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Ngā Inenga Māori: A Preliminary Study on Māori Measurement

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Contents

- 1. Introduction..... 4**
- 2. Overview..... 7**
- 3. Body 8**
 - Human-body Derived Measures..... 8
 - The Rauru 8
 - Possibility of Rauru as a Tribal Tool..... 9
 - Measurement Units 10
 - The Takoto Sighting 10
 - The Base-10 Unit 11
 - Māori Numeration 12
 - Ngahuru Theory 12
 - Counting Systems..... 13
 - Single Mode Counting..... 14
 - The Dual System..... 15
 - The Hoko- Prefix 16
 - The Decimal System..... 17
- 4. Whare Measures 18**
 - Whare Construction 19
 - Taura 20
- 5. Rauru and Its Many Meanings 21**
- 6. Conclusion..... 22**
- 7. Acknowledgements 24**
- 8. References..... 25**
- 9. Glossary..... 28**

Figures

- Figure 1. Ground plan of a whare Māori and Ground plan of temple of Portunus. 19

Tables

- Table 1. Definitions of the pre-European contact East Coast Māori measurement standards. 10
- Table 2. Traditional and Contemporary Māori digits. 12
- Table 3. Numerals in Contemporary Polynesian Languages (Modern Systems)..... 14
- Table 4. Single Mode and Dual Mode of Counting in the Traditional Māori Number System. 16

Abstract

This research was conducted as a Measurement Standards Laboratory of New Zealand (MSL) student internship that started on 26 November 2018 and finished on 1 March 2019. This research project focuses principally on the indigenous metrology of New Zealand by taking a historical approach to pre-European contact Māori measurement practices, artefacts and methods. This paper thoroughly examines an account made by Elsdon Best about Māori measurement standards and a measuring tool that was thought to be employed by pre-European contact Māori- the rauru. Since there is a very limited range of written evidence of pre-European contact Māori measurement methods, this work is heavily dependent on the accounts and observations of Best. However, through further research on Māori measurement and other related topics, as well as the conduction of interviews with various people, the paper includes findings related to other past measuring techniques that were used by Māori in pre-European contact times. It is intended that this preliminary study acts as a basis to initiate further investigation of the topic of Māori measurement.

1. Introduction

Indigenous knowledge is a systematic body of knowledge acquired by generations of a people through the accumulation of experiences, skills and an intimate understanding of the environment in a given culture. This knowledge is built on the understandings and philosophies developed by a civilisation and is usually passed down by word of mouth or through cultural rituals. Indigenous knowledge has been the basis for agriculture, food preparation, health care, education and a wide range of other practices and activities that sustain societies in many parts of the world. This project is heavily orientated around the indigenous knowledge and history of the native Polynesian ancestors of New Zealand, the Māori people.

There are many legends and myths about the history of the Māori people and numerous stories across many tribes regarding the arrival of Māori in New Zealand. In some traditions, it is said that the first explorer to reach New Zealand was Kupe, who landed in New Zealand about year 1300 CE [1]. Using the stars, ocean currents and winds to navigate the seas, he ventured from the ancestral Polynesian homeland, Hawaiki, all the way to New Zealand. Hawaiki cannot be found on a map and there is much debate about where these ancestors came from; however, it is believed Māori came from an island or group of islands in East Polynesia. Kupe arrived at New Zealand on his waka hourua, an ancient voyaging vessel. Waka hourua were double-hulled canoes, a more practical vessel developed by Māori for sailing across the open sea compared to that of the single-hulled canoe.

Kupe returned to his home to spread news of his newly discovered land. Over the next few hundred years more of the Polynesian people followed Kupe on their waka, arriving at several different points on the coast of New Zealand. It is projected that Māori arrived in New Zealand in several waves of canoe voyages sometime between the years 1250 and 1300 CE [2]. Some iwi, or tribes, say that the first group of canoes that migrated to New Zealand were the seven waka that made up 'The Great Fleet' to Aotearoa. These waka were called Tainui, Te Arawa, Mātaatua, Kurahaupō, Tokomaru, Aotea and Tākitimu. Today, many iwi can trace their origins and whakapapa back to these waka.

Another early figure worthy of mention is Rākaihautū credited with being the rangatira on board the Uruao waka, which bought the Waitaha people to Aotearoa, landing at Whakatū (Nelson) [3]. While Kupe tradition only extends as far as northern Te Waipounamu, Rākaihautū traditions take over further south [4].

Once these Polynesian ancestors arrived in New Zealand, most canoes explored the coasts, observing the land and seeking a safe area to settle. Māori lived in family-based villages known as kāinga or pā. Their sleeping houses were called wharepuni, which were rectangular and made of timber, rushes, tree ferns and bark, with a thatched roof and earth floor. Some of their buildings also included pātaka (storehouses), kāuta (cooking houses) and wharenuī (meeting houses) [5]. Ideal areas to inhabit were often located near harbours, the mouths of rivers or somewhere close to the sea. This allowed the people of that settlement area to have good access to fishing and shellfish grounds, as well as being in a desirable location to hunt seals [6].

The Māori ancestors brought edible plants from their Polynesian homelands, including kūmara, yams, taro and tī pore. The climate in New Zealand was

significantly colder than that of Polynesia, so Māori created advanced techniques to adapt these plants to the new environment; one technique that Māori developed involved using stone walls and fire embers to warm the soils. They succeeded in producing several plants in their new lands, especially the kūmara. They also turned inland, and over several generations encountered the great forests. Māori culture evolved from being largely maritime to a culture which, in certain places, was dominated by trees and bird life. This created more food gathering and hunting opportunities for Māori as there was more plentiful wild-life and wild fruits, some of which became some of their primary food sources [7, 8].

Once Māori had settled the islands, established their kāinga and had learnt to provide for themselves in the new lands, these Polynesian ancestors developed a culture over several hundred years that was distinctly Māori. Based on this history, it is clear that Māori had an excellent, natural sense of measurement through their proficiency to use astronomy and subtropical weather systems as navigational guides on their overseas voyages, their competence to develop such sophisticated horticulture techniques to acclimatise their Polynesian plants to New Zealand's lower-temperature environment and their ability to build and develop such strong, durable structures such as the many types of waka and whare that were utilised by Māori. These are only a few examples of the fine and exact arts that were carried out by pre-European contact Māori¹; there are other practices that are yet to be discussed, such as whakairo and tā moko. Furthermore, due to the high degree of precision required for some of these activities, a measurement system seems necessary. However, history is yet to fully establish a proven record of such a system.

There has been one documented account of measurement units that were employed by Māori, as well as one pre-European contact Māori measurement tool called the 'rauru'. This measuring tool was consistently mentioned in the works of the well-known European scholar Eldson Best, who was later to work as an ethnologist at the national museum in Wellington [9]. During the late nineteenth and early twentieth century, Best carried out field work, specifically in Te Urewera in the Eastern Bay of Plenty region of the North Island. Best subsequently published a succession of monographs and bulletins of the Dominion Museum, and in 1918, a five-page bulletin, titled Māori Measurement, appeared in print [10].

Best writes that the 'rauru' was a measuring rod that was used by Māori, specifically those of the East Coast region. Standards of Māori measurement are said to have been derived from various lengths between different parts of the body; the article states that "...the human body and limbs were the mediums employed in measuring." For projects that required consistent measurements, some of these body-part lengths were marked onto a wooden rod. This measuring rod was called a rauru, which was a measuring tool that was "perhaps confined to the East Coast or a portion of that district." To this day, Best's observational notes on the rauru and the human-body derived measures are the only substantive works written on the traditional measurement systems and techniques of the Māori people. In saying this, it is important to emphasise the heavy dependence that this study has on the work of

¹ The term "pre-European contact Māori" refers to Māori before Europeans first arrived in Aotearoa. It is worth noting Māori continued to maintain their culture and tradition for many years following this contact [45].

