

2008

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## Recommended Citation

Hafeez-Baig, Abdul and Gururajan, Raj, "Time Management, Improved Patient Expectations and Added Value Contributing to the Perceived Acceptance of Using Wireless Handheld Devices in the Indian Healthcare" (2008). *ACIS 2008 Proceedings*. 47.  
<http://aisel.aisnet.org/acis2008/47>

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## **Time Management, Improved Patient Expectations and Added Value Contributing to the Perceived Acceptance of Using Wireless Handheld Devices in the Indian Healthcare**

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### **Abstract**

*This study explores the views and opinions of Indian healthcare professionals towards the use of wireless technology in healthcare environment. The study explored specifically whether wireless technology can provide added value to an Indian healthcare setting. The independent variables considered in the study were patient expectation and Time management. This study administered 1000 surveys with a return of 668 usable surveys. Based on a first order regression model, results of the study indicate that Indian healthcare professionals believed that wireless technology can provide added value. Initial findings of this study are reported here.*

### **Keywords**

Wireless Handheld Devices, User perceptions, Indian Healthcare, PDA's, Handheld PC's

### **INTRODUCTION**

The use of wireless devices is becoming popular in healthcare applications for data management. While the concept is relatively new and attractive, the problems identified in using wireless devices in a healthcare setting included the small size of the device, problems in fitting current data collection forms into one readable screen of a handheld device and data entry issues associated with a relatively small screen size. It appears that previous studies, while highlighting the importance of wireless applications in healthcare, provided limited information as to the factors that can determine the acceptance of these applications in healthcare (Barbush 2001; Carroll and Christakis 2004; Lee 2004; Schaper and Pervan 2004; Smithline 2002; Spigel 2004; Thompson 2005).

Our investigation into available literature suggests that the domain of technology acceptance specific to healthcare is poorly understood. For example, information systems models were applied without proper understanding of the domain through a survey instrument. One major problem to this approach is that the researcher is trying to understand issues by standing away from the context. Our previous studies in the healthcare context also revealed that certain models used by information systems researchers were not applicable to healthcare because of context sensitive factors. These were published elsewhere. There is support to this notion in other studies also – for example Sheely Gregor, Chau et al., have highlighted problems of using quantitative instrument alone.

This research investigated various factors of acceptance of wireless devices/applications by health professionals in order to enhance healthcare data management in the Indian healthcare. We chose India for a number of reasons. First, India is emerging as a major health tourism destination. Second, India is significantly contributing to a number of handheld technologies based healthcare applications. India's health care model is radically different to that of the many western and developed societies. The combination of these prompted us to study India in order to understand technology acceptance issues specific to handheld technology based issues in health care.

The reason for such investigation hinges upon the reasoning that in order to successfully implement and use wireless devices and applications that support these devices, it is essential to identify those factors that enable the acceptance and then the adoption of these devices in a clinical setting. If this is not understood, then organisations may spend large sums of money in procuring healthcare applications and technologies that users may not use. Further, it is also essential to study the interrelationships of such factors of acceptance and their influences on the successful integration to enable data management. This is because while technologies may function at desired levels, when integrated with organisations systems, efficiency gains may be compromised. For example, in one of our prior projects, we studied the aspects of digital stethoscopes. While these devices

were well adopted by students studying for medicine, their integration into organisational systems is found to be complicated. Issues such as these have given impetus to this study.

In the last few years the use of personal digital assistant (PDA) and cell phones have found their way in healthcare (Kitchiner 2006; Spivak 2002; Versel 2008). Irrespective of the business and industry, business have equipped or equipping their workforce with wireless tools. Due to high levels of security tools, declining costs of hardware and super fast wireless connectivity, real-time video and streaming audio are becoming the standard use of wireless services. Healthcare appeared to have recognised these factors. Further, in order to maintain a competitive edge, healthcare businesses are forced to providing high quality of care. This has prompted an increase in the deployment of wireless services in healthcare. Therefore, it is timely to investigate those factors that contribute to the acceptance of a given technology in order to make business decisions. This is one of the motivations for this study.

