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Teledermatology: The Case of Telemedicine Adoption and Success in New Zealand

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Abstract

Using a theoretical framework extracted from thetechnological innovation theories, this research attempts to explain factors influencing the adoption and diffusion of telemedicine utilising the video conferencing technology (TMVC) for dermatology within health Waikato (HW) in New Zealand. Findings indicate weak presence of critical assessment into technological innovation factors prior to TMVC adoption. Factors such as complexity, compatibility, and trialability were not assessed extensively by HW and could have hindered its adoption. TMVC was mainly assessed according to its relative advantage and cost effectiveness. This is essential but should consider other important factors explained in this research. The successful diffusion of TMVC in the case study relied on its economical benefit and on its effectiveness as a diagnostic tool. This research highlights the importance of the product champion factor on the successful adoption and diffusion of TMVC.

1. Introduction

Telemedicine means medicine from a distance where distant and dispersed patients are brought closer to their medical providers through the means of telecommunication (OTA, 1995; Perednia & Allen, 1995; Wayman, 1994). Telemedicine emerges as a viable solution to New Zealand health providers in reaching out to rural patients, in offering medical services and conducting administrative meetings and training. Telemedicine covers a wide spectrum of benefits through the use of telemedicine utilising the video conferencing technology (TMVC) in areas such as consultations, diagnostics, therapeutic, transfer of patient related records, case management, training, and meetings.

The entire crown owned hospitals in New Zealand are managed by regional organisations known as Health and Hospital Services (HHS)[1]. At the outset, despite the rapid growth and high visibility of telemedicine projects in countries like the US, relatively few patients are now being seen through telemedicine (Grigsby & Allen, 1997; Hassol, 1996;

[1] Recently, hospitals are now the provider arm of the District Health Boards, e.g., Waikato District Health Board (WDHB).

Wayman, 1994). A study conducted by Perednia and Allen (1995) found that in almost every telemedicine project, tele-consultations accounted for less than 25% of the use of the system. It was mostly used for medical education and administration. The important unresolved issues identified revolve around how successful the telemedicine can be in providing quality health care at an affordable cost and whether it is possible to develop a sustainable business model that could maintain profitability over time. It is found that the successful adoption and diffusion of Telemedicine projects in the U.S relied on: (i) clinical expectations, (ii) matching technology to medical needs, (iii) economic factors like reimbursement, (iv) legal concerns (e.g., restrictions of medical practices across state lines (licensure)), and (v) social issues (e.g., changing physician behaviour and traditional practices and workflow), and (vi) organisational factors (16). Anderson (1) and Wayman (1994) have endorsed these issues as well. The obstacles pointed out by the above results raises concerns about success of telemedicine as a medical tool.

2. Research Objectives

This research was interested in developing an understanding about factors influencing telemedicine adoption and diffusion (use) within one HHS in New Zealand. Particularly, in explaining why and how an HHS viewed and adopted TMVC and how it used TMVC. Issues arising from the two questions would depict accelerators and/or impediments to the wide adoption and diffusion of TMVC in New Zealand. This research focused on the adoption and diffusion of TMVC by health Waikato Ltd (HW), a leading HHS and one of the early adopters of TMVC in New Zealand. HW assessed the potential of adopting TMVC for psychiatry and dermatology. However, this research was interested in explaining factors influencing the adoption and diffusion of TMVC in dermatology only.

3. Theoretical Framework

In search for models that could explain technologies adopted by organizations, Rogers' (Rogers, 1983; 1995) model appeared to be the most widely accepted model by researchers in identifying critical characteristics for innovations (Moore & Benbasat, 1992; 1996; Premkumar & Roberts, 1999; Thong, 1999). Rogers classical adoption model comprised the following factors: relative advantage, complexity, compatibility, observability, and trialability (shown in Table 1).

Some researchers contend that Rogers' theory is robust in predicting adoption/diffusion as well as non-adoption/non-diffusion only and it suits distinctive technologies (e.g., medical equipment, fax machines) with fixed features that do not change during the diffusion process (Larsen & McGuire, 1998; Moore & Benbasat, 1991; 1996). Other researchers argued that Rogers' model does not suit adoptions at the organisational level (Chau & Tam, 1997; Moore & Benbasat, 1991, 1996). However, Fichman and Kemerer (1993) and Kwon and Zmud (1987) stressed that the innovation attributes not only play an important role on its adoption only by organisations, but also support its post-adoption as well. They even extend their argument to include the adoption of complex technologies. Understandably, the strength of Rogers model could be complemented with other contexts in order to have a more holistic understanding about IS innovations in organisations (Fichman & Kemerer, 1993; Thong, 1999) and this could be the subject of a future research (cost and image in Table 1).