Elsdon Best; a range of his manuscripts, observational notes, published writings and correspondence became the basis of this research.

After analysing the many works of Best, this study was directed to his principal Māori sources amongst Hoani Te Whatahoro Jury, scholar, recorder and interpreter from Ngāti Kahungunu and Moihī Te Matorohanga, a tohunga and historian of Ngāti Kahungunu. The course of this research followed their manuscripts, references found in some of their handwritten journals, and other text with relevance to either rauru or Māori measurement. As this study predominantly involves information and history of the Māori culture, it is important to consider that Māori were an oral people, and that a significant amount of their history was passed down through words, stories and songs. This means that it was difficult to find written text that supports our research; however, this pushed the methodology of the research to conduct interviews with a range of people in the Māori community – kaumātua, academics, artists, craftsman, etc. Some of these interviews and conversations became primary sources, and other interviews supported statements made in other sources. With the limited range of documented content on the history of Māori measurement, the histories of other cultures from across the world and the development of their measurement systems has become supporting evidence to the ideas and statements of this research paper. The development of numeracy and numerical language within Polynesian cultures has also been examined as supporting evidence for this research.

The purpose of this study is to elucidate pre-European contact Māori measurement systems and methods, and to investigate the existence of the rauru. We aim to uncover aspects of Māori history relating to measurement to determine how these pre-European contact measurement ideas developed, and whether Māori constructed these length units into some form of a scientific system. The aim of this study is to initiate further discussion and future research on traditional Māori measurement ideas. We hope that this component of indigenous knowledge can be revived, protected and made more accessible to the wider community. There is a desired goal to be able to prove there was a native measurement system so that these measures and their definitions may be re-established in New Zealand, and ultimately, contribute to our documented history and to our body of science.

2. Overview

While carrying out this investigation, there were three obvious themes that were necessary to explore in relation to the subject of Māori Measurement. The first being the simple concept of measurements and measurement systems. This section of research will study Elsdon Best and his account of the human-body measurements that were employed by Māori. This research focuses on understanding and expanding the documented ideas and knowledge of these measurement standards. This project will also look at the standardising of these units that was said to be achieved by using the rauru rod, which Best deems was also a measuring tool. This section leads to the potential development of these units to build a scientific system of measurement, which will also include the examination of types of measurement systems, such as the decimal system.

Secondly, the topic of measurement systems relates to the subject of numeration systems. Therefore, Māori numeration becomes a key aspect of the study. This section of the research looks at 'contemporary vs ancient' Māori numerical terms, number systems and a small range of counting systems that were used by Māori as well as the origins of Māori numeration and enumeration. There is a particularly large focus placed on the origin of Māori numeration, as this may reveal aspects of the origin of Māori measurement and ultimately contribute to the study's purpose of discovering what kind of measurement ideas were present in traditional Māori culture.

Lastly, another essential point in the discussion of Māori measurement is the practices where concepts of measurements would have been applied, particularly in the measurement and construction of whare. Other examples of works that would require such a system are yet to be explored, such as making waka, traditional carving, etc. Whare measures and proportions are a field in which this paper has documented a few accounts. In the research of whare construction, there has been a couple of findings that concern the use of rope and cord in measurement processes of the ground plan of the whare. After analysing these ideas about rope measurement, there was a significant suggestion of relevance between ropes and rauru. This ultimately led to uncovering other aspects of the word rauru, which could be further studied in a future research project.

These three major topics are a foundation to the study of Māori measurement, as they each uncover different fundamental aspects. There is more work to be done however; if there is enough evidence acquired concerning the existence of a Māori measurement system and these traditional measuring standards, this knowledge can be used to grow an understanding of New Zealand metrology, and its indigenous history. In the interim, this preliminary study will highlight the topic of Māori measurement and its key points.

3. Body

Human-body Derived Measures

As discussed, Best's work argues that standards of measurement employed by Māori were derived from the human body. Although there is a very limited range of sources to support this statement about Māori metrology, it is important to note that this particular development of measures is not uncommon among other cultures. The author Hugh Aldersey-Williams from the United Kingdom says that "Ancient units of measure were directly based on the dimensions of the human body" [11]. This is seen to be true across the histories of numerous cultures, such as the Native Americans, the Egyptians, the Greeks, etc. [12]. According to author Steven A. Treese, Native American tribes still base various items on the length of an individual's body parts. Nevertheless, it is imperative to remember that one culture's rational thought is not necessarily the same as another's. However, since the length measures of many indigenous peoples were built on their conception of human anatomy, it is reasonable to consider the possibility that Māori may have used similar methods, ultimately supporting the ideas in the written works of Best, which are yet to be contested.

The Rauru

Assuming that this theory is true, then clearly these measurement standards were only used locally; each two prototypes could have been different in size as there is a significant variation in anatomical proportions across each individual. For instance, one man's arm span might be six and a half feet, but another man's arm span might be a foot less, showing how variable such a measurement standard may be. This would be the case for all units which were based on the human body. This type of variation in length measures forces man to standardise these units, especially for projects that required consistency of units. One particular example of this type of project that was present in traditional Māori culture would have been building whare and other housing structures. According to 'The Dawn of Science: The Rudiments of Modern Science as Observed in Māori Usages', for these types of tasks "it was necessary to select some person to perform the part of a carpenter's rule, otherwise confusion would ensue" [13]. Best's research states that one person was selected, usually the chief of that tribe or someone of high status, and their body measurements would be taken and marked onto either a cord or a rod. The measuring-rod, which was usually for measurements of a more important individual, is referred to as a "rauru". This measuring tool could have been one of the first steps towards fixing a mechanical medium of measurements, enabling Māori to apply these measurement standards in everyday life.

Depending on how high-ranked the selected individual was for the measures of a particular rauru, that rauru was sometimes kept and borrowed by house-builders and anyone else who may have had work that required precise and consistent measurements. Some rauru were even considered taonga and were believed to have been passed down, generation to generation [14]. One particular rauru that Best accounts for in his manuscripts is Te Rauru o Kahungunu, which is a measuring-rod

that held the arm span measurement of the famous East Coast ancestor, Kahungunu [15].

The literature of Best states that the rauru was usually made from ake-rau-tangi (*Dodonaea viscosa*), more commonly known as akeake. The wood from this native bush is a hard, durable timber that was also used to make a range of traditional Māori weapons, such as the patu [16]. Sometimes the measurement marks were bordered with koropito, a tupe of traditional carving pattern, and relieved with small pieces of pāua counter-sunk in the wooden rod, a decorative process called korotiwaha [17].