## LITERATURE REVIEW

To understand the issues associated with data collection using wireless applications, we reviewed information technology studies. The review indicated that this area is not yet fully researched. For example, (Redman 2002) states that the wireless technology is in its infancy stage and warns of the potential pitfalls if IT providers rush to implement the technology, (Shah 2001) warns of the slower speed of wireless networks compared with the desktop computers and highlights the potential problems that could be encountered by healthcare. The relatively high costs to set up initially these wireless networks and the potential for escalation in maintenance cost is mentioned by (Shroeder 1999). The lack of real time connectivity due to the mobility of the device and the problems associated with such mobility is highlighted by (Stevenson 2001). The size of the screen and hence the problems that may be encountered in displaying data due to screen size while capturing data is stressed by (Toms 2000). The problems that may be encountered due to the lack of provision for high quality graphic display on wireless devices is highlighted by Atwal (2001). Bevan (2001) discusses the potential problems of capturing data using wireless devices due to the 'hard-to-see display' nature of these devices. These studies highlight the potential problems that could be encountered while using wireless applications. A close investigation into these studies indicates that they also tend to agree that the usage capabilities of these wireless applications are growing and hence these hardware related problems will disappear in a few years time. A surface reading may indicate that there are more problems in using wireless technology in healthcare. But, as these studies are about 4 to 5 years old, it is reasonable to assume that some of these potential problems are resolved.

There are benefits in using wireless technology in healthcare. For example, David & Spell (1997) observed that by using computerised physician order entry (CPOE) error rates can be reduced by around 55 percent. Ying (2003) identified wireless applications for end-user in healthcare can save time and improve the productivity through the use for prescription writing, lab order entry, results reporting, clinical documentation, alert messaging, clinical decision support, medication administration, and inpatient care solutions. Ying also argues that for the successful adoption of wireless technology substantial user training is essential.

In the Information Systems literature, there appears to be eight dominant models of acceptance. These are Theory of reasoned Action (TRA), Technology Acceptance Model (TAM), Motivational Model (MM), Theory of Planned Behaviour (TPB), Combined TAM and TPB (C-TAM-TPB), Model of PC Utilization MPCU), Innovation Diffusion Theory (IDT) and Social Cognitive Theory (SCT) (Venkatesh et al., 2003). Each of these models have their own unique contribution towards understanding the adoption process and user acceptance of the information technology. Most of these theories try to explain intention as well as usages behaviours (Venkatesh et al. 2003). Existing models of technology acceptance are drawn from various theories and most noticeable in the domain of information systems are Roger's (1995) innovation diffusion theory (IDT). This theory explores the individual perceptions about using the innovations. Davis's (1989) technology acceptance model (TAM) explores the individual intention and perception towards the innovations. Ajzen and Fishbein's (1980) theory of reasoned action (TRA) and Ajzen's (1991) theory of planned behaviour (TPB) explore the relationship between user beliefs, attitude, intention, and actual use of innovations. Most of the previous works on the adoption of innovation have concentrated on the adoption of particular technology or a particular product in a commercial environment.

What can be realized from this review is that the majority of the studies have focused on the 'hardware' or 'physical' component of wireless devices, as this appears to be a focal point of interest to many authors now. Other studies refer to the 'implementation' or 'management' of these wireless technologies in healthcare organizations, as cost appears to be a determining factor in such implementations. None of the studies reviewed appear to have examined the 'usage' aspects of wireless applications. While studies such as Davies et al., (1989) examined the 'Technology Acceptance' in organizations and derive a model for such acceptance, the outcomes of such studies can not be generalized for wireless applications as the wireless technology is radically different from the traditional desktop technology. With desktop technology, users go to data by accessing data

using wired and fixed devices. On the other hand, in a wireless technology, the data come to the users via the hand held devices and this new paradigm gives users a lot of mobility and hence access to data. Previous studies have highlighted variables such as cost, time management, data management, patient perceptions, and benefits of using wireless handheld devices in a healthcare setting (Baker and Hoglund 2008; Grist et al. 2007; Hafeez-Baig 2007; Wu et al. 2007). In late 2006 we undertook a research study in the Indian healthcare environment to study the perception of healthcare professionals towards benefits provided by wireless handheld devices. This earlier study has resulted in the following proposition.

**Research Proposition:** Healthcare environment can benefit from the use of wireless handheld devices (Question number 110 in the survey instrument)