Table 1: *Innovation Characteristics*

i	**Innovation Characteristics**
1	Relative advantage: the degree to which using technology is perceived as being better than using its precursor of practices.
2	Complexity: the degree to which technology is perceived as being easy to use.
3	Compatibility: the degree to which using technology is perceived as being consistent with the existing values, and past experiences of the potential adopter.
4	Trialability: the degree to which technology may be experimented with on a limited basis before adoption.
5	Observability: the degree to which the results of using technology are observable to others.
6	Cost: the degree to which technology is perceived as cost effective (Tornatzky & Klein (1982).
7	Image: enhance one's image or status in one's social system Rogers (1995).

Rogers' (1995) compatibility characteristic is highly envisaged here as past studies (Austin, 1992; Austin, Trimm, & Sobczak, 1995) have considered the problem relating to physicians accepting information technology (IT) for clinical purposes. Tornatzky and Klein (1982) examined the relationship between innovation characteristics and adoption. Their findings are still valid and endorsed by recent research in IT adoption literature (Premkumar & Roberts, 1999; Thong, 1999). They emphasised the importance of Rogers' (1983,1995) model. Cost was outlined as an important factor by other researchers (Bacon, 1992; Elliot, 1996; Tornatzky & Klein, 1982) (Table 1). The image factor was found important to the adoption of technologies in the health literature (Little & Carland, 1991). Even-though Rogers (1995) highlighted the importance of the image factor on IT adoption he suggested that it could be studied from within the relative advantage characteristic. However, Moore and Benbasat (1996) stressed the image factor as an independent factor on its own (Table 1).

The research outcome is expected to add to the existing literature on adoption of complex technology such as TMVC for dermatology purposes. Further identification of those factors that facilitate and those that hinder adoption and diffusion of TMVC would not only assist the authorities of the organisation under study but also help other HHS and policymakers. This research is the first in New Zealand that uses the technological innovation theories in developing an insight into TMVC adoption criteria in the health sector represented by the case of HW.

4. Research Methodology

The research will follow the qualitative paradigm using Yin's (1994) positivist (hard) case study methodology. Although Yin (1994) adopted an implicit positivist stance in describing case study research, his view that case studies are the preferred research strategy to answer the above type of questions would also be acceptable by the interpretive school (Walsham, 1995). The strength of case studies is the ability to capture a greater number of variables than is possible with any of the other strategies. This approach serves the exploratory nature of this research.

Upon reviewing the literature, the researcher developed a set of questions: open-ended to begin with followed by focused questions targeting the adoption and diffusion specifics of TMVC in HW. Interviews were conducted with a consultant that was involved in the adoption phase of the TMVC project at HW, a dermatologist, and a dermatologist registrar during the period December 1999 and April 2000. Interviews were recorded on audiocassettes and notes were taken. Finally, the specialist dermatologist reviewed a draft of the research (during the composition phase) to ensure interpretations and conclusions made. The researcher in finalising this research considered the dermatologist views. As HW represented a single case, generalising the outcomes from this single case to other hospitals was not possible.

5. Case Background

HW was established in 1886. HW is responsible for funding and providing services to 330,000 people living in the Waikato district of the central North Island of New Zealand (HW, 2001). It provides a range of health services to local and rural communities through one main speciality hospital (including an adjacent mental health hospital) and six rural hospitals. In 1994, HW identified the need for a solution to the rural health needs. They explored the option of establishing and linking the main hospital with various rural hospitals through a medical telemedicine network. They appointed a technical consultant to assess the feasibility of introducing the TMVC into HW. The consultant identified many advantages for TMVC in different clinical areas but pursued psychiatry and dermatology only as they were the only department that show interest in TMVC.

