This knowledge had been embedded in the form of pūrakau (storytelling/ Māori narrative), where the stream is depicted as a ngārara (Lizard), where the hiku (tail) flickered. The tail of the stream is in the low-lying sections of land and often changed with large floods, which indicated to Māori not to build in those sections (Thompson, 2020). Furthermore, another instance in which Mātauranga could have supported an engineering project was in 2002, the Waikato expressway near Meremere. There was a small wetland and a culturally significant site where the local Māori believed a Taniwha (supernatural creature) had lived. There were several fatal road accidents believed to be caused by the Taniwha due to the road disrupting its habitat (Hamsworth, 2005). The articles regarding the project were conflicting as to whether there was an effective partnership with the local Māori. However, if Māori were engaged with, perhaps the Mātauranga could have shaped the project differently to prevent accidents. Incorporation of Mātauranga and engineering knowledge could change the way we design, and also improve our partnerships with Māori, providing them with a voice.

The engineering curriculum is driven by the Washington Accord, which is an agreement between engineering tertiary degree providers regarding 12 key attributes graduates should have to be a good professional engineer ("Washington Accord » International Engineering Alliance", 2022). There are five graduate attributes listed in Table 1 which consist of soft skills required to be an engineering professional. The cultural component of these skills are often over looked or addressed superficially and technical skills have higher importance.

Table 1: Washington Accord Graduate Attributes that highlight soft skills (International Engineering Alliance, 1989)

Washington Accord Graduate Attributes	Description
WA3: Design/ development of solutions	Problem solving of complex engineering problems which can consider specific cultural, societal and environmental considerations.
WA6: The engineer and society	Use reasoning informed by contextual knowledge to assist in societal, legal and cultural issues impacting on engineering problems.
WA7: Environment and sustainability	Understand and evaluate the sustainability and impact of the professional engineering work.
WA8: Ethics	Apply ethical principles and commit to professional ethics and responsibilities.
WA10: Communication	Communicate effectively on complex engineering activities with the engineering community and with society.

In New Zealand, Te Ao Rangahau (Engineering New Zealand) monitors and assesses the tertiary institutes offering engineering programmes. Engineering New Zealand recognises the importance of engaging with Iwi and Māori and letting the voices of the Māori community be heard. However, there is a lack of representation of Māori in the industry ("The ABC of inclusion and diversity | Engineering New Zealand", 2018). Recently, Engineering New Zealand had proposed building Te Ao Māori capabilities into their governing board by appointing a Māori Board member (Johnson, 2022). Engineering NZ did note that it is not ideal to solely rely on one member to speak for the Māori community, therefore the governing board is required to build Te Ao Māori capability amongst the full team ("Building Te Ao Māori capability on our Board | Engineering New Zealand", 2021).

While the leadership in the engineering profession recognise the importance of building cultural capability, we do not have enough Māori in the industry to do this alone. Cultural competency, cultural intelligence and building Te Ao Māori capabilities are not new concepts, it is just taking some time to reach the workforce in the engineering sector. The health and legal sectors have already undergone a shift. In the health industry the Hauora Māori curriculum is offered, which covers indigenous rights, impacts of colonial history on indigenous health, Māori protocol and models of care (Medical Council of New Zealand, 2019). Law education in New Zealand has also undergone a transition ("New Zealand Council of Legal Education", 2021), where in 2021 the New Zealand Council of Legal Education mandated the inclusion of Te Ao Māori in the legal curriculum taught at universities (Clement, 2021).

Tertiary teaching in different disciplines all have commonalities regarding equal access and opportunity for everyone, as well as creating safe environments to support the needs of local and regional community groups, while also aiming to achieve bicultural relationships and partnerships underpinned by the Treaty of Waitangi (Mackinnon & Te Aho, 2004). Therefore, due to the shift in the education and industrial landscape with the incorporation of Te Ao Māori, the engineering curriculum at the University of Waikato also needs to better include Te Ao Māori to better prepare engineering students for industry.

