

Indigeneity and Technology: Assigning Indigenous Properties to the Agent-Based IT Artefact Ensemble

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Abstract

The increased use of IT artefacts globally has spurred debate as to what degree indigenous community's benefit from any involvement with such technologies. To confront such challenges, indigenous peoples must continue to progress their goals in seeking solutions towards the construction of the IT artefact that brings a sense of indigenous connection. One such problem is delivering a sense of placement inside the IT artefact where the inherent and essential properties that give an indigenous object, person, or environment their meaning and significance is able to be digitally translated. The key issue here is the need to embrace the environmental attributes of the indigenous community being represented. This study constructs a design to automate a New Zealand Maori welcoming ceremony for the purpose of receiving visitors being greeted onto traditional Maori grounds. An agent-based model is developed operating inside an indigenously tasked environment to encapsulate understanding 'as it appears to exist' for the New Zealand Maori community as a representation of the IT artefact ensemble.

Keywords: Indigenous, IT Artefact, Artificial Intelligence, Model-based Agent.

Introduction

Construction of the indigenous artefact has been in practice for thousands of years based on its own beginnings and knowledge systems of indigeneity. Today, many digital representations are emerging as being traditional, indigenous or cultural versions of the IT artefact created. Technology such as mobile applications and social media platforms are beginning to present indigenous narratives, images and audio files in a new light. With the explosion of IT artefacts for indigenous peoples comes the problem, '*in whose image is the world being portrayed*'. The IT artefact is in danger of disconnecting indigenous communities from their core world-views. To solve such challenges, indigenous communities require a model of technology that goes beyond the observations of monolithic Eurocentric analysis (Fitzsimons and Smith 2000), one that uses theory as an agent for change, but acts in ways that are accountable to the indigenous community and not just academia (Smith 1999). However, transmitting indigenous knowledge using the digitally focused IT artefact comes with its own challenges. Any attempts to match indigenous knowledge using a computer binary representation is a complex task, like compiling the analogue architecture of 'code' itself. For indigenous communities to respond to these types of challenges, they must hold on to their indigenesness when producing IT artefact products such as building their own understandings of algorithms and models to drive computer generated applications. Now is the time to give attention to the IT artefact as being indigenously framed. One such problem is the ability to depict a sense of indigenous understanding during the IT artefact construction, a process employed to group individual components of a systems environment all acting as one during the design phase of the IT artefact.

Problem Statement

Whilst a large amount of publication regarding indigenous research linked to tradition exists, publication's matching indigeneity to computer languages in a modern world are scarce. Indigenous communities do not have the plethora of digital resources available that are technical, or access to indigenously translated computer coded archives, or organized meta-data logic models, or indigenous ontologies that are technically driven towards a binary language, or generated online resources. With such a large amount of work to be completed, it is clear from the lack of resources above, indigenous communities have much to do. One way forward is to address the problem in bite sized chunks such as honing in on the abstract representation of the IT artefact creation. This leads to the research question, can an indigenous sense of understanding be transferred during the design phase of the IT artefact ensemble?

Method

The method for this study following Design Science Research Gregor & Hevner, (2013) begins with a problem statement that is introduced early and investigated further in the literature review. The literature review adopts a multi-disciplinary approach and draws from fields such as indigeneity, philosophy, cognitive psychology, social psychology, the medical and health profession, artificial intelligence and, socio-technology systems to frame the mode of research. Knowledge concepts are reviewed as part of the knowledge transfer process highlighting variances between both indigenous and Eurocentric research. Thereafter, an abstract version of the IT artefact is created representing an indigenous mode of understanding that encapsulates an indigenous socio-technical system using an intelligent agent. New Zealand Maori represents the indigenous community involved in research during the creation of the IT artefact ensemble. The artefact exists in the form of a prescribed table configured from the literature to reflect an agent-based model operating inside a tasked environment. Evaluation considers the differences identified in the literature and matched against the resulting artefact to lead practice during construction. Discussion provides an overview of the research topic and seeks to aid both the research environment and, the related body of knowledge's kernel theories. The conclusion completes the research cycle with findings stated as new contributions to the knowledge base of the research topic outlined (Gregor and Hevner 2013).

Literature Review

The review investigates literature to explain key factors that contribute to the research question such as (a) providing a reason for the IT artefact ensemble, (b) organizing indigenous views of the IT artefact, (c) establishing an indigenous environment for the IT artefact and, (d) mapping indigenous agent properties of the IT artefact. This gives rise to an IT artefact that is able to make claims using theory to be an abstract representation of indigenous notions, ideas and practices involving technology.