## BACKGROUND

Prior studies in the Indian context revealed that clinical data management would be significantly improved by the introduction of wireless technology. There is sufficient evidence to suggest that, due to the time sensitive and life critical operations, healthcare organisations are radically different from that of traditional business models (Gururajan et al. 2004; Gururajan and Murugesan 2005). Hence, the determinants identified in the previous technology studies as published in the Information Systems appears to be having little relevance to healthcare. For example, we identified at least 6 studies in health care that found 'ease of use' construct as being a non predictor of technology acceptance (Chau and Hu 2002; Chismar and Wiley-Patton 2006; Dixon and Stewart 2000; Hu et al. 1999; Jayasuriya 1998). Further, studies conducted in the health context have consistently identified 'usefulness' as a predictor of wireless technology acceptance. The usefulness is specific to clinical usefulness that includes data management, improved data access, transmission and access to high quality data and the time savings due to these data management. These factors appear to be determining the usefulness of wireless technology in a given healthcare settings (Gururajan 2007; Gururajan et al. 2008; Hafeez-Baig 2007). Thus, we believe that if technology is going to be accepted in a given healthcare setting, then the benefits of using such a technology requires identification prior to any implementation. This is because healthcare organisational units can vary in their wireless technology requirement. For example, while the emergency department is an ideal place for wireless technology installation due to the urgency in accessing data, the operation theatre may not benefit very much by the wireless technology due to the complexity of the physical and associated functional environment. So, our aim in this study was to explore a set of common benefits that can be realised by the introduction of wireless technology at an enterprise level rather than investigating individual sub units at an organisational level. This was stated in the above proposition.

Prior studies, based on their qualitative data, revealed that healthcare professionals isolate three main components as being beneficial while using wireless technology. These three factors were the perception of healthcare professionals that patient expectation about their organisation can be improved due to the introduction of wireless technology (Gururajan 2007; Gururajan et al. 2005a; Gururajan et al. 2005b). The underlying basis is that the new generation is mobile savvy and believes that access to data, patients, services etc can be vastly improved with wireless technology. For example, using wireless technology, it is possible to see and talk to a patient in a hospital bed. Similarly, patients can communicate with their families using the Mobile Multimedia Streaming (MMS) technology. These sorts of expectations appear to be influencing patients' choice of health care organisations.

In terms of healthcare professionals such as doctors and nurses, there is a belief that wireless technology can provide added value. As indicated earlier, this belief stems from the fact that wireless technology can bring data to their hands rather than them going to the data. One example is the access to pathology report via a handheld while conducting rounds by a doctor. With the advent of tele-radiology, such access can be made possible. Nurses believe that by using a smart PDA (a device with phone and a camera), it is possible to better communicate a patients condition to a doctor. In the current environment, a doctor needs to be paged or telephoned, a physical examination is necessary to ascertain the condition prior to taking remedial action. This is where crucial time can be saved.

The third element is the concept of time management. Healthcare managers believe that by introducing wireless technology, available time can be better utilised. For example, it is not possible to scribble notes in the database formats. However, it is possible to scribble notes about a patient in a PDA as PDAs come with applications that can facilitate note taking. Nurse Managers believe that such applications can save about 30 minutes per shift while handing over patient records. Similarly, nursing unit managers also believe that 'walking time' can be saved while accessing paper based records or computer terminals as there are limited terminals available in the wards.

These three concepts appear to be the major determinants of the benefits a wireless technology can bring to healthcare organisations. We wanted to test whether these are in fact statistically valid. Thus we created a conceptual model to test the proposition.

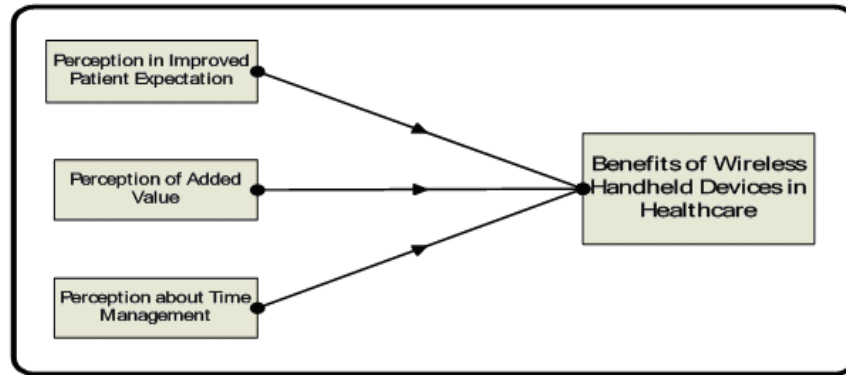


Figure 1: Conceptual Model for the predictors to WHD in healthcare setting

In order to statistically validate the proposition, we also developed three specific hypotheses. The hypotheses were directional as we have sufficient evidence from our qualitative study that these are in fact the beliefs expressed by the participants.

