Evolving the Business Model to Improve Care Performance for Remote Patient Management: A Case Study

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Abstract

The problem of the aging population and its likely impact on the provision of healthcare systems has been increasing. This study presents a conceptual model to explore and investigate the remote patient management (RPM) technology and the business model in enhancing chronic disease care performance. Some scales to measure RPM technology and the business model were developed and validated; then they were used to collect survey data from respondents who had experience. In addition, this study has verified the entrepreneurial alertness as the moderator and influenced the relationship between RPM technology and the business model. The empirical results support the proposed model and can potentially be used in advance of RPM technology adoption for contemporary hospitals using the proper business model, and sensing the change for chronic diseases care. Among key managerial implications, hospital administrators must focus on alerting environmental change then creating reorganized capacities for RPM implementations to ensure better care performance for chronic diseases.

Keywords: Remote Patient Management, Business Model, Performance, Alertness, Healthcare

1. Introduction

Continued advances in science and technology and general improvements in environmental and social conditions have increased life expectancy around the world. As a result, the world’s population is aging. Over the last 50 years, the number of people age 60 years or over has tripled, and is expected to triple again to almost two billion by 2050. Population ageing has profound consequences and implications for all facets of human life, including health and health care. For instance, the rate of hospitalization due to chronic diseases has reached a factor of three times more in the elderly than in other age groups, and the costs of inpatient care among these elderly accounted for 33% of entire inpatient costs, which become the major issue of disease management to hospitals in Taiwan [1]. The problem of the aging population and its likely impact on the provision on health care systems has been increasing. With an aging population, the proportion of patients needing complex care for one or more chronic illnesses has increased [2]. Thus, hospitals not only try to prevent diseases reaching critical conditions rapidly, but also need to manage efficiently and effectively.

The application of real-time telehealth has been focused on home-based health monitoring, which is an extension of in-hospital services via information communication technology (ICT) [3]. Continuing improvements in technology have made home-based health monitoring applications more clinically useful and easier for patients to use without onsite help from health care personnel, although some individuals will need the assistance of a caregiver [4]. Dramatic increases in the numbers of chronically ill patients in the face of shrinking provider numbers and significant cost pressures mean that a fundamental change is required in the process of care. We need to identify patient management approaches that would ensure appropriate home-based health monitoring and treatment of patients while improving the care performance involved in the process.

Novel methods need to be developed if healthcare systems are to manage the increasing level and complexity of diseases. The development of a real-time monitoring healthcare service model with the intervention of ICT has become a research priority [5]. Health care has been uniquely slow to innovate, especially in core processes, financial models, and
RPM systems, applications of e-health and tele-health, were developed and expected to be increasingly important for chronic disease management as they facilitate monitoring vital signs of patients at their home, alerting caregivers in the case of deterioration. In this regard, Meystre (2005) recently concluded that long-term disease monitoring of patients at home currently represents the most promising application of telemonitoring technology for delivering cost effective quality care \[8\]. The large volumes of data collected and managed by RPM systems can provide an opportunity for fitting and personalizing information services. Yet, to be able to comprehensively assess and determine the benefits of home telemonitoring, it is essential to perform a study that can critically synthesize the results of various studies in this area and provides a solid ground for clinical and policy decision making.

Meanwhile, a body of research has been under way to develop and evolve chronic disease management, which has been designed to improve outcomes and reduce spending in long-term care where there are still limited understandings \[7\]. This design principle supports self-management, providing patients with skills and access to a prepared, proactive clinical team aided by information technology and community resources \[2\]. Practitioners, on the other hand, can alert the change and apply our proposed model to refine their thinking about RPM as a strategic resource in chronic disease management.

Consequently, this research extends understanding through which a hospital sense the turbulent environment and what is becoming an increasingly important issue in evolving a business model for RPM to influence the care performance \[7\]. The study integrates the various strands of research and provides a common ground from which further work can proceed. We developed and tested the research model to answer the above question that based on an exploration study from an Academic Medical Centre and its affiliated facilities in Taiwan. In particular, we draw upon literature that has identified critical factors, such as the RPM technology and business models.