The IT Artefact Ensemble

The term '*artefact*' originates in the early 19th century translated from Latin as arte 'by or using art' with factum 'something done or made' (Simpson and Weiner 1989). In a study approach of design knowledge Miah & Gammack, (2014), five components are indicative of the IT artefact ensemble such as user centrality, knowledge sharing, situation-specific customization, reduced model orientation, and practice based secondary design abilities, as outcomes that enhance dimensions of the IT artefact design. Further studies consider the IT artefact as an ensemble of theoretical development Goldkuhl, (2013), portraying the IT artefact as an abstract product of knowledge built from understanding. According to Gregor & Hevner, (2013), the artefact ensemble performs a key role in the knowledge realm who cite the following:

“It is difficult if not impossible to make much progress in the application without theory; conversely, it is difficult to understand the theory without knowledge of the technique”. Diderot, “Arts” in Encyclopedia (1751-1765) (quoted in Mokyr 2002).

From the preceding, every “art” ‘*technique*’ has its speculative and its practical side (Mokyr 2002) that requires knowledge as the core prerequisite to construction. According to Sun & Kantor, (2006) the artefact is viewed as unreal according to two realities being unreal systems with unreal problems.

In relation to the IT artefact as an assembly pre-construction, the artefact is best reflected in the seminal work of Orlikowski & Iacono, (2001) who open wide discussion within the IS research domain in theorizing the IT artefact. Their study outlines short-comings of IS stating:

“the tendency to take IT artefacts for granted in IS studies has limited our ability as researchers to understand many of their critical implications – both intended and unintended – for individuals, groups, organizations and society” (Orlikowski & Iacono, 2001 pg133).

Some researchers view the abstract IT artefact as an avenue to create new knowledge through the production of novel or innovative artefacts that are able to be analyzed, then introduced into the field of research (Simon 1996). Other researchers view the artefact using theories such as Design Science Research that considers the artefact to be a product of constructs, models, methods and instantiations (Hevner & Chatterjee, 2010; Winter, 2008), or characterizing the IT artefact by assigning agency and, addressing the social involvement to the artefact (Bijker et al. 2012; DeSanctis 2003; Lin and Silva 2005). All adding to the disciplinary discussion of the IT artefact ensemble.

Organizing Indigenous views of the IT Artefact Ensemble

To establish an exemplar that replicates an indigenous knowledge system transmitted to the IT artefact, importance must be given to the way indigenous knowledge is organized with its own views and interpretations of understanding that can then be theorized when creating the IT artefact. To narrow the study topic further, indigeneity for this paper represents the New Zealand indigenous Maori views of the IT artefact construction. Whilst this approach tends to restrict indigenous research and the development of theory (Poortinga 1999), it is as equally important for research to deliver a mode of enquiry that is characterized as being “unique, traditional and, local knowledge developed around specific conditions of indigenous communities to a particular geographic area” (Grenier, 1998). The alternative would be a generalized version of indigenous research leading to further disconnections and barriers when seeking knowledge about the IT artefact construction. According to Ravirajsinh, Manaka, Thouchom, & Ranjitsinh, (2011) indigenous knowledge is traditional to the extent that its creation and use are part of the traditions of a communities identity. Indigenous knowledge is created in everyday life, evolving as a response of individuals and communities to the challenges posed by their social environment and past time events. This concept is further discussed by Taiaiake, (2015) who views indigeneity stating:

“Indigenous traditions, cultures and identities are not historical artefacts or museum pieces; they are vital and, critical to indigenous wellbeing and shared understanding of how to live in the world” (Taiaiake, 2015, pg. 1).

In creating the IT artefact ensemble, New Zealand Maori values, beliefs and ways of doing ‘*as it appears to exist*’ Shedlock & Vos, (2018) is an important component during the IT artefact creation. One such model is shown in Figure 1: Maori Data Triangle (Hazel, et al. 2018). The model depicts a high-level strategy when considering technology. The triangle shape represents the topic domains that emerged from a focus group meeting of like-minded indigenous sensitive members representing academics, community, politicians, and the business community. The text on the outside of the triangle considers the collection of information, analysis and tools employed to understand data and the impact of data on the Maori community both intended and unintended.