- Healthcare setting can benefit through wireless handheld devices by better time management (Question number 103 in the survey instrument)
- Wireless handheld devices can improve patient expectation in healthcare setting (Question number 107 in the survey instrument)
- Wireless handheld devices can provide added value to healthcare systems (Question number 109 in the survey instrument)

## METHODOLOGY

In order to test the proposition, a survey instrument was developed from the qualitative study<sup>1</sup>. The survey instrument contained over 110 questions involving a range of questions starting from demographics to specific benefits and perceptions. However, the last section of the survey instrument specifically explored the proposition developed for this study. Details of the survey and the qualitative components have been documented in other published studies. Footnote below is a reference for more information on the qualitative methods and survey instrument development. The numbers in bracket next to a given hypothesis (for example Q103) indicates the question number in the survey administered.

## DATA ANALYSIS

In total 1000 survey questionnaires were distributed to the Indian healthcare professional. The professionals were drawn from both public and private hospitals. The healthcare professionals either had some form of wireless experience or were aware of wireless technology applicable to healthcare. We did not apply any screening techniques.

These were distributed in person through a research support agency in India. A time out period of four weeks was agreed and a telephone follow-up was initiated. The total data collection period was three months from the time the first questionnaire was distributed. Out of 1000 questionnaires, 668 (return rate 66.8%) usable questionnaire were coded into a spreadsheet for further statistical analysis. Following table shows the descriptive statistics.

<sup>1</sup> Detailed discussion on the qualitative study and selection of survey methodology can be found in our previous publications (details to be provided on acceptance of this paper).

Table 1. Gender, Experience and Type of Organization

	Gender		Experience			Total
			Less than 2 Years	3-10 Years	More than 10 Years	
Female	191 (28.6%)	Count	43	116	32	191
		% within Gender	22.5%	60.7%	16.8%	100.0%
		% within Experience	44.3%	29.6%	18.4%	28.8%
		% of Total	6.5%	17.5%	4.8%	28.8%
Male	476 (71.3%)	Count	54	276	142	472
		% within Gender	11.4%	58.5%	30.1%	100.0%
		% within Experience	55.7%	70.4%	81.6%	71.2%
		% of Total	8.1%	41.6%	21.4%	71.2%
Total	667 (99.9%)	Count	97	392	174	663
		% within Gender	14.6%	59.1%	26.2%	100.0%
		% within Experience	100.0%	100.0%	100.0%	100.0%
		% of Total	14.6%	59.1%	26.2%	100.0%

**Correlations:** Prior to conducting high level statistical analysis through SPSS ver 16, a correlation analysis was conducted between dependent variables and the independent variable to establish the Multicollinearity of the independent variable. The correlation analysis provided below:

Table 2. Correlation analysis

	HC will benefit from WHD	WHD and time Management	WHD will improve patient expectation	WHD will Provide added value
HC will benefit from WHD	1.000			
WHD and time Management	.356**	1.000		
WHD will improved patient expectation	.445**	.324**	1.000	
WHD will Provide added value	.716**	.311**	.416**	1.000

We conducted the Pearson Correlation test to determine the correlations between the variables. The table above shows that Indian healthcare professionals see the positive correlation between the benefits and their relationships to added value, time management and improved patient expectations. These variables are significantly and highly correlated. This correlation analysis shows that Indian healthcare professionals perceived the wireless handheld technology to be useful and to be beneficial in their given healthcare environment.

### Reliability Analysis

Prior to analysing the data for multiple regression analysis, a reliability analysis of the variables was calculated using Cronbach's Alpha. A value of 0.764 for all the four variable used namely, *HC will benefit from WHD*, *WHD will save time*, *WHD will improve patient expectation*, and *WHD will Provide added value*. According to (Hair et al. 2006), this Cronbach's Alpha value is suitable for high level statistical analysis.

From correlation table number 1, correlation among the independent variables (*WHD will save time*, *WHD will improve patient expectation*, and *WHD will Provide added value*) is less than 0.5 ( $r < .5$ ). According to Field (2003) if there is high correlation among the independent variables, then there could be problems of multicollinearity. As the correlation between the predictors is less than 0.5, it can be assumed that there is limited evidence on the multicollinearity. Thus, the predictors to predict the *healthcare will benefit from WHD* are valid.

### Regression Analysis

A multiple regression analysis was conducted between the dependent variable “HC will benefit from WHD” and the following independent constructs (Question number 110). The main reason for conducting the multiple regressions was to understand any potential issues with collinearity as SEM and PLS tend to avoid these issues. Further this research is still at exploratory stages and we felt that it is appropriate to conduct a traditional regression approach to uncover factors that are not yet validated.