The next section describes the theoretical foundations and the research hypotheses in this research. Then, we describe our research method and the process through which we gathered data. Finally, we present the analyses and results of our research and discuss their implications for future research and practice.

2. Theoretical Foundation and Conceptual Model

To advance the application of RPM, we need to develop the related capabilities, which can enable the new business model to fit future policy and hospital management needs, such as capitation reimbursement and case management. Johnston et al. (2000) argued that RPM systems are emerging in response to public and private policies designed to improve outcomes and reduce spending. Some of these models establish conditions that foster the adoption of enabling technologies, including remote patient management (RPM), and adoption rates are now beginning to accelerate \[6,7\].

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Meanwhile, a body of research has been under way to develop better chronic illness care through this business model. The business model on how to develop and evolve chronic disease management, which has been designed to improve outcomes and reduce spending in long-term care where there are still limited understandings \[7\]. This design principle supports self-management, providing patients with skills and access to a prepared, proactive clinical team aided by information technology and community resources \[2\]. Practitioners, on the other hand, can alert the change and apply our proposed model to refine their thinking about RPM as a strategic resource in chronic disease management.

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types of capabilities that might contribute to this study. A dynamic capability perspective serves as an initial foundation for exploring the critical capabilities which effect performance. Finally, we describe the different elements of the model in the following sections.

Figure 1. Research Framework

2.1. RPM Technology

RPM Technology stands for the capacity of a hospital to assess and implement the RPM related hardware, software, networks and protocols comprising platforms. Today’s healthcare organizations must scan, implement and evaluate existing and emerging ICT in order to construct an integrated and reliable ICT infrastructure to support the information needs for all medical units, ensuring that the respective data resources can be accessed internally and externally. RPM is a disruptive technology; its use will depend on a reorganization of care processes that include physiological monitoring, protocol driven decision support [6]. It even needs to redefine roles for clinical and rethinking cooperation with nonclinical providers, and using telecommunications or devices that place patients at a distance in their home or local community.

In addition, facilities can use monitoring devices, which connect frequently with the care providers to prove better services. It brings change and challenges for hospitals to develop the capabilities under the demand of chronic disease care for an aging population. A critical issue for healthcare organizations is to maintain sound ICT to cope with new challenges and impacts in today’s healthcare environment [12]. Therefore, the following hypothesis is proposed.

H1: A higher level of RPM technology will be positively associated with care performance.

H2: A higher level of RPM technology will be positively associated with the business model.

2.2. Business Model

The business model stands for the capacity of a hospital exploits RPM for a technology-based invention, which leads to provide new care services, enhance partnership with other caregivers or relationship with patients. Researchers identify how important this is and emphasize that adapting an innovative business model brings the company competitive advantage [13, 14]. Osterwalder et al. (2005) defined business model as “A conceptual tool that contains a set of elements and their relationships and allows expressing the business logic of a specific firm. It is a description of the value a company offers to one or several segments of customers and of the architecture of the firm and its network of partners for creating, marketing, and delivering this value and relationship capital, to generate profitable and sustainable revenue streams” [15]. In the healthcare industry, hospitals face the impacts of the complex challenges including technological innovation, preventive care needs and consumer-focused requirements [6, 7]. Therefore, most technological enablers have failed to bring about lower costs, higher quality, and greater accessibility.

Some barriers to the adoption of RPM are particular to these technologies. Most providers and delivery systems have little experience with remote clinical technologies. They are poorly prepared to evaluate the technologies or to make decisions about their acquisition or deployment. Given the increasing number and complexity of RPM solutions and the lack of guidance from the field about their utility, it is difficult for provider systems or health plans to estimate the potential effect of a specific technology. We believe that the primary reason is a lack of business model innovation. Coupling technological advances with appropriately matched business models is the right prescription for our current health system [16].