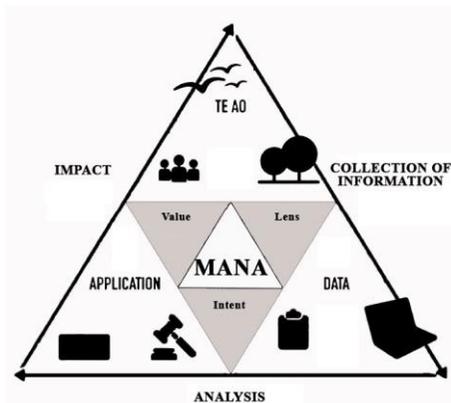


Figure 1: Maori Data Triangle

Four larger triangles are on the inner part each representing (explained clockwise from the top):

- *Te Ao* - The world views of an indigenous people, their environment encompassed using Maori relationships, genealogy links, tribal resources and assets and socio economic activities based on how Maori live their lives using a world view familiar to Maori;
- *Data* - A description of data from an indigenous view of the world. The construction of algorithms and the storage of digital information imbedded within the language (korero), the processes (tikanga), the songs and sounds (waiata), as well as their art (mahi toi);
- *Applications* - Applied to decision making processes through the construction of innovative software using data;
- *Mana* - The center triangle includes three further triangles (smaller) represent the lens used to collect data, intentions of usage and values linked to data. The central triangle represents aspiration of self-autonomy (mana) through self-authority and self-responsibility.

Supporting the views of Hazel, et al. (2018), in respect of organizing the artefact at the development level, Hunter, Koopman, & Sledge, (2003) state the IT artefact should enable traditional owners to describe, contextualize and annotate resources in their own words, their own languages and from their own perspectives. Shedlock & Vos, (2018) further defines the above work by creating an indigenous point of reference when engaging with the construction of the IT artefact as:

“the indigenous IT artefact is based on the notion indigenous knowledge holders are able to adopt symbols, patterns, terminology and languages to connect to the existence of known events that are uniquely indigenous by nature” (Shedlock & Vos, 2018 p.5).

In review, the above definition highlights the involvement of the indigenous knowledge holder as a central figure during the abstract production of the IT artefact when involving indigenous processes and practices during construction. Indigenous knowledge is traditional with unique properties to the extent that its creation and use are part of the traditions of communities. Indigenous knowledge is created in everyday life, evolving as a response of individuals and communities to the challenges posed by their social environment and past time events. Dei, (2000) describes the indigenous knowledge holder as being in possession of an array of knowledge types based on being traditional knowledge, which is inter-generationally passed on by community elders; empirical knowledge, which is based on careful observations of the surrounding environments (nature, tradition and society); and lastly revealed knowledge, which is provided through dreams, visions and intuition. In supporting an indigenous system of the IT artefact construction, the indigenous knowledge holder may be represented as an individual, group, community or in artefact form.

Establishing an Indigenous Environment for the IT Artefact Ensemble

Environmental representation of the IT artefact continues to be a discussion topic in IS with concentrated efforts to analyze and conceptualize such socio-technical systems (STS). There is extensive literature available on environment knowledge systems such as professional knowledge systems Cranefield, (2009) teaching knowledge systems Fives & Buehl, (2008) and knowledge management systems (Wigg, 2000).

Socio-technical systems are portrayed as complex entities where any change often impacts people actors and technologies at the same time (Fuenschilling and Truffer 2014). Van der Merv, Biggs, & Preiser, (2018) considers STS to be a set of inherent conditions which provide a group of people and the community with the ability to maintain functional continuity and systems level flexibility. According to O'Hara, Watson, & Kavan, (1999), STS consists of organizational structures, technology, people and, processes each with their known core components acting in tandem within the system. Lin & Silva, (2005) describe a semiotic connection to STS during the artefact creation stating, the creator of technology is obliged to adopt the artefact creations environmental norms, values, and practices in order to represent any digitally formatted artefact effectively. In regards to socio-technical systems framed as being indigenous Turk & Trees, (1998) study works with indigenous communities to build applications such as the deployment of multimedia and data repositories for indigenous community's whilst Howes

& Chambers, (2009) seeks to analysis the impacts and emerging issues for indigenous technical information systems. Others such as Heath, Knoblauch, & Luff, (2000) investigates socially engaging with technology - all adding to the conversations of indigeneity and socio technology systems.