- Perceived use of Wireless handheld technology in healthcare will save time (Question number 103)
- Perceived Use of Wireless handheld technology in healthcare will improve patient expectation (Question number 107)
- Perceived use of Wireless handheld technology in healthcare will provide added value (Question number 109)

The regression model returned a correlation coefficient of 0.732 ( $R = .732$ ). The model also conforms to a straight line with the  $R^2 = .536$  indicating an acceptable level of variance in the dependent variable. The regression model also indicates that Indian healthcare professionals perceive that there will be value added benefits by using the wireless handheld devices in Indian healthcare environment.

Further, an ANOVA was run to confirm the level of significance. The ANOVA returned a significant value of  $p < .05$  indicating that the model is highly significant. This is shown below in the table.

Table 4. ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	438.834	3	146.278	255.451	.000a
Residual	380.224	664	.573		
Total	819.058	667			

Above tables confirms the three independent variable used together as a set, are significantly related to dependent variable ( $P < .05$ ), hence multiple correlation coefficient is significant. F statistic with degree of freedom of 3 and 664, and  $F = 255.5$ . The F statistic is significant at  $p < .05$ . Hence, in the opinion of Indian healthcare professionals, the independent variables are significant for degree of freedom ( $F(3,664) = 255.5$ ,  $p < .05$ ). Subsequent to this, we ran a coefficient analysis to determine the strength of variables. The following table provides this detail.

Table 5. Coefficients analysis

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
	B	Std. Error	Beta			Zero-order	Partial	Part
Time Management	.146	.031	.135	4.756	.000	.356	.181	.126
Improved patient expectation	.078	.034	.072	2.292	.022	.445	.089	.061
Provide added value	.667	.033	.636	20.285	.000	.716	.619	.536

Regression coefficient for time management and added value are significant ( $t = 4.76$ ,  $p < .05$  and  $t = 20.29$ ,  $p < .05$ ). From the table above, it can be seen that the variables time management and added value are highly significant and the variable improved patient expectation is significant and uniquely contribute to the regression equation and explaining the variance in the benefit of WHD in healthcare environment.

This gave us the confidence to run a unique variable contribution analysis in determining the model posited earlier in this paper. The contribution analysis is provided below.

Table 6. Unique contribution analysis

Independent Variables	Dependent Variable	Hypo	$\beta$	r	Variation due to Path	R2	t-Value
WHD and Time Management		H1	.135	.356**	0.048		4.76
WHD will improve patient expectation	HC will benefit from WHD	H2	.072	.445**	0.033	.534	2.3
WHD will Provide added value		H3	.636	.716**	0.455		20.3

The table above shows that the independent variable added value is strongly contributing to the regression model in determining the dependency of benefits of wireless handheld devices in the Indian healthcare ( $r = 0.716$ ). The other two variables improved patient expectation and time management contribute relatively less in determining the model ( $r = 0.445$  and  $r = 0.135$  respectively). From the table above, it can be inferred that the three independent variables time management, improved patient expectation and added value are all significant. Further, it can be inferred from the above table that two independent variable provide added value contributes strongly to the model while the other two independent variables save time and improved patient expectation contribute relatively weak to the regression equation.

Further, a multiple regression analysis was conducted between the dependent variable Healthcare will benefit from the use of wireless handheld devices, and the three independent variables improved patient expectation, will save time, and provide added value. The multiple correlation was significant at  $R = .732$ ;  $F(3,664) = 255.5$ ;  $p < .05$ . The variation was explained at 53.4%, which is acceptable. From the above data analysis, we can draw the graphical relationship between the three predictors and the dependent variable as follows:

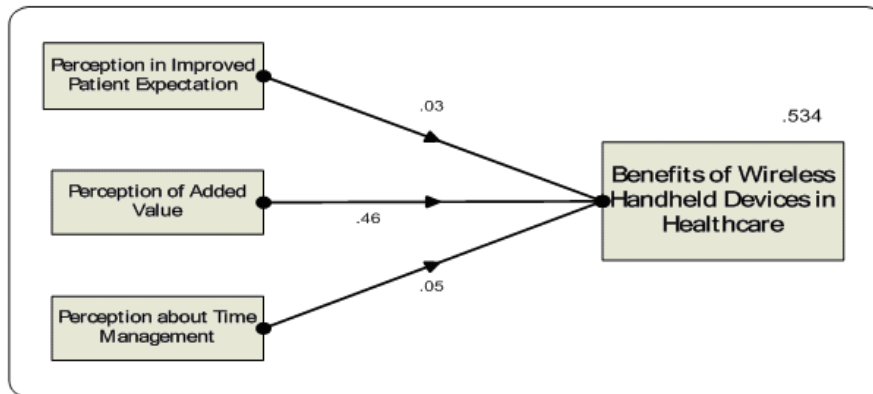


Figure 2: Interaction relationship of the predictors to WHD in healthcare setting