In September 1995, three TMVC-ISDN (integrated systems digital network) systems were leased (the third one was only used for a few weeks and was returned), one of which went to a rural Taumarunui Hospital, 100 miles (160 km) south of HW, where there was a single specialist physician and a number of medical officers. The 23-bed rural hospital serves a population of 10,000. The rural hospital offered no specialist surgical services at the time the TMVC system was installed but employed specialist physicians and medical practitioners.

The TMVC systems were not identical at the time of adoption, e.g., the unit in dermatology was upgraded in 1998 to ISDN 128 kbits/s bandwidth. Two years later, another TMVC unit running at 384 kbits/s was installed for educational purposes. This has not been used for consultations but continues to be regularly employed for educational and administrative purposes. The initial pilot studies involved experimenting with the TMVC in conducting dermatology and psychiatry sessions (later on, it was pursued in dermatology only).

6. Case Findings

The following sub-sections depict findings for each of the characteristics shown in table 1. At the end of each subsection, findings from the post adoption phase are outlined.

Relative advantage

HW has identified the various advantages of TMVC in comparison to their earlier practices:

- The system allowed instant and continuous access to remote and rural patients. By establishing the network, all rural hospitals would have instant access to specialists at the main hospital.
- Saving on patients' time lost in travelling to see specialist at the central hospital (e.g., 5 hours round trip between the main hospital and Tamarunui).
- Saving on doctor's time lost in travelling to see rural patients at rural hospitals.
- Could be used for medical training (continuing education).

The dermatology department of HW is participating in the UK Multicentre Teledermatology trial run by the Institute of Telemedicine and Telecare at Queen's University in Belfast in assessing the effectiveness and the financial feasibility TMVC. HW's studies (Oakley et al., 1996; 1997; 1998; 2000) were adapted from the UK Multicentre Teledermatology studies. This allowed HW benefiting from the experience of early adopters in dermatology.

Trialability and complexity

The consultant along with the head of dermatology department "clinical director" participated in the assessment of the TMVC system and conducted few trials with the vendor's branches in Australia. He included clinicians during the assessment phase but their involvement was limited and not conclusive. They had to travel long distances (4 hours round trip) to trial the system, which was difficult to coordinate. The general perception developed that the system was not complex and with basic training it could be easy to operate. There were not many functions to master, or a need for keyboard expertise or tools knowledge, etc. like in the personal computer environment. Other issues like adopting a protocol that should govern TMVC encounters, the bandwidth and its reliability, and the technical specifications of the equipment were not explored thoroughly before adopting TMVC.

After adoption, technological problems proved frustrating as the TMVC encountered lots of blackouts due to an unreliable ISDN connection and related peripherals (the TMVC equipment). This resulted in the cancellation of several TMVC consultations. The 128 kbits/s ISDN connection and single chip, pan-tilt video camera was not sufficient to produce high quality images. There were concerns regarding the accuracy of clinical diagnosis made with the TMVC compared to face-to-face (one-on-one) consultations. HW further investigated this concern and found seventy five percent of cases were correctly diagnosed by TMVC. On the other hand, twelve percent were incorrectly diagnosed (Oakley et al., 1997). This was related to low clarity of the images transmitted via the TMVC and its failure in showing skin lesions (e.g., pigmented lesions, rashes). This could be enhanced with greater experience and improved image and communications technology. The study (Oakley et al., 1997) concluded that TMVC could be used with a reasonable degree of accuracy. HW even suggested the use of standard photographs using Polaroid or single reflex camera could be used before, after or instead of the TMVC.

TMVC in the remote site was situated in a room that had not been specifically prepared for telemedicine. The lighting was poor and the wallpaper was disturbing. This resulted in having poor quality images and consultations. However, a protocol was adapted from the UK trials that assisted HW in administering their TMVC encounters with rural patients. The diagnoses were discussed over the TMVC and a management plan was formulated that included a treatment plan and a follow-up plan (Oakley et al., 1998). Prior to the TMVC encounter, a database record including the patient's details was sent to the dermatologist by email. After the encounter the dermatologist filled a database report and was sent to the patient's GP by email (Oakley et al., 2000).

Compatibility

The general perception developed is that the technology is acceptable by consultants and physicians in seeing patients. HW refused one of the systems during the assessment phase because the TMVC camera used to make a loud noise while moving. This would annoy patients and physicians during TMVC encounters.