For the purpose of this study, an intervention was facilitated by a Māori engineering lecturer to incorporate three lectures of Māori education into the current curriculum for a third year engineering course. The aim of this study was to understand the following:

- Student backgrounds and how to best engage with them

- Engineering student familiarity with regards to Māori culture and beliefs
- Student perceptions regarding the necessity of including Te Ao Māori in engineering education
- Student perceptions regarding the connection between The Treaty of Waitangi and engineering
- Student perceptions of the course, the intervention and suggested improvements

The associated potential outcomes from introducing this intervention include

- Contributing to reducing racism held in the profession
- Better understanding stakeholders that engineers may come across in their profession
- Better understand how to engage and liaise with stakeholders
- Better understand Māori aspirations
- Better appreciate and understand engineering's connection to The Treaty of Waitangi

Methodology

The University of Waikato offer a series of four papers (courses) that provide the students with development of soft skills required for the engineering profession. The papers are considered the ENGENX70 papers and are titled Engineering and Society (ENGEN170), Engineering and Business (ENGEN270), Engineering and the Environment (ENGEN370), and Engineering and the Profession (ENGEN570). ENGEN370 provides students with skills to assess and address environmental challenges ("Waikato Paper Outlines", 2022). It includes the evaluation of engineering practices and projects through assessment tools such as life cycle analysis, environmental and societal impact assessment and resilience and risk analysis. It also teaches the principles of designing to reduce the impact of projects on the environment. As part of the course, students organise themselves into groups, identify an environmental problem they would like to solve, propose a solution for the problem, and then assess the solution using life cycle assessment, impact assessment and risk and resilience assessment. ENGEN370 was chosen for the teaching intervention due to the obvious connection between Te Ao Māori and the environment because the environment is entwined in the Māori identity and spirituality (Poa, 2020).

The intervention in this course consisted of three lectures in Māori education. The Māori education component included the following:

- The Treaty of Waitangi
- The interface between Te Ao Māori and engineering
- Māori knowledge / Mātauranga
- Navigating relationships with Māori
- Understanding Māori Aspirations
- Engagement and partnership - case study examples of bilateral partnerships
- Cultural competency in the Aotearoa context
- Understanding tikanga – Māori protocol and customs
- Pōwhiri/ Whakatau – Māori welcoming ceremonies, including informal and formal procedures
- Understanding Whare Tipuna - Māori meeting house

Students enrolled in ENGEN370 were asked to participate in a survey regarding their perspectives of the Māori education component once the teaching intervention had concluded. The survey asked students to rate their own knowledge of Te Ao Māori, what previous exposure they have had to Māori education, and what Māori knowledge and skills they thought were required in the engineering profession.

The survey included the following questions:

1. What gender do you identify as?
2. What year at university are you?
3. What degree are you studying?
4. What major are you studying?
5. What is your ethnic background?
6. What level of education have you received in Māori education prior to now?
7. Rank your proficiency of: Māori history; Māori cultural beliefs; Māori traditions; Māori language; Māori protocol on a Marae; Treaty of Waitangi.
8. Rank your agreement/disagreement to the following:
    - The need in engineering to speak Te Reo Māori in the work place
    - The need of iwi / tangta whenua to be involved at the governance level in projects
    - The need of iwi to be engaged prior to starting a project
    - The connection between the Treaty of Waitangi and engineering
    - The importance of cultural competence and understanding Te Ao Māori in engineering
9. Your enjoyment of the Te Ao Māori lectures and workshop
10. Is there anything you would like to learn about Māori culture?
11. Is there anything you really enjoyed / anything interesting you learnt?
12. Is there anything that could be done to improve the course?

The study was approved by the Human Research Ethics Committee of the University of Waikato under HREC(HECS)2022#10.

Results & Discussion

Approximately 12% of the students enrolled in the course (16 participants out of 130 students) participated in the survey. While this seems low, this was actually a good response rate compared to other engineering surveys such as class evaluations where only 2-5% of the class participant in the evaluations. All of the participants in the survey identified their gender as male. While it would have been better to have a mixture of genders in the respondents, only 20% of the students enrolled

in the course were female. The majority of the participants (94%) were three years into their engineering qualification, while remainder were in year two. The participants consisted of students from mechanical (37.5%), civil (25%), software (25%), mechatronics (6.25%), and electrical/ electronic engineering (6.25%) (Figure 1).