The higher level statistical data analysis clearly shows that perception of added value from the use of wireless handheld devices influenced the healthcare professionals’ decision to use the wireless technology. 53% variation in the dependent variable Benefit of wireless handheld technology in healthcare setting is explained predominantly by the dependent variable perception of added value, where as role of other two independent variable is very minor.

## DISCUSSION

Participants surveyed in this study strongly endorsed the determinant ‘added value’ as a major predictor of benefits that a wireless technology can bring to health care. Our previous studies indicate that shift handover reports, access to online databases such as the MIMS, faster communication with medical professionals, reduced response time and improved service quality as some of the benefits realised by introducing wireless handheld technology in health care domain. In effect, the participants of this study affirmed the notion that ‘usefulness’ is more critical (than ‘ease of use’) while deploying wireless handheld technology (Rod Ward 2008).



Previous studies have already indicated some of these aspects. For example, staff crisis encountered by health care can be addressed by introducing wireless technology that can save time expended in walking from one location to another to access documents as attested by Davis (2002). Health care operations are complex. However lack of mobility offered by legacy systems adds to this complexity, especially in information access. Wireless technology can address this issue to some extent by offering mobility imbedded in information systems. This concept is discussed by Yacano (2002) who suggested that increasingly complex information challenges can be developed using handheld technology. Nursing staff need to comply with rigorous regulatory framework. In fact, health care in Australia is audited on various compliance aspects. Wisnicki (2002) has already identified that wireless handheld technology can help data collection in a clinical environment in a way that it can address the rigorous regulatory framework. For instance, in the current information systems, it is not possible to write notes due to the data base architecture. These notes are manually written and subject to transcription errors. Handheld technologies can help nursing staff to record various details that cannot be accommodated by the limitations placed by databases. Further, such recording can be attested by date and time stamps, thus meeting some aspects of regulatory aspects.

Reducing the medication errors appears to be a major goal among health managers (Siracuse et al. 2008; Turisco 2000). This is because it is difficult to validate medical data due to their complexity and time sensitivity. Generating affordable applications that allow for greater mobility as suggested by Athey & Stern (2002) as well as reducing medical errors in these applications will be a great value to health organisations. The reduction can be at data validation level or at developing algorithms that can validate decision making. Handheld technologies can play a crucial role. In fact, there are pilot applications being trialled where artificial intelligence is embedded in health applications to develop decision making modules to assist nurses and physicians. In addition to these, wireless applications would also provide benefits to healthcare due to its flexibility and mobility in better data management as indicated by Wisnicki (2002). Other added value in using wireless technology may include addressing complex patient data requirements (Davis 2002), proper integration of data to existing systems (Craig & Julta 2001), and improved access to data from anywhere at any time (Stuart & Bawany 2001).

Participants of this study have identified 'improved patient expectation' as one of the determinants the wireless technology can bring to health care. While this determinant is not as strong as the 'added value' factor, it is possible to conceive that data management will result in better service delivery. For example, by properly integrating data into organisational systems, billing cycles can be better handled and reduced. This also improves time management. While sub-factors associated with these two factors need further investigation, in our previous studies in Australia and Taiwan respectively, these two factors appeared to have emerged as strong candidates for determining the introduction of wireless handheld technology in healthcare. While these two factors may not just confine to clinical usefulness, it can be inferred that their influences beyond clinical domain is undoubtedly critical for organisations, especially for effectiveness and efficiency.

## **CONCLUSION AND FUTURE RESEARCH**

This study explored the views and opinions about the benefits of using wireless handheld devices in Indian healthcare systems. Indian healthcare professionals clearly see the advantages of using wireless devices in a healthcare setting. It was found that wireless technology can provide added value to the existing healthcare environment, where as due to lack of infrastructure, improved patient perception and time management were not significantly contributing to the perception of realising benefits from the use of wireless technology in Indian Healthcare environment. It appears that healthcare professionals appreciate the overall benefits of wireless technology, but specific benefits may need further investigation. Another aspect future research may consider is the determinants of wireless handheld devices in specific healthcare contexts such as the operation theatres and emergency departments as these contexts are radically different.

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