Parente (2000) argued that a business model can help healthcare organizations to identify the market barriers that must be overcome and provide perspective on opportunities for delivering healthcare services [17]. Furthermore, scholars accumulated lots of research on the topic of the business model for RPM exploitation, from conceptual levels to describe business model elements and finally the application of the business model concepts but limited research discussed the strategic value. For instance, the Veterans Health Administration (VHA) began with the innovations necessary to realign a health care delivery system for effective chronic care management, including a new framework for creating value, and then began to experiment with RPM [6]. The RPM deployment resulted in further decreases in hospital volume, fewer emergency department visits and length of stays for acute beds, as well as a shift in care to outpatient clinics and into the home, which contributed to important financial and patient care goals for the VHA.
and resulted in further deployment of RPM. Therefore, the following hypothesis is proposed.

H3: A higher level of the business model will be positively associated with care performance.

2.3 Entrepreneurial Alertness

Entrepreneurial Alertness stands for the degree to which a hospital senses external threats from competitors, market opportunities and changes in the healthcare environment, technology, and policy. Sambamurthy et al. (2003) defined entrepreneurial alertness as the capability of a firm to explore its marketplace, detect areas of marketplace ignorance and determine opportunities for action [18]. Organizations are open to, and interact with their environments. The competition in today’s healthcare environment is very keen; organizations are not able to focus only on developing rare, valuable and immobile resources. They have to catch the environmental change and respond to it in time in order to be successful [19, 20].

For instance, a long-term elderly care program has been launched in Taiwan to meet the rapidly increasing need for long-term care in Taiwan's aging population. Moreover, the government input more resources to delivery care as a result of the increasingly aging population. There are some policies developed and implemented in Taiwan recently, for example for “Ten Years Project for Long-Term Care” began in 2007. The program reflected the future need for long-term care services are increasing because of longer life expectancies and aging populations. In this study, we propose that entrepreneurial alertness will enhance healthcare organizations to acquire RPM technology, and endeavour to develop a business model [21]. Therefore, we propose the following hypothesis.

H4. Entrepreneurial alertness will enhance the positive relationship between the RPM technology and the business model.

2.4. Care Performance

Care performance stands for the degree to which a hospital achieves its goals of RPM adoption, it includes timeliness, patient centeredness, and disease control. Most prior IS research on firm performance adopted financial indicators, but these have limited applicability to health industries. In particular, due to rapid change in the healthcare industry, financial performance figures do not necessarily indicate the continued accumulation of strength. In the last decade, healthcare reforms have begun transforming and reconstructing healthcare as commodities and products. The efforts and processes of introducing RPM into an organization and providing services and connections to consumers, employees and partners take on a part of this services' transformation. Therefore, our investigation attempted to identify what factors should be used to evaluate the care performance.

The Institute of Medicine’s report (2001) and related research provide sound foundations to measure hospital performance [22]. They argued that timeliness is where hospitals “reduce waits and the sometimes harmful delays for both those who receive and those who give care”. It is an important characteristic of any service and it is a valued focus of improvement in healthcare. Besides, patient centeredness stands for a hospital that “provides care that is respectful of and responsive to individual patient preferences, needs, values and ensuring that patient values guide all clinical decisions”. As mentioned above, the development of a real-time monitoring healthcare service model with the intervention of ICT has become a research emphasis [4]. For example, an intervention used to improve control of blood pressure in patients with hypertension was proposed by recent studies [23, 24].