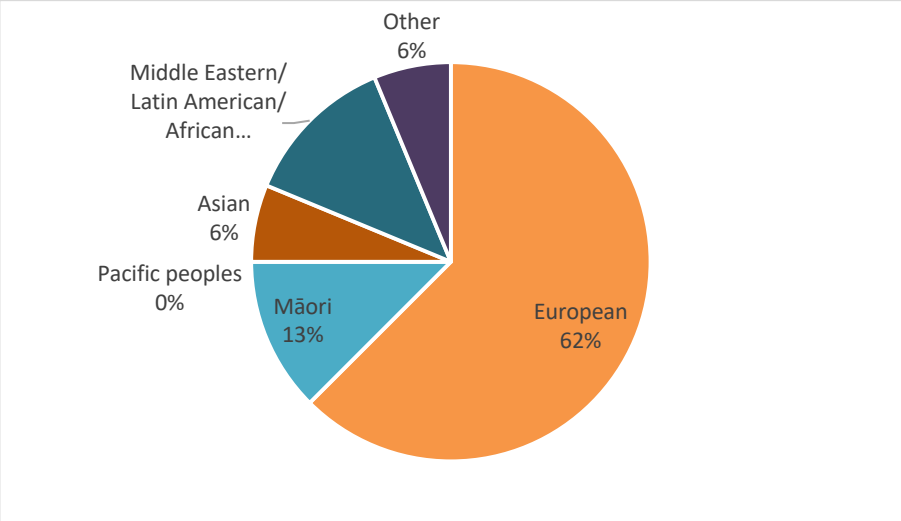

Figure 1: Participant ethnic background

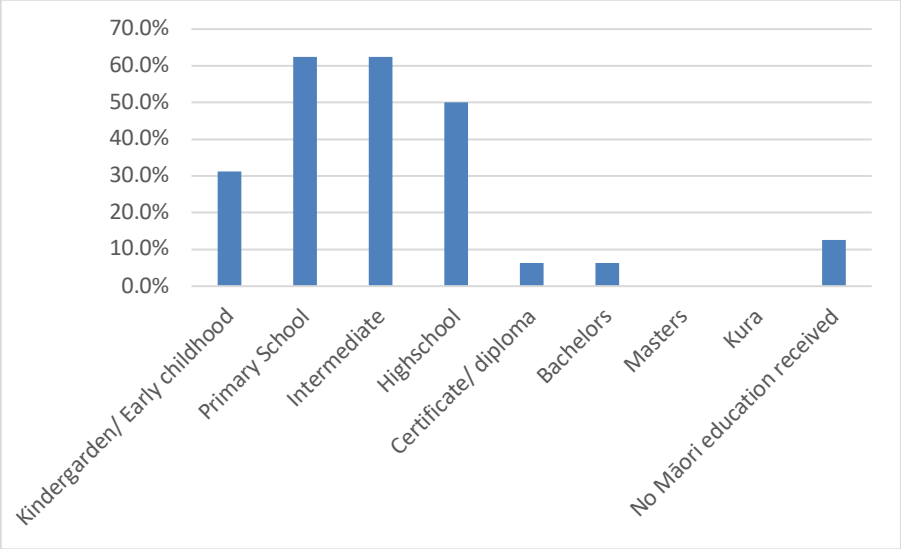

Figure 2: Participants previous Māori education

The majority of respondents had received previous Māori education in primary and intermediate school (62.5%) while 50% of participants had received Māori education in high school. Only two participants have not received any prior Māori education.

Assessment of engineering student familiarity with regards to Māori culture and beliefs

The survey participants ranked their competency in Māori history, cultural beliefs, traditions, and language. It was seen that 50% of respondents ranked themselves as being “somewhat competent” in Māori history, with 8.33% being “competent”. The respondents that believed they are competent in Māori history had also indicated they had received prior Māori education throughout their education at primary school, intermediate and high school. This allowed the students to continually

build on the knowledge they had previously learnt, as well as further retaining the knowledge they had already gained.

Surprisingly, 36.4% of respondents believed they were experts or competent in marae protocol while 27.3% of respondents believed they were not competent in marae protocol. It is uncertain why so many participants claimed to be competent in marae protocol. The lead author, even being Māori, did not have an opportunity to visit her marae until she was 22 years of age, while the second author had stayed on a marae numerous times, in one instance for nine days (he would still not claim he was an expert in marae protocol). Having said that, there are a variety of marae education packages and visits that people and schools can participate in. There is also opportunity to visit Te Tii Waitangi marae where Te Tiriti o Waitangi was signed ("Te Tii Waitangi Marae | National Library of New Zealand", 2022).