Possibility of Rauru as a Tribal Tool

As stated previously, Best deems that the rauru device could have been confined to the East Coast region, or even parts of that region making this unique to a specific tribe or tribes. In saying that, it is crucial to acknowledge that Māori were not a uniform people. It seems that the time period that this research project is investigating was a time when there was some diversity occurring from within the broader context of Māori culture. Each iwi had developed their own dialect, their own techniques for hunting, fishing and various other activities, their own style for multiple arts, practices and much more. Even hapū, which are sub-tribes within an iwi, showed similar variations. An example of this diversity could be seen in kawa; kawa is traditional Māori custom, particularly regarding the expected protocol for a pōhiri, or meeting, in a wharenuī. The kawa of some hapū might be pāeke, which is the speaking procedure where all the local speakers speak first, while other hapū might switch between the guest speakers and the local speakers. Considering the variance of numerous aspects of everyday Māori life, attempting to highlight some universal measuring process or technique is unrealistic. However, the idea that this particular measuring tool could have been an instrument employed by one, or a few, tribes, is a plausible concept. The validity of this statement could also explain why there is such a limited amount of knowledge about the artefact; as this may have been knowledge available only to those of the East Coast.

Due to the contrast in dialect across different iwi, it is important to acknowledge the likely possibility of these human-body measures having no universal terms or names. Best affirms that the following definitions of measurement units were all units obtained from East Coast tribes.

Measurement Units

Table 1. Definitions of the pre-European contact East Coast Māori measurement standards.

Māori measurement standard name	Human-body length
Konui, pona konui	Length of the first joint of the thumb
Koiti, koroiti	Length of the little finger
Ringa	Width of the hand
Matikara	Span of outspread fingers
Awanui	Span of two outspread hands, thumb tips together
Tuke, tuke ringa, whatianga	The cubit. Elbow to finger tips
Pakihiwi, tumu	Length of arm – shoulder to finger tips
Hau, wahanga	The half māro – from middle of breast to finger tips of outstretched arm
Pakihiwi-māro	Length of arm plus width across shoulders
Mārō, whanganga, aronui	The fathom – span of arms outstretched horizontally
Pae	Same as māro but arms curved; used in measuring circumference of trees
Takoto	Length of prone body plus that of arm outstretched beyond the head
Kumi	Ten māro, or ten arm fathoms

Source: Adapted from [18], see [15].

Best also mentions another unit standard in one of his manuscripts called the ‘putu,’ that was the same length as a foot, which is equivalent to about 30.5 cm, [19]. This unit is not mentioned in any of the other manuscripts or articles, so perhaps this particular unit was an influence of the Europeans.

As seen in the definitions of these measurement units, most of the names of these units either directly translate or emerge from the Māori names of the particular body parts involved with each unit. For instance, koiti is the unit whose length is equivalent to the length of the little finger, while the Māori word, kōiti, literally translates to ‘little finger’. Another example is the takoto unit, which is the same measure as the length from the foot to the hand of the vertically extended arm. The word, takoto, also translates as ‘to lie down’, which is parallel with the unit definition in describing the ‘length of a prone body’.

The Takoto Sighting

Another fundamental fact regarding the takoto unit of measurement is that there has been a written account from Captain R. A. Cruise actually witnessing this method of measurement being used. On 27 April 1823, Cruise writes a journal entry about a native North Cape chief and approximately 60 of his men coming to Cruise’s ship on two of their war-canoes, to measure the length of ship. Cruise says that “He alone came

up the side; and after gazing about for some time, proceeded to measure the ship from stem to stern. This he effected by prostrating himself upon the deck, and marking upon it the distance of his hands, which he extended as far beyond his head as he could, counting at the same time the number of prostrations he made. When he had got the length, he ascertained in the same way the breadth of the vessel, and announced it from the poop to his astonished followers, who sat in their canoes, and patiently waited the return of their chief" [20]. Although there is no mention of the name of this measurement unit in Cruise's entry, this is still supporting evidence that a measurement method such as the takoto method was employed by Māori. Furthermore, since there has been proof of the use of one of these ancient measurement units, perhaps it is indeed true that the rest of these units were exercised too.

The Base-10 Unit

In addition to the topic of these East Coast units, of all the ones listed, there is one unit that is exceptionally unique – the kumi. The kumi unit is equal to ten maro units, or ten spans of arms outstretched horizontally. Interestingly, this is the only unit of these ancient standards that is a multiple of another unit. The importance of this should be emphasised because this could be considered the first step towards producing a scientific system of measurement; that is, a table of units in which one unit represents a certain number of a preceding one.

The realisation that this unit is in base-10 directed the study to the ideology that Māori may have employed a decimal numbering system, and in turn, a decimal measurement system. In saying that, some relevant kōrero, to this base 10-unit idea, was collected during the interviewing stages of the research. One of the interview participants of this paper is Taina Ngarimu, educationalist and well-known kaumātua from Whareponga Marae, of the East Coast tribe, Ngāti Porou. Taina Ngarimu shares that his brother, Joe Ngarimu, who is a builder, worked on Materoa Whare, which is the meeting house at Whareponga Marae. Koro Taina shares that "When Pāpā Joe was working on Materoa Whare, he said that Māori must have had a measuring system that related to some sort of decimal system because everything was in groups of tens" [21]. This particular bit of information was interesting because, as mentioned before, Best says that in traditional times, house builders would use rauru rods to complete the measurements required for construction of whare. Best also accounts for Te Rauru o Kahungunu, which had the measure of Kahungunu's arm span recorded on it. Perhaps the measurements in "groups of tens" that Joe Ngarimu discovered on Materoa Whare could have been groups of ten arm spans, which would be equivalent to one kumi standard. Another possibility is that Joe Ngarimu may have encountered the use of another measurement unit in "groups of tens", which would suggest Māori may have developed the decimal measurement system further than Best was able to document. These ideas, and these accounts in Best's research, as well as in the work of the Ngarimu brothers, makes Māori numeration and construction of whare two crucial topics in this study.

Māori Numeration

Concepts of measurement and numbers are clearly connected. Subsequently, for the purpose of this research, Māori numeration and the development of counting systems are essential focuses in gaining an advanced understanding of primal Māori concepts and methodologies of measurement. In saying that, below is a list that compares the traditional and modern Māori terms for the first ten numerical figures.

Table 2. Traditional and Contemporary Māori digits.

Number	Pre-European contact Māori term	Contemporary Māori term
1	Tahi	Tahi
2	Rua	Rua
3	Toru	Toru
4	Whā	Whā
5	Rima	Rima
6	Ono	Ono
7	Whitu	Whitu
8	Waru	Waru
9	Iwa	Iwa
10	Ngahuru	Tekau

Source: Adapted from [22].

Of these numerical terms, the only term no longer employed in counting is the term that meant 10, which was ngahuru. Ngahuru is not unknown in the modern Māori language but is unusual as it was replaced by the commonly known term, tekau. According to a linguistics article, the term tekau was used in pre-European contact times to denote the number twenty [23, 24]. It must be stated that this article is the only account found in this investigation that suggests tekau meant 20 in the Māori language, so it would be wise to consider the possibility that this may have been a misconception. However, because there has been a very limited amount of recorded knowledge regarding the topic of Māori measurement, the previous statement will be documented in this paper as one account related to traditional numerical terms.

Ngahuru Theory

There is a sufficient number of sources that state that the term ngahuru was replaced by the term tekau; however, it has been difficult to find any evidence explaining why. There are some speculations that the change was of the European influence, but we remain uncertain. One particularly interesting theory about the term ngahuru is the naming of this term as a combination of its two root words, 'nga' and 'huru', in relation to the number ten. 'Ngā' is the plural of 'te', which literally means 'the'. 'Huru' means to draw in, or contract. It is said that 'ngahuru' was the term to describe the counting of ten on one's fingers by holding one's hands out and drawing in each finger to count each digit. When counting to ten, both hands would have all fingers drawn in; this is

why the plural is subjoined with the term 'huru' [25]. Although this theory stands alone, it is seen to be true in the grammatic history of the Māori language that the meaning of a word can be stemmed from its root words. It is also intriguing to consider that the naming of other Māori numeral terms could have been related to the actions of physically counting.