An indigenous environment system is characterized as local knowledge that is unique to a given culture or society which is implicit through actions usually passed down between generations in an auditory format (Grenier 1998; Knorr-Cetina 1999). One challenge for indigenous research arises when attempts are made to link the IT artefact as being an indigenous IT environmental system since no clear understanding is available. Kenny, (2010 p.535) views indigeneity as complex, "it is impossible to come up with a coherent or principled understanding for indigenous groups" let alone the environment lived-in. Furthermore, the use of indigenous environment systems have often been accused of not being scientific enough, mysterious, old without value, belonging to the rural poor illiterates, weak and powerless with no fit in a modern society and, is not growing, but dying during the post-colonial period (Ranasinghe 2008). However, the goal of research by indigenous researchers is to develop an indigenous framework engaging with indigenous development (Agrawal, 1995), understanding indigenous knowledge (Howes & Chambers, 2009), discussing the purpose of constructing indigenous knowledge ways (Kwang-Kuo, 2005), critical analysis of indigeneity (Levi-Strauss, 1966), progressing indigenous research (Shawn Wilson, 2003), and decolonizing methodologies (L. T. Smith, 1999) all contributing to an environment of indigeneity during research. This gives rise to four environmental representations of STS involving indigenous community structures, indigenous technology, indigenous people and indigenous processes during the construction of the IT artefact.

Indigenous Community Structures - ethical consideration around any artefact construction is an essential ingredient in any indigenous social setting (Smith 1999). Indigenous social structures such as laws, ideologies and theories 'as it appears to exist' to the indigenous community involved in research determines and leads practice (Tedre and Pajunen 2013). Therefore, indigenous community (organization) structure is represented as a body of priorities connected to indigenous rules as laws, ideology, and theory that drive practices and processes, familiar to the indigenous community involved with the IT artefact creation.

Indigenous Technology - accepting knowledge obtained using a multi-disciplinary approach. Indigenous technology is part of a relational system of knowledge. Discussed by S Wilson, (2008) relationships don't just shape indigenous social reality, they are their reality. Technology is based upon a close connection to the environments eco-system where relationships are formed with land, air and sea, the living and non-living, real and unreal. Indigenous knowledge is formed from the ritual of maintaining accountability to relationships. For technology to be recognized as a repository of knowledge, it must be accountable to all of the relations, make careful choices during construction such as methods of data collection, forms of analysis, and finally in the way information is presented. Thus, an indigenous technology paradigm must move beyond the concept of individual knowledge to relational knowledge as a shared collective (Grant et al. 2010; Henry and Pene 2001; Shawn 2001; Shedlock and Vos 2018; Smith 1999; Thater-Braan 2007; Tuhiwai and Reid 2000; Wilson 2003). Indigenous technology is a representation of the community minds (thoughts) who prioritize the social, economic and environment well-being as a commune.

Indigenous People - involves actors interacting with the indigenous STS who are naturally reflected in the real indigenous world. The structure of STS is reinforced by ones genealogy paying particular attention to the values and processes of knowledge passed from one generation to another Blackstock, (2016) that are enacted in the real-world. Genealogy is an act to introduce self to other unknown groups to forge a bond of kinship through the act of announcing ones genealogy, providing a sense of high awareness of one's environment (Reed et al. 2012). Self-identification is central to providing a level of status within the indigenous community (Anaya, 1996). This is a physical connection property portrayed to prioritize the roles played within any STS structure such as the performed roles of elders, roles of leaders, roles of supporters, roles receiving visitors, etc.

Indigenous Processes - an intuitive sensory connection. Levi-Strauss, (1966) provides insights where the mode of indigenous knowledge relies almost exclusively on intuition and evidence directly available to the senses. The way indigenous communities refer to conceptual content is unique to each subset of

indigeneity represented (Kwang-Kuo 2005). The indigenous environment makes itself spatially available to perception and suggestion as a conscious state of thought (Sefa Dei, 2002). Indigenous intuition is aware of the possibilities for alternatives and perspectives based on tactical relevance, suggestion and, a mental approach uniquely available to the community concerned (Begay and Maryboy n.d.). Indigenous processes spatially connects the indigenous community concerned with the IT artefacts operations. Where indigenous knowledge is claimed to be a group dynamic based on a place of habitat, indigeneity provides the association to the place as a result of long-term occupancy in that specific habitat, a lived space of emplacement (Morie 2008). Such as being connected to the ecology, economy, politics and social norms of the community, an attached sense of internal embodiment reflecting a social context that is a reflection of the indigenous community involved in research (Muehlebach, 2001).

In review, the IT artefact ensemble reveals an indigenous socio-technical system (*iSTS*) established as an architectural framework for the purpose of grouping property types of the indigenous intelligent agent within a single setting. These property types can be used to position indigenous priorities and thereafter, the delivery of indigenous meta-data containing practices and processes for the intended purpose of the IT artefact.