The majority of students said they were unsure or not competent in Māori cultural beliefs (85.7%) and traditions (71.4%), 88.9% said they were not competent or somewhat competent in Te Reo Māori language.

According to the Ministry of Education, teaching Māori in the school curriculum was not compulsory ("Frequently asked questions / Te Reo Māori in Schools Strategy / Professional learning / Home - Te Reo Māori", 2022). However, from 2023 all schools and kura will be required to teach Te Takanga o Te Wā (Māori history) and Aotearoa New Zealand's history, to understand how the two histories have shaped the country ("Aotearoa New Zealand's histories and Te Takanga o Te Wā", 2022). This change will enable future engineering students entering tertiary education have a deeper base knowledge of Māori history.

Understanding the student perceptions of the necessity of including Te Ao Māori

It was clear that students believe that inclusion of Māori were significant for projects. 56.3% of students agreed to strongly agreed that Iwi / tangata whenua need to be included at governance level in engineering projects. 75% of participants believed that iwi need to be engaged with prior to starting a project. 56.3% of participants agreed to strongly agreed that cultural competency and understanding Te Ao Māori is important in engineering, while 25% strongly disagreed.

The statement which exhibited a high level of disagreement was “Engineers need to speak Te Reo Māori in the work place”, where 56.3% disagreed to strongly disagreed. There were 37.5% that neither agreed nor disagreed. Observing the class undertaking the survey, the lecturer said “There was a lot of interest in the idea that engineers should be able to speak Māori in the profession. I noticed the students got really passionate about it, to the point where the quiz stopped and they started to debate within the lecture theatre”. Often when people do not agree with information they automatically reject it, particularly if it does not align with their previous beliefs (Kappes, Harvey, Lohrenz, Montague & Sharot, 2019).

Understanding the importance of Bilateral relationships with Māori

Bilateral relationships was an important concept covered in the intervention, as relationships with Māori can be considered “ticking a box”, particularly if participating in engagement or consultation with Māori is forced due to there being laws or rules rather than something that is genuinely desired. Through the intervention students were exposed to case studies regarding bilateral partnerships such as Te Awa, the shopping mall at the Base in Hamilton, New Zealand. The shopping mall was a bilateral partnership which enabled the incorporation of Māori design, reflective of the culture of the Waikato-Tainui people. The building resembled a Māori waka (canoe), and included elements signifying the local environment, the Waikato river and the landscape. By providing the opportunity to local iwi to collaborate in the design, allowed for Waikato-Tainui carvers to be involved and Māori stories to be shared through their art (Hawkes, 2012).

When students were surveyed regarding this part of the intervention, there were many comments about “learning about relevant groups for consultation” and they “felt better prepared for industry”. Students also mentioned that the partnership prompts were useful, and that they “hoped to apply these when they got into the industry”. The partnership prompts were presented during the intervention, as follows:

- What Māori processes, resources and people are affected by what's being done?
- Is the partnership mutually beneficial?
- What do both parties contribute? (Kaupapa, Tikanga, Mātauranga)
- How do I make sure what I am bringing to the table is valuable? (understanding Māori aspirations).
- Do all parties benefit equally from the outcome and partnership?
- What Te Tiriti (Treaty) principles apply to what I am doing?
- Is there a kaitiaki of the process or resource you are impacting?

Another comment made by students was the lack of understanding and knowledge about the New Zealand government's Vision Mātauranga policy. The policy aims to develop the science and innovation potential of Māori knowledge, resources and people in the following areas: indigenous innovation, the environment, health and social well-being, and indigenous knowledge. The aim of the policy is to build the capability of Māori individuals, organisations, rūnanga, trusts, iwi, hapū, and marae to engage with science and innovation to benefit New Zealand as a whole. This policy recognises Māori as partners in science and innovation, seeks to promote relationships between Māori and the science and innovation sectors, and to ultimately recognise Mātauranga Māori as a valid knowledge system in science and innovation. This is important, particularly leading into the fourth-year engineering projects where students are asked how their project relates to Vision Mātauranga.