Patients' perceptions about being seen through TMVC were assessed by HW before adoption. The TMVC was a better option than travelling to the main hospital as it saved them valuable time and money. However, 96 percent agreed or strongly agreed that early diagnosis was better as it was a more face-to-face encounter (Oakley et al., 1997). There were some concerns about rapidly moving patients but no specific difficulty were reported about examining infants (Oakley et al., 1996; 1997). During 1995 a survey of rural patients attending HW clinic was conducted (unpublished as reported by the dermatologist). The majority of patients claimed they would prefer telemedicine consultations instead of attending a standard outpatient appointment. There were some concerns about the lack of familiarity with the technology among the older patients. They seemed reluctant to interact freely with the dermatologist at the other end of the connection.

After adoption, the TMVC system was not used immediately. It was the emergence of a dermatologist within HW with initiative to adopt the new technology that resulted in the success of TMVC in dermatology. The dermatologist showed keen interest in the technology and its advantages in seeing rural patients. This individual initiative and interest lead to the successful diffusion of TMVC for dermatology. The dermatologist was a product-champion in embracing the technology and in overcoming the different hindrances highlighted earlier. Surprisingly this dermatologist was not involved in the assessment phase prior to TMVC adoption. Later on, other dermatologists were trained to use the technology and reported no difficulties in using the system for clinical purposes or in familiarisation with the implemented protocol. However, the technological impediments highlighted in the preceding section frustrated the dermatologists and raised doubts about the usefulness of the technology in live tele-consultations and in the accuracy of the diagnosis. One of the main dermatologists indicated that it was possible to overcome some of those barriers by developing their experience with the TMVC system (e.g., the ability to accurately judge a symptom, to detect the actual colour of some of the skin diseases). However, a later study (Oakley et al., 1998) found that TMVC is moderately useful in dermatology. It proved its effectiveness as a follow up tool in seeing patients with known skin diseases where the TMVC is used for interview rather than detailed diagnosis. Dermatological diagnosis is made from both history and examination of the skin disease. Dermatologists are used to having diagnostic difficulties with skin diseases as they vary in nature and surrounding circumstances. The dermatologist could easily diagnose these skin diseases in person by biopsy, and/or choose a watch-and-wait policy to make an accurate diagnosis. Replacing this traditional practice, in light of the observed technological implications, seemed concerning to dermatologists.

Image and Observability

HW considered TMVC to be an image enhancer. It would project HW as technology leaders and could be approached by other HHS for guidance and for consultation, as indicated by the consultant. HW was among the early participants in exploring the potential of telemedicine for medical care in New Zealand in the early nineties. The various stakeholders involved in assessing the importance of telemedicine for HW have witnessed its effectiveness in seeing rural patients. Some of HW's staff even visited a few telemedicine sites in the US including Mayo clinic in Minnesota. This resembled a trigger for exploring the potential of adopting TMVC in HW. However, the guidelines extended

from these visits were general and emphasised the suitability of TMVC as an efficient medical tool for rural and distant settings.

Cost effectiveness

HW went through an exhaustive cost-benefit analysis to justify the investment made on TMVC. HW anticipated to save at least NZ$ 175,000 on clinician's time and on travelling expenses. The cost savings were expected to be more than what has been indicated because there was a lack in reliable financial data at various clinical and administrative applications (could not be included in the cost-benefit study). Also their study did not include cost savings that could be gained from the patient's side (time and expenses lost in commuting to main hospital for treatment). It was emphasised to reflect the total and actual costs of TMVC and not to include grant funds in the actual cost analysis simply because when these grants diminish, HW would not have to scout for new financial resources for their TMVC projects. This is particularly so in the light of strict funding from the New Zealand government, which has not been up with the increasing needs of the different HHSs (Neame, 1995).

After adoption, HW implemented a cost benefit analysis – part of the UK Multicentre Teledermatology trial (Oakley et al., 2000). Findings revealed that TMVC consultations were less time consuming for patients than hospital consultations and were less costly. Patients reported to travel on average (271 km) to see a specialist at HW. This would have cost them NZ$160 compared with the NZ$7 spent on commuting to the TMVC centre. The TMVC link seemed beneficial to them. Further, the average consultation time was almost similar to traditional appointments. Waiting-time was reported to be less than traditional dermatology consultations (Oakley et al., 1998). The study showed that the economic benefits of TMVC favoured the patient rather than the secondary health provider (Oakley et al., 2000).