Mapping Indigenous Agent Properties to the IT Artefact Ensemble

Over the past decade intelligent agents have gained a wide range of attention in fields such as power systems management, flood forecasting, business process management and, social interaction bringing resolution to some difficult optimization problems (Byrski et al. 2015). Categorized using terms such as ‘agent’, ‘agent-based’, ‘intelligent agent’ and ‘multi-agent’, one reason for the success of agents, is their ability to reflect intuitiveness similar to human cognition and, the discovery of mechanical theories purported as being universal (Toulmin and Leary 1985). Although indigeneity queries the universality of such theories preferring to assign traits more aligned with a social context to adopt traditional and ecological settings (Yang 2000). One such social context is the highly discussed indigenous Maori model Durie, (1994) described as the ‘four cornerstones of well-being’. An indigenous Maori representation of an environment able to reflect agent like activities such as (1) the body (*taiao tinana*) reflected through the laws, rituals, ideology and, beliefs systems of the agent, (2) the environment knowledge (*taiao hinengaro*) of the socio-setting such as knowledge of the landscape or the seasons, or availability of flora and fauna to the agent, (3) the family (*taiao whanau*) connections including extended members and the actions of the agent and, (4) the sensory (*taiao wairua*) and intuitive data available to the agent revealing – an indigenous Maori mode of an agent-based model working in unison.

To achieve an abstract version of the IT artefact ensemble using an agent-based system, an initial early step is to specify the design of the IT artefact as fully as possible (Jennings 1999). Investigation of the agent’s environment of awareness, describes the agent as one that is capable of flexible autonomous action such as meeting the social ability to interact with other agents (possibly humans) in order to satisfy its design objectives. Applied in this manner, the IT artefact ensemble addresses two fundamental design challenges during construction, being, the social design and second, the agent design (Wooldridge 2002). Whilst, the social design considers ‘where in the environment’ the agent behaves, the agent design represents an intelligence tasked with figuring out ‘what it has to do’ such as delivering acts of communication, cooperation and reaching agreement to meet the design objectives (Russell and Norvig 2003). Although, one fundamental difference during the agent design occurs, where the agent is organized towards reaching intended agreement using concepts of negotiation and positioning as opposed to indigenous agents adopting agreement based on a relational connection that does not tout position (Hendry 2014). Furthermore, the system should be able to think and act rationally using a ‘law of thought approach’ and, acting rationally as a ‘rational agent approach’ using practical attributes of reasoning such as assigning intentions and means-end motives (Wooldridge, 2009).

Russell & Norvig, (2003) provides a description for a range of property types engaging with their environments as being either deterministic vs stochastic; episodic vs sequential; static vs dynamic; discrete vs continuous and single agent vs multi agent environments. The indigenous agent purports to enjoy similar attributes across the tasked environments properties described and offer further insights where (1) the indigenous agent sensors are not only able to detect what exists in its environment when

selecting actions but is also able to show an awareness of its environment prioritizing actions based on known relational connections to the world it knows about Grenier, (1998) and (2) enabling traditional owners to describe, contextualize and annotate resources in their own words and, their own languages Hunter, Koopman, & Sledge, (2003). This allows the community involved to state the world or tasked environment for themselves L.T.Smith (2000), establishing an indigenous link during design.

In modelling indigenous agents as part of a tasked-environment, Russell & Norvig (2003) portrays the agents behavior operating in a system used to explain the **Performance, Environment, Actuators and, Sensors (PEAS)** component types. *Performance* evaluates the behavior of the agent to maximize the expected value of the performance as a measure whilst the *Environment* describes the terrain the agent operates within. The *Actuators* represent the available motor controls used by the agent. Finally, the *Sensory* information reflects the components used by the agent to interact with precept properties such as maintaining distance (proximity), line of sight (infrared), determining distance (light) listening to sound (microphones). In this way, the agent receives sensory input from its tasked-environment and can perform actions which change the environment in some way (Jennings et al. 1998).

In review, adding to the guise of an *iSTS* model mentioned in the earlier section, a connection exists between the tasked environment of PEAS Russell and Norvig, (2003) and the four corner stones of wellbeing for Maori (Durie 1994). As an example, *iSTS* provides the architectural framework whilst the tasked environment of PEAS represents the environment the agent behaves within to achieve its design goals. By substituting PEAS with equivalent indigenous Maori understandings Durie (1994), the tasked environment is able to operate with indigenous agent property's such as working with indigenous meta-data to meet acts of communication, cooperation and agreement. Also, the indigenous properties of the tasked environment offer an additional view to the property tasks described by Russell & Norvig, (2003) adding an indigenous awareness that prioritizes actions based on known indigenous relational connections to the world it knows about.