Engineering organisations which recognise Mātauranga as a valid knowledge base to support engineering and science activities will help ensure successful project outcomes such as the siting of the marae adjacent to the Waitepuru stream, in this instance by recognising the value of pūrakau as a source of knowledge. A key element supporting genuine engagement with Māori is the acknowledgement that Māori have the resources and capability to contribute (Guidelines for engagement with Māori, 2022). Through the use of education and supporting our engineering graduates to understand and adopt these mindsets, they will be able to have better partnerships with Māori in projects.

Assessing the connection between Te Tiriti o Waitangi and engineering

The participants were surveyed around their competency of Te Tiriti o Waitangi (The Treaty of Waitangi), 50% said they were competent to expert level. There were 56.25% of the participants agreed to strongly agreed there is a connection between Te Tiriti o Waitangi (The Treaty of Waitangi) and engineering. Both areas are important points to explore further, particularly how students would define what makes them competent regarding Te Tiriti o Waitangi (The Treaty of Waitangi), but also to educate the students further in how engineering relates to Te Tiriti o Waitangi. While governance of Māori is ceded to the Crown, Māori still retain chieftainship of their lands, which means they should still have a say in what engineering activities are undertaken on their lands, particularly when looking at major civil or infrastructural projects that have a significant impact on the land, resources and people.

Evaluation of the course, and suggested improvements

The content and delivery style of the intervention were evaluated by the participants. A large proportion, 81.25% of participants, were satisfied or really enjoyed the Māori content. The positive feedback included comments from students looking forward to the ENGEN570 paper. Many students felt the content was comprehensive and students felt encouraged by the inclusion of this content.

Highlights of the course noted by participants include the Whare Tipuna challenge, and building and understanding the wharenui. Participants had noted that they did not know much prior to these learnings, or students which knew some components were also introduced to new concepts. Some of these new concepts which came up often were around the powhiri, understanding the challenge

process on marae, and having a better understanding of marae traditions. A participant had said they:

> *"enjoyed just thinking about Te Ao Māori again, hearing the language. Learnt bits and piece they hadn't heard before, like the mention of other relevant groups to consult for a project – good to be more prepared for the social structures and be open minded to realise one group may likely not be the only one of relevance. also hadn't heard of vision Mātauranga before."*

There was a small minority group, which accounted for 12.5% of the class, who said it was terrible in their opinion. In response to the question "Is there anything you really enjoyed/ anything interesting you learnt?", one student said

> *"That the first thing was said was the lie that 'Māori are the indigenous of New Zealand'. In recent years changes have been made to the understanding and legislation surrounding the treaty of Waitangi to properly include the Mori Ori of which were in New Zealand before the Māori. History is written by the Victors".*

This was interesting as research into Moriori language and genealogy suggests the Moriori were actually Māori Polynesians who migrated from mainland New Zealand to the Chatham Islands in the 1500's, and their dialect has similarities with the Ngāi Tahu tribe of the South Island. The Chatham islands were invaded by displaced Māori from the Ngāti Mutunga and Ngāti Tama tribes, and due to a misunderstanding, resulted in a massacre of the Moriori.

What could be added/ what do you want to know

Out of the nine respondents that answered the question: "Is there anything you would like to learn about Māori culture?", three participants said that there was nothing more they would like added to the course or they were unsure. A third of the participants said they would really like to learn more or improve their Te Reo Māori. There was a desire to also learn more about Māori culture, myths, beliefs and history, as well as understanding more about how Māori were engineers, such as how they would hunt, and build waka and wharenui.

Improvements to the course

The participants were encouraged to suggest improvements to the course from improved teaching styles to the content covered. Just over a quarter of the participants who commented said to continue in the same direction, and the current course was enough.