3. Research Methodology

3.1 Develop the service model

This research project was carried out from January, 2008 to August, 2010. It is methodologically based on the project development life cycle, and an adoption of the waterfall model. Based on Wagner's model [25], we conducted expert interviews to develop an IT – mediated chronic care service model as a guide to improve chronic illness care. Regarding the healthcare framework, we use home self-care as the basic unit of tele-healthcare, and the healthcare professionals would bridge the six kinds of services in this model, Including (1) 24-hour real-time health status tracing and monitoring (2) Emergency care referral and health consultation (3) Home visits (4) Return visit scheduling (5) Prescriptions delivery (6) Social welfare services application. Once the services model is mature, the expansion of the equipment measuring physiological information will be considered. The recorded physiological information of each patient will be turned into a continuous report and be sent via the information system (IS) to healthcare professionals for monitoring purposes. A simplified service model is displayed in Figure 2.
3.2 Measurement Development

At the outset, this study developed the constructs of RPM technology, the business model, and the associated measures about care performance. A number of prior relevant studies were reviewed to ensure that a comprehensive list of measures were included. The initial survey instruments and subsequent refinement of the instruments were done by researchers via several rounds of in-depth personal interviews with a panel of academics, medical staff and practicing managers (e.g., owner or manager of long-term care facilities or nursing home, LTC) in Taiwan. It ensures content validity through the calculation of content validity ratios on each scale item. This process was continued until no further modifications to the questionnaire were necessary. Feedback from the in-depth personal interviews served as the basis for refining the experimental scales of the survey instruments.

This questionnaire contained two major parts, including a portion for the respondent’s description and another for the responses to our research constructs. The basic data portion requested the owner to give facilities’ characteristics include size, and ownership. The second part contained four constructs for this study. These instruments as shown in table 1. Data were collected using a five point Likert-type scale.

Table 1. Instruments on this research

<table>
<thead>
<tr>
<th>Construct</th>
<th>Scale Items</th>
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</thead>
<tbody>
<tr>
<td>Entrepreneurial Alertness</td>
<td>ALT1: We can sense the development trends of RPM technology to affect care services. ALT2: We can sense the requests for RPM regulation or policy from government or third parties. ALT3: We can sense the development trends of RPM technology to enhance the cooperation with other institutes.</td>
</tr>
</tbody>
</table>
response rates in healthcare research, this study
endeavoured to find a specific local contact person (i.e.
secretary of owner) for each target facility. In addition
to a reasonable response period—four weeks, follow-
up activities were also conducted by email, phone call
or mail to increase response rate, and to minimize the
extent of common method variance bias and non-
response bias.

The initial survey was mailed in early May, 2010.
Postcards and phone call reminders were sent to non-
responders in early June, 2010. There are 43 matched
questionnaires after aggregation for the facility level.
Data were excluded to ensure the construct validity
where a respondent gave incomplete answers for each
construct. Two responses were considered incomplete
and had to be discarded. This left 41 valid responses
for the statistical analysis, and a valid response rate of
80.39% of the initial facilities.

3.3 Analysis methods

The empirical data collected were analyzed using
the PLS program, which is particularly suitable for
identifying the variance and validating the causal
relationships between latent variables comprising complex theoretical and measurement models. The
hypotheses, proposed for the predictive and
nomological structure were validated at the same time.
PLS allows the validations of the measurement model
and estimation of the structural model in a small
sample size. The questionnaire administered in the
limited-scale questionnaire survey included items
worded with proper negation and a shuffle of the items
to reduce the monotony of questions measuring the
same constructs. The statistical analysis strategy
involved a two-phase approach in which the
psychometric properties of all scales were first
assessed through confirmatory factor analysis (CFA)
and the structural relationships were then validated by
bootstrap analysis.

4. Results

4.1 Measurement properties

All the constructs in the conceptual model were
modelled as reflective and were measured using
multiple indicators. The assessment of item loadings,
reliability, convergent validity, and discriminate
validity was performed for the latent constructs
through a confirmatory factor analysis (CFA). Reflective items should be one dimensional in their
representation of the latent variables, and therefore
correlated with each other. Factor loadings of scale
items should be above 0.707, showing that all the
variance is captured by the constructs in Table 2. All
constructs in the measurement model exhibit good
internal consistency as evidenced by their composite
reliability scores. The composite reliability coefficients
of all constructs in the proposed conceptual framework
are more than adequate, ranging from 0.801 to 0.878.