Counting Systems

When analysing numerals, counting systems must also be investigated. Best argued that ancient Māori utilised single, binary and semi-vigesimal (base-20) systems of numeration [26]. Colleagues of his time shared the same views and, therefore, this statement was generalised for other Polynesian languages. However, there is some controversy regarding the accuracy of Best's discussion about Māori counting systems. To investigate this further, this research compares Māori numeration systems to that of the other Polynesian islands. There is minimal difference between the languages regarding their numerical terms, including ngahuru and its Polynesian variants. These similarities emerge since the Polynesian languages are all part of the Oceanic group of the Austronesian family of languages. Consequently, Best and his colleagues generalised the previous statement about counting systems for other Polynesian languages too. The table below shows a handful of examples of the hundreds of Oceanic languages that share similar terms for their numerals.

Table 3. Numerals in Contemporary Polynesian Languages (Modern Systems).

#	Tongan	Samoaan	Rennellese	Nukuoro	Marquesan	Tahitian	Rapanui	Hawaiian	Māori
0	noa	selo				‘aore	‘ina	‘ole	
1	taha	tasi	tasi/tahi	dahi	tahi	hō‘e, tahi	tahi	kahi	tahi
2	ua	lua	gu(a)	lua	‘ua	piti	rua	lua	rua
3	tolu	tolu	togu	dolu	to‘u	toru	toru	kolu	toru
4	fā	fā	hā	haa	hā/fā	maha	hā	hā	whā
5	nima	lima	gima	lima	‘ima	pae	rima	lima	rima
6	ono	ono	ono	ono	ono	ono	ono	ono	ono
7	fitu	fitu	hitu	hidu	hitu /fitu	hitu	hitu	hiku	whitu
8	valu	valu	bagu	valu	va‘u	va‘u	va‘u	walu	waru
9	hiva	iva	iba	siva	iva	iva	iva	iwa	iwa
10	hongofu lu	sefulu	angahugu	hulu	‘onohu‘u/ umi	‘ahuru	‘angahuru	umi	tekau
10 ²	teau	selau	gau	lau	hānere	hānere	hānere	hanele, haneri	rau
10 ³	afe	afe	noa	mano	tautini	tauatini, tautini	ta‘utini	kaukani, tausai	mano
10 ⁴	mano	sefulu afe	bane	semada					tekau mano
10 ⁵	kilu	mano	tuia	seguli					rau mano
10 ⁶	miliona	miliona	nimo	seloo				miliona	

Source: The Journal of the Polynesian Society [24] [23].

Single Mode Counting

The Māori single, binary and semi-vigesimal (base-20) systems of numeration that Best discusses are not very accurate classifications according to current relevant definitions. A single numeration system is simply a system for expressing numbers, and a binary system is a base-2 counting system. However, these types of systems are not seen in pre-European contact Māori numeration. It is clarified that when Best was referring to single and binary systems, he implies the methods of counting singly and counting in pairs [27].

There are various other prefixes that are applied to the numerals when counting singly. For instance, when using these expressions as numbers in conversation, the term 'ko-' is prefixed to the first, i.e., kotahi. From two to nine, the prefix is 'e', e.g., e rua, e toru, e whā, etc. And the tenth has no prefix as a cardinal. Another case would be when we use the numerals as ordinals, the prefix is 'tua-', e.g., tuatahi = first, tuarua = second, tuatoru = third, etc. [28]. Similar prefixes are seen across multiple Polynesian languages.

The Dual System

Regarding Best's description of Māori counting in pairs, binary is not an accurate term for the system he discusses. However, this technique, which is more commonly known as the dual system, was in fact a counting system that was operated by Māori. Counting in the dual mode applied the same numerals as counting in the single mode, except for the number tekau/ngahuru. However, these numerals were not used to refer to single items, but to pairs. To count a number of pairs, one of the first nine integers were subjoined with the word pū, which literally translates to double/twice. For example, tahi pū meant one pair, which was two items, rua pū meant two pairs/four items, toru pū meant three pairs and so on. Counting in the dual mode was never employed in counting people but its use was exercised in counting things like baskets of produce or game. There was a discussion in our research about this dual system and the use of the word pū in counting in an interview with Māori academic, Dr Vincent Olsen-Reeder. Dr Olsen-Reeder sheds light on the Māori word pūtahi, which means 'to join' or 'to come together' [29]. As mentioned before, various Māori words tend to derive from definitions of root words; in this case the root words of pūtahi are pū, which, in this sense, means to pair, and tahi, meaning together.

Table 4. Single Mode and Dual Mode of Counting in the Traditional Māori Number System.

Number	SINGLE MODE tatau takitahi	DUAL MODE tatau tōpū	COMPOSITION
1	Tahi		
2	Rua	tahi pū	1 × 2
3	Toru		
4	Whā	rua pū	2 × 2
5	Rima		
6	Ono	toru pū	3 × 2
7	Whitu		
8	waru	whā pū	4 × 2
9	iwa		
10	ngahuru	rima pū	5 × 2
20	tekau	ngahuru pū	10 × 2
100	tahi rau takitahi	hokorima pū	50 × 2
200	rua rau	tahi rau pū	100 × 2
1,000	tahi mano	rima rau pū	500 × 2
2,000	rua mano	tahi mano pū	1,000 × 2
	(tini)	(tini)	

Source: [30].

The Hoko- Prefix

In regard to the semi-vigesimal system that Best claims Māori used, he implies that the vigesimal system was a system for counting in twenties. This is seen in the traditional use of the prefix 'hoko-', which has been defined to multiply the subjoined numeral by 20. Over the years, there have been debates about this prefix, as some people have said that this prefix is also used with the first nine integers to mean 'multiplied by 10'. In a conversation with Herewini Te Koha, CE of Te Runanganui o Ngāti Porou, he elucidates a famous example of the prefix 'hoko-' being used to multiply a number by 20 in the naming of the 28th Māori battalion, which was commonly known as Te Hokowhitu-a-Tū. The New Zealand Army refers to itself as Ngāti Tūmatauenga, and hokowhitu translates to seven multiplied by 20; Te Hokowhitu-a-Tū represents the 140 men in the battalion of Ngāti Tūmatauenga [31]. Considering the significance and the time-period of this example, it is more commonly assumed that the hoko- prefix meant 'multiplied by 20'.

Provided that there is a famous example of the traditional method of counting in twenties, it is reasonable to assume that Māori expended this method. However, stating that Māori employed a vigesimal system appears to be another inaccurate description of the systems involved with Māori numeration. "A true vigesimal system requires not just an emphasis on the number 20 itself, but its recurrence in powers, for instance $20^1 = 20$, $20^2 = 400$, $20^3 = 8,000$, and so on" [23, 30]. There is no such recurrence of powers of 20 in the Māori language, which suggests that a base-20 system was not present in pre-European contact Māori society. Instead, there is a clear recurrence in

powers of the number 10, e.g., $10^1 = \text{tekau/ngahuru}$, $10^2 = \text{rau}$, $10^3 = \text{mano}$, which suggests Māori employed a decimal system. Comparing the numerals of modern Austronesian languages, ranging from Madagascar through South-East Asia and into the Pacific, shows that the decimal system is the dominant numerical system that was operated [32] [33].