The IT Artefact Ensemble

The IT artefact exists in the form of an indigenous socio-technical system able to employ an indigenously framed tasked environment (Russell & Norvig, 2003; Durie 1994). The tasked environment is shown as a table depicting the activities of an agent-based model. The result is an indigenously framed intelligent agent aware of its operating environment, the laws that govern the environment, the meta-environment knowledge required to understand the wider environment, the people operating in the environment and, the sensory information surrounding the environment. The IT artefact is initiated through the indigenous narrative of greeting visitors onto traditional Maori grounds (Marae) in New Zealand.

The Indigenous Narrative

New Zealand Maori have an approach when welcoming guests to their traditional homes that incorporates practices such as using their indigenous language (te reo), connecting genealogy (whakapapa), a way of doing (tikanga), portraying authority (mana), deploying protocols (kawa), using correct/ incorrect ideologies (tapu & noa), portraying an internal essence of self (mauri) and adopting spirituality (wairua) all intrinsically coupled to practices and protocols of welcoming visitors to traditional homes in New Zealand (Evans 2009). Each with their own modes of intricate knowledge based understandings. However, the above is left for future study and for this paper, the key outcome is to depict a sense of indigenous connection to the IT artefact ensemble at design time adopting a welcome ceremony as an example of traditional Maori heritage in action with technology.

A typical scenario for traditional welcoming ceremonies in New Zealand involves (1) visitors arriving at the gate of Maori traditional grounds (Marae), (2) people from the Marae assembling in preparation to greet the visitors in their meeting house (wharenui) – at times indicated by the blowing of a sea-shell (putatara), (3) once all of the occupants of the Marae are prepared in the meeting house, with visitors waiting at the gateway entrance, (4) a warrior from the Marae approaches and proceeds to challenge the visitors – a traditional act seeking the visitors reasons for standing at the entrance of the Marae, (5) once the intentions are obtained from the visitors, the warrior decides whether to allow the visitors to come

onto the traditional grounds or not – if the reasons are aggressive, the visitors are unable to proceed else, the visitors are assumed to be attending in peace so, the warrior guides visitors along the required pathway in the direction of the meeting house, (6) this is a signal for the female (wahine) to call in a whaling manner to the visitors moving the visitors past the warrior and into the meeting house of the occupants, (7) once the visitors are inside and all seated, verbal greetings are made between the visitors and the house orators – usually in the presence of elders and thereafter, songs are exchanged and, (8) traditional connections are made through the act of touching noses with each visitor (hongiri). (9) To finish the act of greetings visitors, a meal is provided to complete the formalities of welcoming visitors onto traditional Maori Marae grounds.

The Indigenous Tasked Environment

The *i*STS framework provides a tasked environment outlined below in Table 1, as an indigenous Maori agent-based model employed to welcome visitors to traditional Maori tribal homes. The table is used to describe the environments behavior components where the agent receives input from its tasked-environment and can perform actions which change the environment in some way. The first row shows the headers for the tasked-environment. The headers are the Performance, Environment, Actuators and Sensors (Russell & Norvig, 2003). The second row consists of the Eurocentric version of STS Property types linked to the tasked environments *structure* – the body such as the rules and laws used to shape community activities to follow during the welcoming ceremony, the *technical environment* – the technical knowledge of the meta-environment both natural and artificial, the *people* – as family tribal members from the community and roles played during the ceremony, and finally, the *processes* and the intuitive information available to the tasked-environment. The third row consists of the indigenous version of *i*STS Property types, interpreted as an indigenous Maori mode representing the four cornerstones engaged with the tasked-environment Durie (1994), depicted as being the body (Taiao Tinana), the knowledge (Taiao Hinengaro), the family (Taiao Whanau), the processes (Taiao Wairua). The fourth row outlines the *i*STS Priorities for the model-based agent, each with their known inner functions acting in unison within the tasked environment. The fifth row reflects the tasked-environments *i*STS Practices of the model-based agent.

Table 1: *i*STS Tasked-Environment to Welcome Visitors to Traditional Tribal Homes

| Agent-based Components | Performance | Environment | Actuators | Sensors |
|-------------------------------|--|--|---|--|
| STS Property | Body (The Structure) | Environment Knowledge (The Technical) | People (The Family) | Intuition (The percepts) |
| <i>i</i>STS Property | Taiao Tinana (the body) | Taiao Hinengaro (the knowledge) | Taiao Whanau (the people) | Taiao Wairua (the intuitive) |
| <i>i</i>STS Priorities | Indigenous rules as laws, theories, ideologies and beliefs. | Indigenous socio-economic knowledge of the meta-environment. | Indigenous actors represented in tribal communities. | Indigenous self is intuitively available to perceptions based on tactical relevance with place and space. |
| <i>i</i>STS Practices | <ul style="list-style-type: none"> - ceremony - customs - rituals | <ul style="list-style-type: none"> - tribal housing - climate type - seasonal tides for gathering seafood - seasonal harvest - native landscape - flora and fauna - tribal commune link - sub-tribal links | <ul style="list-style-type: none"> - warriors (physical protector) - female (emotional protector) - elder (heritage holders) - male (male orator speaker) - hunter (food gatherer) - cook (caterer) | <ul style="list-style-type: none"> - putatara sound - warrior sounds - audio voice female - audio voice male - recognize image - identify body position - identify objects - identify norms - identify object-hongi |