Other impediments highlighted by the literature (Perednia & Allen, 1995), such as reimbursement and licensure were critical in the case of HW, as emphasised by the dermatologist. Reimbursement is in fact a critical factor that has contributed to the lack of expansion of the telemedicine network. The '"provider" (HW) depends on payment from the "purchaser" of health services - one of the difficulties in NZ is determining who should pay for remote consultations when these are in a location where HW does not offer a face-to-face service. Licensure was not much of an issue until recently, when it has been necessary to introduce a credentialing system to each department and its medical staff. Credentialing extends to teleconsultations requiring appropriate training. The dermatologist further commented that the legal situation for telemedicine consultations is not clear here or anywhere else.

7. Case Discussion

Prior to TMVC adoption

It was demonstrated that TMVC would provide various advantages to HW in seeing rural patients and in integrating the various dispersed rural hospitals with the main centre. This would boost effective and quality medical care across HW and the other HHSs.

According to the research findings, factors like relative advantage, cost effectiveness, observability, and image were main contributors for TMVC adoption in HW, with more emphasis on the first two being the main influencers and the rest acting as facilitators and accelerators. This substantiates Bacon's (1992) findings, which indicated that organisations adopt IT projects based on their support for explicit business objectives (e.g., relative advantage) and on their cost effectiveness. However, these two main factors

(relative advantage, and cost) and other accelerators (image and observability) are not sufficient to guarantee successful adoption and diffusion of TMVC. HW has undertaken an exhaustive cost-benefit analysis to justify the investment made on TMVC but did not undertake a similar approach in assessing the impact of the other factors: complexity, compatibility, and trialability. The TMVC equipment and the bandwidth have failed HW on several clinical occasions. The failure of the TMVC equipment in providing accurate and clear images raised doubts about the success of the technology as a suitable medical tool. Although the dermatologist emphasised that such shortcomings could not easily be detected by experimenting "trialability" with the equipment before adopting it and pointed to the fact that training and developing experience takes a period of time, this does not mean ignoring the trialability perspective completely.

This case points to the need for such an approach by HW and other potential HHS in assessing the real potential of TMVC alongside essential innovation characteristics (in table 1) before adopting TMVC. This could be justified in part due to the fact that the technology was newly introduced in New Zealand and there is not much understanding about its complexities or incompatibilities among suppliers and potential adopters. That's why early adopters of the technology face higher risks and encounter higher expenses in gaining the technology and the "know-how": implementing it, integrating it, conducting research, and development. Other HHSs interested in TMVC would benefit from the reduced prices and the advancement in the technology and the experiences of early adopters. After adoption, HW realised this fact and joined the UK trials in order to benefit from their experience with dermatology and replicated their studies within HW.

This research emphasised the importance of having a product champion for the successful uptake of TMVC. Without this champion the project would have failed in progressing any further. Although this research did not highlight this emergent feature in the theoretical framework section, earlier research pointed to its importance on innovation success (Rogers, 1983; 1995). Understanding features pertaining to this factor could be the subject of a separate research on its own.

In addition, this research highlights the importance of addressing the following issues by HW's and other HHS's management prior to TMVC adoption:

- Studying TMVC in relation with clinical and administrative applications. This should justify TMVC uptake in the different areas, e.g., dermatology, psychiatry, radiology, education, meetings, etc., and whether it could be relied on as an efficient tool. If TMVC is going to be used as a clinical tool, then TMVC emerges as a viable solution within a rural setting. In the case of HW, the TMVC was an ideal solution for connecting the rural hospitals with the main speciality hospital. On the other hand, selecting the right technology for the clinical area is essential in order not to waste valuable resources.

- Studying TMVC in relation with clinical practices. This refers to the possibility of accepting seeing patients through TMVC by dermatologists. Addressing this human-machine interaction is essential in depicting TMVC success or failure as highlighted by the case and the health literature (Austin, 1992; Austin et al., 1995). Introducing a protocol that would organise TMVC interactions with patients is envisaged here in overcoming lots of incompatibilities.

- In line with (Austin, 1992), this research emphasises the importance of user's (patients, nurses, clinicians, and other potential users of the system) involvement and acceptance to ascertain the successful adoption and diffusion of TMVC. The product champion could play a major role in encouraging clinicians and other end-users in using and in accepting the technology. Looking for clinical leaders and product champions that would take ownership of the TMVC system and guarantee its success before and after adoption. However, this research was not

able to validate this assertion prior to TMVC adoption, as the champion dermatologist was not involved in that stage.