The Decimal System

The base-10 counting system is used in most modern societies and was the most common system for ancient civilizations. Ethnographers continue to speculate about the history of the decimal system, since there is still very little evidence to help us clarify its origin. However, there are several cultural historians who have suggested possible explanations of the base-10 system. One of the most commonly accepted theories is that pre-historic man counted on his fingers. Øystein Ore, known for his work in the history of mathematics, says “The great preponderance of people use a basic decimal or decadic group of 10 objects, as one should expect from counting on the fingers” [34]. Egyptian hieroglyphs dating back to 3000 B.C. show evidence of a decimal system [35] [36]. This system was also employed by the Greeks, as well as the commonly-used base-5 system that the Romans utilised as well. Ore terms the base-5 system the quinary system, which he suggests was derived from counting the fingers of one hand. Some other cultures used different number-based systems; e.g., some of the American Indian tribes applied the base-20 counting system, which is believed to have been established by counting on both fingers and toes. There have also been theories about base-4 and base-8 counting systems, arising from counting the spaces between fingers [37].

Researching the origins of multiple counting systems and reading theories that suggest such systems are derived from the human body has resulted in the conclusion that perhaps the foundations of numeration correspond to the early development of measurement. There is no evidence clarifying their histories. However, there are multiple theories in various cultures, that are yet to be contested, about numeration and measurement that emphasise the commonly-accepted idea of each being a derivative of types of human-body measures. Even so, numerous theories and the speculation of commonly-accepted concepts cannot be considered substantial evidence. Consequently, it has become critical to thoroughly explore all aspects of relevance to this topic, including areas in Māori culture where these measurement units and methods would, theoretically, have been applied, specifically in the construction and measurements of whare.

4. Whare Measures

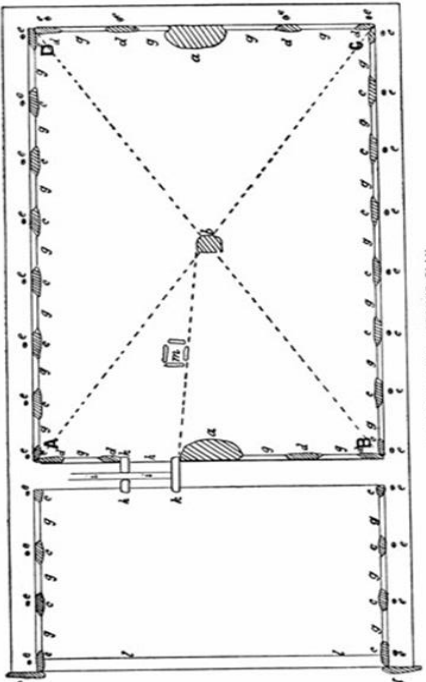
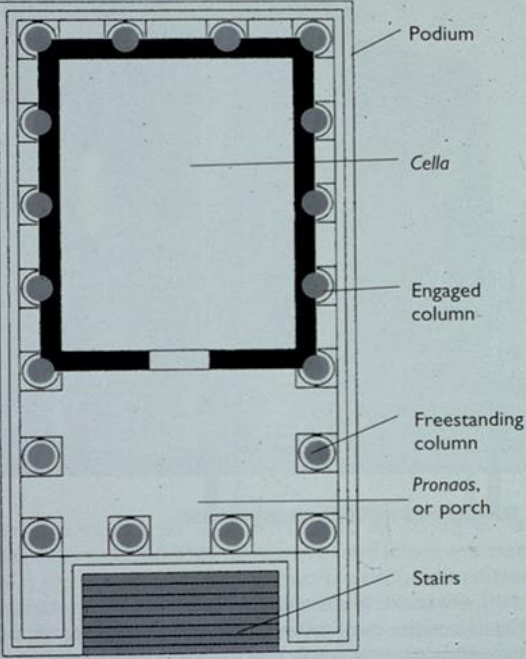
As stated previously, in an interview with Taina Ngarimu, there was information regarding a builder's perspective on the measures of Materoa Whare in Whareponga Marae. The builder, Joe Ngarimu, states he believes Māori must have employed a decimal system because "everything was measured in groups of tens."

In another interview with well-known Tūhoe Māori activist, Tame Iti [38], there was one particularly interesting comment made regarding the architectural measures of a wharenui. Tame Iti grew up in Te Urewera, the area in which Best carried out much of his fieldwork studies. Tame Iti shares a personal experience regarding the restoration of a whare tipuna in Ruatoki, Kuramihirangi Whare, which he reaffirms is a pre-European contact structure. During this process of restoration, there was an architect who was brought in to help with the re-establishment of Kuramihirangi Whare. After examining the plans and architectural drawings of Kuramihirangi Whare, Tame Iti said that the architect had stated that the measures of the whare were almost exactly like that of the Romans and the Greeks.

This conversation with Tame Iti is still in progress, in the hope of being able to gather more specifics about what kind of measures the architect was referring to. In the interim, there has been a keen interest in the examination of architectural plans of whare Māori and classical temples. Diagrams of each were collected and compared, and there were similarities found between the two structural drawings. These diagrams will be included in this study (see Figure 1); however, speculation of their similarities will not be documented until further information is discovered or the specifics of the measures are disclosed by Tame Iti.

The small number of accounts regarding the measurement of whare has forced the direction of this study to the history of whare construction and any of the exploration processes involved with building whare that incorporate elements of measurement.

Figure 1. Ground plan of a whare Māori and Ground plan of temple of Portunus.

Ground Plan of a Whare Māori:	Ground Plan of Temple of Portunus
 <p>A MAORI WHARE — GROUND PLAN.</p>	 <p>Podium Cella Engaged column Freestanding column Pronaos, or porch Stairs</p>
<p>Source: Journal of the Polynesian Society, The Māori Whare: Notes on the Construction of a Māori House [39].</p>	<p>Source: Temple of Portunus plan. Adaption of drawing by John W. Stamper [40].</p>

Whare Construction

There has been a historical transformation in the development and construction of whare, as demonstrated by archaeological evidence that reveals that “large carved meeting-houses as described by explorers from the 1830s onward did not exist before the arrival of Europeans” [41]. Pre-European contact Māori buildings share little resemblance to the large and intricate whare seen across New Zealand today.

Shapes and forms of dwellings changed over time. Subsequently, this area of the study will focus primarily on one of the earliest known form of dwellings, which also seems to be the most commonly-documented pre-European contact abode, the wharepuni (sleeping house). These structures usually took the more commonly-seen, rectangular shape; however, it should be noted that shapes and sizes of whare varied according to the occupants. Wharepuni were designed to be warm houses to reside in, especially for the winter. In this sense, it was very common for a wharepuni to have an interior hearth, a low door and if there was a window, it would be quite small. Rev. H. W. Williams, who was president of the Polynesian Society from 1929 until his death in 1937, describes the specific materials involved with the general whare’s construction. Whare usually consisted of a timber framework that was carefully notched, and lashed together with flax (*Phormium tenax*), while the wall spaces were filled in with screens mainly made of kakaho and the reeds of the toetoe plant (*Arundo*

conspicua). The whole whare was covered with bundles of raupo (*Typha angustifolia*) that were bound on with strips of flax [39].

Before the construction of the whare, the site had to be prepared by levelling the grounds. This statement from Williams was reaffirmed in an interview conducted with Pā Karaitiana Kingi, a catholic priest from Ngāti Kahungunu, who was educated in the traditional whare wānanga. In some iwi, the grounds were first levelled by eye, then after the first heavy rain, any hollows or dips were made more visible and were then filled in to create a flat construction surface [39]. The building of the whare would then begin at the base of the structure.