A response from a participant noted it would be better to align the course more closely to engineering. Some of the other responses suggested removing any Māori content from the course or making the course voluntary. One participant said:

> *"If something has to be included think about it as an international level instead of pigeonholing to New Zealand. An engineering degree is of science, not politics."*

In contrast, another student noted that:

> *"Having a set of Māori lectures is nice, but to truly convey Te Ao Māori and Mātauranga Māori I believe a stronger move would be to have papers convened by Māori (engineer) lecturers. That way, rather than a handful of Māori lessons in a paper you could have a paper where Mātauranga Māori infuses the whole paper."*

This student also noted:

> *"If we are trying to teach Māori worldview then teach the normal material through that lens. Otherwise it is merely a check box exercise."*

Law education in New Zealand had undergone a transition, where in 2021 the New Zealand Council of Legal Education mandated the inclusion of Te Ao Māori in the legal curriculum taught at universities. Te Ao Māori concepts were incorporated into every law subject ("New Zealand Council of Legal Education", 2021).

Students who were against learning Te Ao Māori, had strong opposing views. Comments like "*…An engineering degree is of science, not politics*", show ignorance in Māori cultural revitalisation (Doerr, 2009). The Vision Mātauranga policy that was introduced by Ministry of Business, Innovation and Employment, was developed to assist in the recognition of Māori and their knowledge being an

important component of science and innovation. One student showed their bias that engineering and Māori education were two very separate topics, when in fact engineering is conducted in the context of society and their needs, i.e. society drives what engineering projects are conducted according to what is acceptable socially, culturally and politically at time. People learn to be whatever their society and culture teaches them (Wan & Kaplan, 2017).

Other students suggested learning Te Ao Māori should be voluntary. These students are continuing to encourage silencing, a technique used to comfort and limit acknowledgment of the history and inequities experienced by priority groups. By encouraging cultural competency to be voluntary, this allows for those individuals to reaffirm their own perspectives, rather than confronting their biases and reflecting on what has happened previously (MacDonald, Smith & Funaki, 2021).

Neriko said “ignorance can empower some people to disempower others”, he spoke Te Reo being an issue due to some Pākehā (non-Māori) not understanding it rather than just embracing or promoting learning. If we continue to disempower Māori, through ignorance as a collective by not incorporating cultural competency into our engineering curriculum, we will further continue in creating a separation between Pākehā and Māori, as well as limiting the knowledge and potential opportunities for innovation our industry could have (Doerr, 2009).

There were a small minority of students who were opposed to what was taught. In other instances, resistance tactics were used to undermine what was taught about Māori. These tactics are often used to take attention away from the cause. Other resistance tactics used by those who do not want to learn about Te Ao Māori are diversion, denial, detriment-centring, and the demand to move on (Harris, 2018).

Style of teaching

The style of teaching can impact how a student receives and maintains information, and it is important for teachers to understand the students perspectives (Dennick, 2016). The teaching method applied to the delivery of this intervention would be classified as constructivist, where the students were given the opportunity to construct their knowledge rather than the typical lecture style of passively receiving information ("Constructivism", 2022).

It was found that half the participants had noted that they enjoyed the style of teaching, as they said it was more similar to a discussion rather than a typical lecture. One of participants said they:

> *“Enjoyed engagement, group conversations and open questions. The lecturer made them think by actually asking the class and waiting for answers”.*

Another participant noted:

> *“Felt a little rushed, some relevant content had to be skipped over for time’s sake, although I prefer that it was sacrificed so that a more robust understanding through conversation could be had.”*

The course permitted open discussion and was promoted as being a safe space for questions to be asked.

The style of the delivery suited the students needs and assisted with their enjoyment. Even though there was mention that lectures may had been rushed it indicated that the students wanted to be there, and wanted to learn more. The open discussion forum worked well in this study, however this could pose a potential risk of students asking questions to their group or lecturer which are confronting to their peers, and therefore could make some peers feel unsafe. This could be particularly true for Māori students when their cultural and belief systems may be questioned and scrutinised. Therefore, whoever is delivering the content, must navigate the fine line between robust discussion and students feeling their worldviews and values are being attacked.

Conclusion

The study found that the engineering students felt they had limited knowledge of Māori cultural beliefs, Māori traditions, and Māori language, however there is a strong desire to learn more. The style of teaching using a constructivist approach was appropriate and students found it an engaging way of learning.