After TMVC adoption

This research pinpointed two areas of concern that would hinder the successful diffusion of TMVC within HW and other HHS at the long run:

- The economic benefits of TMVC were found to favour the patients rather than HW. This fact would have hindered its adoption in the first place. On the other hand, TMVC would provide patients with fast access to quality care. This is indeed a valid point and one of the main goals of telemedicine. However, in light of the stiff funds from the government and the financial pressure exerted on HW, HW and other HHS could increase their fees for the TMVC encounters in line with the savings made by patients. This will benefit all the parties involved in the TMVC encounters and HW would succeed in sustaining its TMVC service to rural areas. The dermatologist emphasised that HW cannot increase its fees as their income is fixed and is supplied by the "purchaser" (now the DHB). HW is not allowed to charge the patient extra for consultations or treatment provided by the public hospital. However, in light of the above discussion, a special pricing model could be introduced specifically for telemedicine in New Zealand. This would lead to the wide adoption and diffusion of TMVC in New Zealand. This point needs further investigation.
- In line with the relative advantage characteristic, the current TMVC equipment did not seem to be suitable for dermatology as a diagnostic tool. Although it proved its success as a follow-up tool, its failure as a diagnostic tool as such eliminated one of the main objectives of having the TMVC system in the first place. The solution would require upgrading the specifications of the TMVC equipment and the bandwidth to a higher capability and introducing new devices (e.g., dermascope) in conjunction with the TMVC equipment. This is a very expensive option and financially infeasible. HW even raised doubts about the overall usefulness of the TMVC equipment for dermatology in the first place. On the other hand, the use of a standard camera and email would be the best applicable solution (HW developed a system for still image/historical data referrals and it is not being used!). Later on, the dermatologist commented that higher specification equipment would increase the number of accurate diagnoses but the equipment used in the department is not considered a failure. It continues to be used, despite its age and the availability of much more useful technology. This further emphasises the product-champion feature highlighted above. The dermatologist further commented that a large body of research indicates that interactive teledermatology (e.g., TMVC) results in more accurate diagnoses than pre-recorded teledermatology. The latter is more convenient and less costly however. A hybrid system may be the best compromise.

However, HW was quite successful in joining other communities in the teledermatology area (the UK trials) where they benefited from their experience and took part in their research studies (Oakley et al., 1996; 1997; 1998; 2000) in analysing TMVC effectiveness. Most importantly, the adoption of the clinical protocol allowed the seamless integration of the technology with core clinical practices and hence hedged against alienating the TMVC equipment by dermatologists. All of that was not possible without the presence of the champion dermatologist within HW.

Telemedicine is being used successfully in countries like the US as indicated by interviewees. This entails further research into the effects of other factors in facilitating TMVC adoption and diffusion. Organisational, individual, and environmental factors are

highly emphasised here as indicated by researchers (Perednia & Allen, 1995; Tprnatzky & Klein, 1982) and by the dermatologist at HW. On the other hand, TMVC has a great potential to diffuse in New Zealand, as it does not face (wider scale) the more complicated licensure and reimbursement like the U.S.

8. Conclusion

It has been suggested that technological innovation characteristics and specifically Rogers' (1995) model has helped in gaining a richer picture about factors influencing TMVC adoption within HW and in identifying most influential ones. It has helped also in explaining various features pertaining to TMVC from various angles with respect to the depicted factors. This entails a thorough look and assessment into innovation characteristics as precursor to TMVC adoption.

The adoption of complex technologies like TMVC is not a straightforward process and should not be assessed according to its cost benefit analysis only. The adoption decision for TMVC should consider various essential factors, including innovation factors, pertaining to technology and to potential adopters (involving all the stakeholders in the TMVC encounters). Although TMVC delivered convenient and fast quality care to rural patients, the successful diffusion of TMVC was found to rely on its economical feasibility to HW. HW even raised doubts about the suitability of the adopted technology for clinical purposes. Thus, unless HW addresses these obstacles, the diffusion of TMVC will be limited. This is essential to reap the real benefits from telemedicine in New Zealand.

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