Taura

Measurements involved in whare construction seem to be mainly exercised through the use of ropes and cord in the measurement of the ground plan of the whare. According to the works of Williams, the two ends of the whare, known as the roro (front end) and the tuarongo (the back), were first laid down. The building would then be squared by measuring the diagonals, which were referred to as hauroki. Best's research accounts for the same process and further states that the diagonals of the house-plan were measured with the taura tīeke or measuring-cord. This cord is said to have had the whanganga, or the arm-span unit marked on to it, which would be used to determine how long the length of the diagonal was. The taura tīeke was also sometimes termed taura whakawhiti or tatau whakawhiti [42].

Cords and ropes, also known as 'taura' or 'aho', seem to have been utilised in another method of the squaring of the whare base. This method is an account made by Pā Kingi, who shares information regarding the building of whare wānanga. Kingi says that the design of a whare wānanga would be determined by the tohunga, or teacher, of that whare. As stated previously, the land would first be prepared and then the architect/tohunga would express his desired whare length and width. He would do this "by going to the middle of the block of land, standing there with a pou and then he gets what's called te aho, the rope, and ties it to the end of the pole." He then asks one of his pupils to take the other end of the rope and walk straight out in front of him. As the boy walks out with the rope, he tautens it and keeps walking until the tohunga instructs him to stop. The spot where the tohunga has ordered the pupil to stop would be marked as half the length of the whare. The pupil would come back to the middle, where the tohunga stands, and the same process would be carried out to measure the left-hand corner and the right-hand corner. Pā Kingi says this would be the dimensions of half of the whare base, and that they don't need to repeat the process for the other half "because the other half was exactly like the half that he's just measured out." This is one account of the measurement of the whare base, which Kingi emphasises was mainly done by the eye. However, the use of the ropes, or aho, seem to have played a vital role in this process of measurement and should be further investigated as an early development of a pre-European contact Māori measurement tool.

5. Rauru and Its Many Meanings

On the topic of ropes and cords, interestingly, there is one interpretation of the word rauru that translates to the 'plaiting of three or more strands producing a flat cord.' This has been documented because of its portrayal of a potential relationship between ropes and cords, and the naming of the measuring-rod accounted for in the works of Best. There are also two other meanings of the words rauru that have not been described in this paper yet; the first is the umbilical cord and the other is the name of an ancestor.

Rauru is a Māori term for the umbilical cord, specifically the end attached to the mother. This is stated in this project as there are a few similarities between the umbilical cord and the cords/ropes. There has also been umbilical cord and birthing references that are seen across other elements of this paper. In a letter of correspondence from Hinemihia Lardelli and her whānau from Ngāti Porou, they give an example of an umbilical cord reference being used to describe the failed outcome of the building of a whare. "If the project took too long with little progress it would be termed 'rauru maruaitu' ...", which refers to a disaster, as the term is usually used when describing a baby that has been strangled by its umbilical cord or is a still born child [43]. This translation of rauru to umbilical cord should be investigated in terms of its possible connections to taura, which were said to be used for measuring purposes, and may ultimately lead to further research on the rauru measuring-rod or other measuring tools.

And the last meaning of Rauru is the more commonly known name of an ancestor named Raurunui-a-Toi. Raurunui-a-Toi is referred to as the grandson of Toi in some traditions, and the son of Toi in others. Raurunui-a-Toi is documented in this work as he shows relevance to both the umbilical cord aspect of the word rauru, and the ideas of measurement related with the term rauru. The tribe of Ngā Rauru say that when Raurunui-a-Toi's mother, Rongoueroa, was about to give birth to him, the umbilical cord became tangled. However, because the child was born healthy, he was named Rauru [44]. In this sense, it should also be noted that the term 'rauru nui' means large umbilical cord - a birth without complications that produced a normal healthy child [43]. Rauru is related to ideas of measurement because he is believed to be the originator of carving. The Lardelli whānau say that Rauru was a master carver and "...that's the reason why he is associated with carving and all that comes with it! Rope measurements! For binding and lashing! For tuku tuku panels in between carvings...". This has directly related Rauru to a traditional art that requires a high-degree of precision and incorporates elements of measurement. The Lardelli family have also directly associated Rauru with rope measurements, which have become a key topic in the overall study.

These translations and meanings are significantly different to each other; however, there are elements of each seen across aspects of the study. These different insights should also be noted as they each unravel different features of the word rauru, which contributes to this study in terms of being able to interpret the probability of the measuring-rod's existence. This will influence the opinions on the validity of Best's works on Māori measurement and ultimately determine whether his observations on

traditional measurement and written accounts will be recognised as a proven record of one type of measurement method employed by pre-European contact Māori.

6. Conclusion

In summary, this project was heavily dependent on the work of Elsdon Best and his observational accounts regarding human-body derived measurement units, the standardisation of these units through the selection of one individual's measures and the use of the measuring-rod, rauru which would hold these standard units and allow them to be applied to measurement projects. There was a shortage of resources that had information regarding Māori measurement, so the accounts of Best were further explored by analysing the origins of measurement across other indigenous cultures.

The units that are outlined in Best's notes were investigated and one of these units, the takoto, had been witnessed and documented by Captain R. A. Cruise. This was acknowledged in the study as proof of one of these units, which, in turn, increased the probability of the existence of the rest of these units. The kumi unit was also further examined as a base-10 unit, which led the study towards concepts of Māori numeration, origins of counting and counting systems, specifically the decimal system.

This research showed a correlation between the theories of the origins of counting and the origins of measurement both being based off the body, ultimately showing a recurrence in the theme of human-body derived measurement.

Another aspect of the topic that was explored, but should be further studied, was the application of measurement in the construction of whare. There were interesting measurement concepts of whare discussed by three kaumātua of three different tribes, which included the suggestion of a decimal system because "everything was in groups of tens", ideas of architectural similarities to Roman measures and the use of ropes in measuring the length and width of the whare. Ideas of rope measurements were researched as a potential development of a measuring tool, which uncovered links between rope measurements and the rauru measuring-rod.

And finally, this led to the discussion of other translations of the word rauru and their relevance to different elements of the paper.

We have acknowledged that this is a preliminary study on the topic of Māori measurement and that there is more work to be done. The following list is a number of suggestions for future researchers to consider if they hope to further this study:

1. Following the ideas of rauru translating to the 'plaiting of three or more strands producing a flat cord', trying to find contacts from traditional weavers or a weaving school would be ideal to get a perspective on this type of cord.
2. Traditional carvers or carving schools could also be contacted to enquire whether they utilise traditional measurement methods in their practice.
3. Having further contact with the Lardelli whānau could be beneficial as they seem to know a lot about rauru.
4. It may be useful to get in contact with Joe Ngarimu to gather more details about his work on Materoa Whare.

5. Getting in contact with Tame Iti would be recommended to gather specifics about the architectural perspective on the similarities between whare measures and Roman measures. Contacting architects and getting a professional opinion on the statement could also be beneficial.
6. The 'Te Whanake' Māori language textbooks by John C. Moorfield contained some of the translations of some of the units mentioned in Best's work. Communicating with those who own 'Te Whanake Resources' may help in terms of understanding where those translations are sourced from.
7. An important cultural aspect of this study is to talk to people of the community, specifically kaumātua who may have had similar pre-European contact knowledge passed down to them.
8. It could also be valuable to talk to the New Zealand Archaeology Association in the hope of seeking any archaeologist who may have worked on excavating old whare or pā sites.
9. Te Papa National Museum should also be reached due to their ability to preserve knowledge and history, including an extensive range of Māori content.
10. Another topic that should be investigated is the idea of proportions and ratios in terms of whare construction. This could have been a major influence on the way these structures were measured. It seems that at that time the concept of proportionality was fully understood and implemented, however, the need for absolute measurement was less important.