The iSTS framework reflects 'how' to portray an indigenous Maori agent-based model using the above tasked-environment. For example, visitors arriving at the entrance of the indigenous Maori tribal grounds initiates the *actuator* warrior to deliver a *sensory* message (putatara sound) to all other actuators, to be ready (in position) for a 'call to action'. The female is ready to use *sensor* (audio voice female) to call visitors. The elder is ready to use *sensor* (identify ritual objects and norms) to guide the ritual of greeting visitors. The male is ready to use *sensor* (audio voice male) to speak to visitors. The hunter and cook *actuators* have already actioned tasks based on notification knowledge prior to the visitors arriving. As a result, a meal is ready for service by *actuator* cook once *sensor* object-hongi is initiated by *actuator* elder. The tasked environments knowledge of its inner environment such as the climate type determines whether the ceremony will be held in-doors or outside, knowledge of the tides will determine seafood type for hunting (deep-sea fish or shoreline shells), knowledge of seasonal harvest will determine the types of crops available (corn or sweet potato) to cater for visitors, reflected in the way the environment makes itself available to indigeneity. Four indigenous representations of the tasked environment are created being:

Performance Body (Taiao Tinana) – Performance is based on recognizing indigenous rules such as the laws, theories and ideologies employed to inform the practice of ceremony, customs and, rituals using an indigenous Maori world-view, a connection with known activities that are familiar to the indigenous community involved with the tasked-environment.

Environment Knowledge (Taiao Hinengaro) – the environment is represented as an array of knowledge types such as knowledge of tribal traditional house, knowledge of seasonal harvest, knowledge of climate type, knowledge of native landscape such as flora and fauna, knowledge of tribal communities, knowledge of tribal families.

Actuators as People (Taiao Whanau) – Actuators interacting with the system, is a naturally reflected occurrence in the real indigenous world. The indigenous actuator is based on the notion indigenous communities involve people and tribal information that are in touch with their traditions and heritage. The actuator provides action as a function of their role within the community such as warriors who protect the environment, speakers who are the orators on behalf of the community, gatherers who fetch food and the caterers who cook food.

Sensors as Intuition (Taiao Wairua) – Sensor information that connects the indigenous community to the tasked environments operations. An intuitive representation that involves interaction with spatial information. Processing is based on a perception of social awareness and relational social connection.

Evaluation

The literature adopts a multi-disciplinary approach as a response to the task of assigning indigenous agent properties to the construction of the IT artefact. Indigenous knowledge evolves as a response of individuals and communities to their social environment and past time events – espousing actions based on known indigenous relational connections to the world both real and unreal, lived and unlived spaces.

The IT artefact ensemble reveals an indigenous socio-technical system established as an architectural framework for the purpose of organizing the indigenously tasked environment. Indigeneity views the tasked environment of artificial intelligence to be a relational one consisting of indigenous priorities and practices in meeting acts of communication, interaction and reaching agreement. During design, the tasked environment attempts to align with indigenous knowing such as being inter-generationally linked, adopting empirical knowledge based on observations of the surrounding environments (nature, tradition and society), and revealed knowledge provided through dreams, visions and intuition of the indigenous Maori community such as their ceremony for welcoming visitors. The IT artefact ensemble assigns indigenous properties to the tasked-environment, prioritizing actions based on known connections to the world it knows about and, enabling traditional owners to describe, contextualize and annotate resources in their own words and, their own language.

Four modes are employed using indigenous knowledge models. These are Taiao Tinana as a body where performance is based on a sense of connection to protocols and practices that are familiar to the indigenous community involved with the IT artefact; Taiao Hinengaro as a system aware of the meta-

environment it operates within; Taiao Whanau and the people actors involved with the system as would naturally occur in the real indigenous world and; Taiao Wairua - the sensory information that is intuitive and spatially connected to the indigenous community concerned with the IT artefacts operations. At the time of writing this paper, no literature exists that explicitly represents indigenous intelligent agents adopting tasked environments during the ex-ante construction of the IT artefact.