Overall, the students felt that they enjoyed the content and students had noted that they looked forward to learning more in future years. There is a risk of cultural safety for Māori students being involved in these learning environments, with students who might not be culturally aware when asking questions. There would need to be further investigation on how to minimise this risk. There is the risk that incorporating Māori education lectures could be viewed as a 'tick box', therefore for the incorporation to be more meaningful, Mātauranga needs to be imbedded in the full paper for it to be done successfully. It is acknowledged that the response rate was low from the students who participated in the study. However, it still suggests that the next generation of engineers is ready to incorporate a different knowledge base into their curriculum and into the profession to better prepare themselves for Māori partnerships in projects. We can look to the legal education, where they have mandated the inclusion of Mātauranga. It is recognised that cultural capability is becoming more common, and engineering needs to move ahead and be progressive; our future generation, and our future engineers are ready.

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Acknowledgements

I wish to express my gratitude to my supervisors and Marama Salsano, who have helped my immensely throughout my kaupapa. I acknowledge your expertise, the valuable kōrero shared, contributions and support.

Copyright statement

Appendix F: Defining Thesis Terms

Engineering is technical and process driven (Geddam & Kaldor, 1993). This rangahau may be anchored in Kaupapa Māori Methodology, and whakapapa to engineering, therefore technical language will be used for context of the authors ideas. Before the waka sets for voyage, some clarification of terms which are specific to this thesis is important to establish.

Engineering is a complex journey. It is acknowledged the course of the waka may not be linear rather multidirectional, similar to an individual's engineering journey. This section will define the segments of an engineer's journey.

Engineering education

Engineering education is a part of the complex system of what makes up engineering (Cheville, 2014). Engineering education aims to train engineers to cultivate talents to meet national and international standards (Ye & Li, 2022).

Engineering education is defined by the lessons and design projects that which takes place in the delivery of curriculum to replicate engineering industry practices (Mills & Treagust, 2003).

Engineering education can be delivered in from university degrees, diploma levels and certifications. There is a range of formal qualifications accredited by Te Ao Rangahau, Engineering New Zealand. For the purpose of this rangahau engineering education will only cover the qualification type Bachelor of Engineering with Honours – BE(Hons). Engineering education in this thesis will cover a variety of specialisations, including biomedical, chemical and process, civil, computer systems, electrical, electronic, environmental, food, forest, mechanical, mechatronics, natural resources, network and communications, product development, and software engineering (Engineering New Zealand, Te Ao Rangahau, 2023).

The definition of engineering education in the context of this rangahau will only encompass the education delivered to engineers of Aotearoa, New Zealand. These three domains of engineering education are aimed at forming engineers who are intellectually trained, practically adept, and ethically responsible for their work (Sheppard, Colby, Macatangy, & Sullivan, 2006).

Engineering industry

In this rangahau Engineering industry is defined as the proceeding phase to an individual journey after engineering education. Engineering industry is not a term which has been defined in literature before, although the 'engineering practice' and 'engineering work' is defined. Engineering practice or work is defined as focusing on solving problems using calculations, consulting reference work or by acting in a way which helps recall a previously learned answer. Engineering work is affecting change in the worlds through the uses of processes, procedures, technology and the introduction of new products or knowledge (Sheppard, Colby, Macatangy, & Sullivan, 2006). Engineering work is ought to improve society and world for the common good. Engineering industry both influences and is influenced by society (Pleasants, 2012). Engineers will undertake a problem to solve for a solution, the problem is often a real or perceived need from a client. For example

`We need a means of ensuring that this 100-year old bridge meets modern-day safety and sustainability standards, while maintaining its distinct architectural features.'), the question may be posed as 'How do I reduce carbon emissions for a road?' `Will thermal cycling cause fatigue in the proposed solder joint configuration?' (Sheppard, Colby, Macatangy, & Sullivan, 2006).

For the purpose of this thesis engineering industry will adopt and apply the definition of engineering work and practice.

Engineering system

Engineering system is a term the author is adopting to describe the interface between engineering education and engineering industry (Geddam & Kaldor, 1993). An engineering system describes the integration of the two key phases of an engineer's journey. An engineering system is governed by the institutions and professional bodies which accredits the engineering profession. In a New Zealand context, it is Te Ao Rangahau, Engineering New Zealand.

Whakarāpopoto: Chapter Summary

This section clarified terms which will be used throughout the rangahau. The terms used are specific to this rangahau and used to assist in interoperating the phases of an engineering journey.