These are just a few recommended steps for the future of this project. However, any other routes or directions for this study should be taken to achieve the long-term goal of being able to document New Zealand's metrology history. Pre-European contact Māori measurement is a topic of study that has been overlooked for too long. Understanding and proving this knowledge could contribute greatly to New Zealand's body of Mātauranga Māori and result in the revitalisation and improvement of accessibility of this information throughout society. Traditional methods of measurement could be utilised when building marae, or maybe these indigenous units could be taught in schools; there are many possibilities to be able to incorporate learning from this study in everyday life – we just need to persist.

As a closing note in this section, it is fair to acknowledge that there is still a lot of work to be done with respect to unravelling the fascinating Māori culture. During centuries, Māori have continued and developed upon long traditions of activity to preserve traditional and authentic knowledge generation by generation. They have always innovated and discovered novel ways of doing things along the way. Therefore, a long cultural continuum can be traced from the distant past to contemporary Māori society, and Māori activity today is in fact part of a long tradition, although often expressed in new ways. In more recent history, there is not always a relationship between a Māori innovation and European contact. However, if this relationship could be traced, Māori often adapted European ideas and technologies to fit within their own frames of reference and used them in new ways, which were for Europeans often quite surprising.

“Kua tawhiti kē to haerenga mai, kia kore e haere tonu. He nui rawa o mahi, kia kore e mahi tonu.” –

We have come too far, not to go further. We have done too much, not to do more.

Sir James Henare.

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9. Glossary

‘Ngā Inenga’ Dictionary.

A sizeable number of these Māori words have multiple meanings and translations. The translations outlined below are the translations that are relevant to this report.

aho	(noun) fishing line, cord, string, line, medium for an atua in divination
Aotea	(personal noun) canoe that brought Turi and his people from Hawaiki, eventually arriving in Taranaki where they intermarried with the tangata whenua tribes
Aotearoa	“The long white cloud” - used as the Māori name for New Zealand
aronui	arm-span, measurement unit from tip to tip of fingers with arms outstretched horizontally, roughly equivalent to a fathom
awanui	measurement unit, span of both hands open with tips of thumbs placed together
e	(particle) used before hia? and when stating numbers of things where the number begins with a word of one vowel or two short vowels
hapū	(noun) kinship group, clan, tribe, subtribe - section of a large kinship group and the primary political unit in traditional Māori society
hau	measurement unit from middle of breasts to fingertips (half mārō)
hauroki	1. (modifier) diagonally 2. (noun) diagonal - diagonals (originally in measuring the ground plan of a house, etc.)
Hawaiki	(location) ancient homeland - the places from which Māori migrated to Aotearoa/New Zealand
hōhonu	deep, depth
hoko-	(particle) Prefix used with numbers from one to nine to mean ‘multiplied by 10’, especially if followed by takitahi (e.g., hokowhā takitahi = 40). However, if tōpū is added to the number instead of

	takitahi it doubles the number (e.g., hokowhā tōpū = 80). Often tōpū is omitted
hokowhitu	1. (numeral) one hundred and forty, 140 2. (numeral) seventy, 70 3. (noun) 140, band, company, party, complement of men, army
iwa	(numeral) nine, 9
iwi	(noun) extended kinship group, tribe, nation, people, nationality, race – often refers to a large group of people descended from a common ancestor and associated with a distinct territory
Kahungunu	the ancestor who was the great-grandson of Tamatea Arikinui (Tamatea was the captain of Tākitimu waka)
kāinga	(noun) home, residence, village, settlement, habitation, habitat, dwelling
kākaho	(noun) culm, stem of toetoe – used for lining the walls of buildings and for making kites
kaumātua	(noun) adult, elder, elderly man, elderly woman, old man – a person of status within the whānau
kāuta	(noun) cooking shed, kitchen, cookhouse, house, shack
kawa	1. (verb) (-ia,-ina) to perform the kawa ceremony, open a new house 2. (noun) a ceremony to remove tapu from a new house or canoe 3. (noun) marae protocol – customs of the marae and wharenuī, particularly those related to formal activities such as pōhiri, speeches and mihimihi
ko-	prefix to term tahi (one), i.e., kotahi
koiti	measurement unit, length of little finger
kōiti	little finger
konui	measurement unit from tip of thumb to first joint
kōnui	thumb
kōrero	1. (verb) (-hia,-ngia,-tia) to tell, say, speak, read, talk, address 2. (noun) speech, narrative, story, news, account, discussion, conversation, discourse, statement, information

koro	(noun) elderly man, grandfather, granddad, grandpa – term of address to an older man
koroiiti	measurement unit, length of little finger
koropito	a carving pattern mentioned in the works of Elsdon Best
korotiwaha	(verb) to countersink (woodwork), inlay – process of countersinking pieces of shell in carved objects
kotahi	1. (numeral) be one, single, alone, 1 2. (stative) be united
kūmara	(noun) sweet potato, kūmara, Ipomoea batatas
kumi	measurement unit, 10 arm-spans, 10 mārō/aronui/whanganga lengths
Kupe	(personal name) an early visitor to Aotearoa/New Zealand who returned to Hawaiki
Kurahaupō	(personal noun) crew of this canoe from Hawaiki are claimed as ancestors by many tribes, including some from Taranaki, Whanganui and the southern North Island
Kuramihirangi Whare	(noun) the meeting house at Te Rewarewa Marae in Ruatoki
mano	1. (numeral) thousand, large number, multitude 2. (numeral) infinitely large number, multitude, thousands, great number, horde, throng, host 3. (numeral) combines with other words to form other numbers
Māori	1. (noun) Māori, indigenous New Zealander 2. (modifier) Māori, e.g., Te reo Māori = The Māori language 3. (verb) to be Māori, apply in a Māori way 4. normal, natural, native, usual
marae	(noun) courtyard – the open area in front of the wharenuī, where formal greetings and discussions take place. Often also used to include the complex of buildings around the marae
mārō	arm-span, measurement unit from tip to tip of fingers with arms outstretched horizontally, roughly equivalent to a fathom
Mātaatua	(personal noun) migration canoe which landed at Whakatāne and finally ended at Hokianga before being dragged overland to Tākou
Materoa Whare	(personal noun) the name of the wharenuī at Whareponga Marae
matikara	measurement unit, span of outspread fingers
ngahuru	(numeral) ten, tenth (following te) – used in a similar way to tekau but less frequently. Combines with other words to form the numbers from 11 to 19