Discussion

This study provides a pathway for research involving indigeneity matched with technology to pursue. An abstract model ex-ante is revealed of the IT artefact ensemble that is indigenously framed. Without this type of study, the digital gap may continue to widen between Indigenous and Eurocentric research in regards to the IT artefact meta-data that currently exists and, does not for indigenous communities alike. Adding to the theory development of STS, indigeneity puts the (*i*) in the socio-technical system to reveal *i*STS, an indigenous body of work with its own tasked-environment operating as an intelligent agent. The system is capable of accessing indigenous properties to lead indigenous priorities and practices during the IT artefact construction. Without the existence of (*i*), the system becomes an every-day Eurocentric representation of technology in a social setting.

The other addition is to the domain of artificial intelligence working with indigeneity. The study opens a pathway for AI to link with indigenous notions and ideas using technology. The agent-based model represents an ensemble of knowledge used to position indigenous understandings at the design stage, adopting an indigenous mode of the tasked-environment which can thereafter, be converted to unique indigenous properties. Difference arises during the agent design when the Eurocentric agent is organized towards reaching intended agreement using concepts of negotiation and positioning as opposed to the preference of indigenous agents, adopting agreement based on a relational connection that does not tout position. Furthermore, the system should be able to think and act rationally using an indigenous 'law of thought approach' and, acting rationally using an indigenous 'rational agent approach' such as assigning indigenous property's based on knowledge connections to living and non-living spaces or adopting predictive activities based on known indigenous connections.

Conclusion

Research surrounding the IT artefact that is indigenously framed is well overdue. The research question is, can an indigenous sense of understanding be transferred during the design phase of the IT artefact ensemble? The study shows an indigenous ensemble version of the IT artefact using indigenous notions, ideas and understanding as a representation of an agent based model ex-ante aware of the environment it resides within. As a contribution to the development of IS theory, a theoretical description of *i*STS is presented as an indigenous Maori agent based model with its own categorized properties, priorities and practices operating within an AI tasked environment. To this end, the agent-based model shows 'how' indigenous decision-making is organized and 'what' the agent has to do to meet indigenous acts of communication, cooperation and agreement during the IT artefact construction ex-ante – a theoretical model depicting an indigenous intelligence that represents indigenous knowledge and practices. Whilst there may be some existing incompatibilities between the field of IS and indigeneity during research, the over-riding goal should be to establish a co-existence agreement where both are aware of the others understanding towards the IT artefact.

Future Work

There are a limited number of publications connecting IS to indigeneity and vice versa opening wide opportunities for research. Furthermore, it becomes increasingly obvious, communication translation services from indigenous to computer languages are rare at the time of writing this paper. Also, ongoing research discussion and contributions in the areas of testing discrete applications against the enclosed research effort or, providing further defined analysis using a single approach – are all possible.

Limitations

This paper uses an interpretive view employed to conceptualize the construction of the IT artefact ensemble. Given the multi-disciplinary approach, and the need to address indigenous research, investigations leave room for further analysis. No discrete modelling is applied to this paper for preview.

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Terminology

| Maori Word | Translation |
|-----------------|---|
| Ao | (noun) world, globe |
| Hongi | Salute by pressing noses together |
| Kawa | Charmed: protected by the ceremony of Kawa |
| Korero | To tell, say, speak |
| Mahi-toi | Art, craft |
| Mana | Authority: control, influence. Having influence of power |
| Maori | Native or belonging to New Zealand |
| Marae | Enclosed space in front of a house, courtyard, village common |
| Mauri | Life principle, Talisman, a material symbol of the hidden |
| Putatara | Subspecies of large sea snail, shell is used for conch shell trumpets |
| Taiao Hinengaro | World, <i>seat of thoughts and emotions</i> |
| Taiao Tinana | World, <i>body, trunk, main part of anything</i> |
| Taiao Wairua | World, <i>spirit,</i> |
| Taiao Whanau | World, <i>offspring, family group</i> |
| Tane | Male, man |
| Tapu | Under religious or superstitious restriction |
| Te reo | Form of words, The voice, tone speech, dialect |
| Tikanga | Rule, plan, method, reason: way of doing |
| Toi Mahi | In the expression of – work, work at |
| Wahine | Female, women, feminine |
| Waiata | To sing |
| Wairua | Spirit |
| Whaikorero | Speak in a formal way |
| Whakanoa | Using correct |
| Whakapapa | Genealogy |
| Whareniui | Meeting house, large house |

H. Williams, 1997. Dictionary of Maori Language