Ngā Rauru	(personal noun) tribal group of the Waitōtara-Whanganui area
Ngāti Kahungunu	(personal noun) tribal group of the southern North Island east of the ranges from the area of Nūhaka and Wairoa to southern Wairarapa
Ngāti Porou	(personal noun) tribal group of East Coast area north of Gisborne to Tihirau
Ngāti Tūmataunga	Māori name for New Zealand Army
ono	(numeral) six, 6
pā	(noun) fortified village, blockade, city (especially a fortified one)
pae	measurement unit, length of curved arm-span (used in measuring circumference)
pāeke	(noun) the speaking procedure where all the local speakers speak first
pakihiwi	1. measurement unit, length of arm from shoulder to finger tips 2. shoulder
pakihiwi-mārō	measurement unit, length of arm (from shoulder to finger tips) plus width across shoulders
pāpā	1. (noun) father, uncle, dad – term of address to an older man
pātaka	(noun) storehouse raised upon posts, pantry, larder
pāua	(noun) pāua, abalone, sea ear, Haliotis
pona konui	measurement unit, from tip of thumb to first joint
pou	post, upright, support, pole, pillar
pū	1. (particle) suffix used with numbers to multiply that number by 2 2. (modifier) double, twice
pūtahi	(verb) (-ngia) to join, meet
putu	measurement unit, foot – a measurement equivalent to 30.5 cm
rākau	1. tree, stick, timber, wood, spar, mast, plant 2. weapon, tool
rau	(numeral) hundred, 10 ²
raupo	(noun) bulrush, a tall, summer-green swamp plant distinguished by its large flowering spike which looks like brown velvet, the stems (kākaho) being used as construction or decoration material
rauru	1. (noun) wooden measurement rod, measurement tool 2. (noun) plaiting of three or more strands producing a flat cord

	<p>3. (noun) umbilical cord (end attached to the mother)</p> <p>4. (noun) spiral form of carving ornamentation</p> <p>5. (personal name) Rauru is the common name of the ancestor Raurunui-a-Toi</p>
rauru maruaitu	umbilical cord of disaster: stillborn baby; severe complications that result in the expected death of the mother
rauru nui	large umbilical cord: a birth without complications that produced a normal healthy child
Raurunui-a-Toi	(personal noun) an ancestor of the East Coast commonly known as Raurunui, known as son of Toi-te-Huatahi, some regard Raurunui as grandson of Toi-te-Huatahi
rima	(numeral) five, 5
ringa	<p>1. measurement unit, width of hand</p> <p>2. hand</p>
roa	long, length, far
Rongoueroa	(personal noun) early ancestor, mother of Raurunui-a-Toi
roro	(noun) front end of a meeting house, verandah, porch, lobby
rua	(numeral) two, 2
Ruatoki	(noun) a locality in the Bay of Plenty Region of New Zealand
tahi	(numeral) one, 1
Tainui	(personal noun) crew of this canoe from Hawaiki are claimed as ancestors by tribes of the Waikato, King Country and Tauranga areas
Tākitimu	(personal noun) a migration canoe - the crew of this canoe from Hawaiki are claimed as ancestors by Ngāti Kahungunu, Ngāi Tahu and Ngāti Ranginui.
takoto	<p>1. measurement unit, length of prone body plus that of arm outstretched beyond the head</p> <p>2. To lie down, lie, lay</p>
tā moko	<p>1. (verb) (-a) to tattoo, apply traditional tattoo, apply moko</p> <p>2. (modifier) traditional tattooing</p> <p>3. (noun) traditional tattooing - Māori tattooing designs on the face or body done under traditional protocols</p>
taonga	<p>1. (noun) property, goods, possession, effects, object</p> <p>2. (noun) treasure, anything prized - applied to anything considered to be of value including socially or culturally valuable objects, resources, phenomenon, ideas and techniques</p>
taro	(noun) taro, <i>Colocasia esculenta</i> - a plant with edible, starchy corms and large, edible, fleshy leaves

tātai	1. (verb) (-a,-hia,-ngia,-tia) to measure, arrange, set in order, plan, recite (genealogies) 2. (verb) (-hia,-ngia,-tia) to calculate
tātai whakawhiti	(noun) rope used to measure out the ground plan of a house
taura	(noun) rope, cord
taura fieke	(noun) rope used to measure out the ground plan of a house
taura whakawhiti	(noun) rope used to measure out the ground plan of a house
Te Arawa	(personal noun) canoe which brought the ancestors of the Arawa and Ngāti Tūwharetoa tribes to Aotearoa
tekau	(numeral) ten, 10
Te Hokowhitu-a-Tū	(noun) Māori Battalion
Te Rauru-o-Kahungunu	1. The rauru of Kahungunu 2. The measuring rod that holds the arm-span of the famous ancestor, Kahungunu
fieke	(verb) (-tia) to measure out, set out – especially the ground plan of a house
tī pore	(noun) Pacific Island cabbage tree, <i>Cordyline fruticosa</i> , <i>Cordyline terminalis</i> - an introduced species of cabbage tree
toetoe	(noun) native plants with long, grassy leaves with a fine edge and saw-like teeth
tohunga	1. (verb) to be expert, proficient, adept 2. (noun) skilled person, chosen expert, priest, healer – a person chosen by the agent of an atua and the tribe as a leader in a particular field because of signs indicating talent for a particular vocation
Toi	(personal noun) commonly used name of the early ancestor, Toi Te Huatahi
Tokomaru	(personal noun) canoe that brought some of the ancestors of Taranaki tribes from Hawaiki
toru	(numeral) three, 3
tua-	(particle) Prefix used with numbers 1 to 9, aha and hia to form ordinals, i.e. to show something in an ordered arrangement, e.g., tuatahi, first
tuarongo	(noun) back of the interior of a house, back wall

Tūhoe	(noun) tribal group of the Bay of Plenty, including the Kutarere-Ruātoki-Waimana-Waikaremoana area (Ngāi Tūhoe)
tuke	1. measurement unit, the cubit, length from elbow joint to fingertips 2. elbow
tuke ringa	measurement unit, the cubit, length from elbow joint to fingertips
tukutuku	1. (verb) to decorate with lattice-work, make tukutuku panels 2. (noun) ornamental lattice-work – used particularly between carvings around the walls of meeting houses
Urewera (Te)	Te Urewera is an area in the North Island of New Zealand, much of it in the northern Hawke's Bay Region, and some in the eastern Bay of Plenty
waka	(noun) canoe, vehicle
waka hourua	double-hulled canoe
waru	(numeral) eight, 8
whā	(numeral) four, 4
whakairo	1. (verb) (-hia,-tia) to carve, ornament with a pattern, sculpt 2. (modifier) carved, carving 3. (noun) carving
whakapapa	(noun) genealogy, genealogical table, lineage, descent
whakawhiti	1. (verb) (-a,-hia,-ngia) to cross over, change, interchange, ferry 2. (verb) (-a,-hia,-ngia) to cross (something over something else) 3. (noun) crossing, transit, crossing over, exchanging
whānau	(noun) extended family, family group, a familiar term of address to a number of people – the primary economic unit of traditional Māori society
whanganga	1. arm-span, measurement unit from tip to tip of fingers with arms outstretched horizontally, roughly equivalent to a fathom 2. (-tia) to measure with the arms extended.
whare	(noun) house, building, residence, dwelling, shed, hut, habitation.
whareniui	(noun) meeting house, large house – main building of a marae where guests are accommodated
Whareponga	(noun) marae located 20 km east of Ruatōria and 45 km north of Tokomaru Bay, on the East Cape. Whareponga Marae's primary hapū are Ngāi Tangihaere and Te Aitanga a Mate of Ngāti Porou
wharepuni	(noun) principal house of a village, sleeping house
whare tipuna	(noun) ancestral house – a term often used for a meeting house

whare wānanga	place of higher learning – traditionally, places where tohunga taught the sons of rangatira their people’s knowledge of history, genealogy and religious practices
whatianga	1. measurement unit, the cubit, length from elbow joint to fingertips 2. joint (of leng or arm), place at which anything is bent
whitu	(numeral) seven, 7