Table 2. Factor Loadings and Composite Reliability of
Constructs

<table>
<thead>
<tr>
<th>Construct</th>
<th>Indicator</th>
<th>Loadings</th>
<th>Composite/Reliability (AVE/Cronbach)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alertness</td>
<td>ALT1-3</td>
<td>0.784, 0.813</td>
<td>0.801 (0.87/0.798)</td>
</tr>
<tr>
<td>RPM technology</td>
<td>RPM1-4</td>
<td>0.822, 0.862</td>
<td>0.892 (0.89/0.810)</td>
</tr>
<tr>
<td>Business Model</td>
<td>BM1-4</td>
<td>0.794, 0.838</td>
<td>0.876 (0.82/0.841)</td>
</tr>
<tr>
<td>Care Performance</td>
<td>CP1-4</td>
<td>0.818, 0.864</td>
<td>0.876 (0.77/0.811)</td>
</tr>
</tbody>
</table>

To assess discriminate validity, (1) indicators
should load more strongly on their corresponding
construct than on other constructs in the model and (2)
the square root of the average variance extracted
(AVE) should be larger than the inter-construct
correlations [26]. The presence of variance captured by
a construct is given by its AVE. The PLS method was
applied to evaluate discriminate validity of the major
constructs of the conceptual framework. As the results
show in Table 3, all constructs meet this requirement.
The values for composite reliability are all above the
suggested minimum of 0.70. Thus, the convergent and
discriminate validity of all constructs in the proposed
conceptual framework can be assured.

Table 3. Descriptive Statistics and Inter-correlations
among Major Constructs

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Composite Reliability</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alertness</td>
<td>0.501</td>
<td>0.513</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RPM Technology</td>
<td>0.623</td>
<td>0.56</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>Business Model</td>
<td>0.578</td>
<td>0.313</td>
<td>0.533</td>
<td>0.654</td>
</tr>
<tr>
<td>Care Performance</td>
<td>0.978</td>
<td>0.397</td>
<td>0.608</td>
<td>0.334</td>
</tr>
</tbody>
</table>

*Diagonals elements are the square roots of average variance extracted (AVE).

4.2 Test of the structural model

As shown in Fig. 2, the path linking all the
constructs represents the total impacts on care
performance. These results provide strong empirical
evidence for the nomological validity of these
constructs and the effects on care performance. The
estimate of 0.301 on the construct of care performance
(R² = 0.301) for the path provides good support for the
hypothesized impact of the RPM technology and
business model on the dependent variables, care
performance (e.g. H1 and H3). Besides, the estimate of
0.239 on the construct of the business model for the
path provides good support for the hypothesis H2.
With the significant path coefficient, the analysis result
also provides support for the hypothesis H2 in direct
effect. Moreover, the results have shown the significant
positive effect on care performance when mediated by the business model. Additionally, alertness as a moderator to influence RPM technology on the business model is significant (P<0.05). The alertness has a positively moderate effect on the influence of RPM technology on the business model (H4). An F test is further applied to test the significance of the effect size of the overall model. As a whole, the research model has strong explanatory power for the constructs of RPM technology, the business model and care performance. The significant path coefficients, effect size, and the value of the R² reinforced our confidence in the results of the hypotheses tested and provided support for the nomological network of the proposed model.

4.3 Supplementary Analysis

We carried out additional analyses to explicate the complementarily effects of alertness on relationships between RPM technology and the business model as shown in figure 3. The original model had significant results for direct effects for RPM and BM. Furthermore, we draw graphs to understand the pattern of the moderating effects. We split the sample into high and low alertness of the moderator variable and regressed from the independent variable (RPM technology) to the dependent variable (business model) under two different situations. For example, the business model achieved with higher levels of RPM technology (above the mean) when alertness is higher (above the mean) than when it is low (below the mean) as shown in figure 3.

5. Discussions and Conclusions

This study proposed an exploration model, developed measures for these constructs, and validated the conceptual model through a rigorous PLS analysis. The nomological structures of the RPM technology and business model are well validated by the empirical data. The results indicated that the level of the RPM technology and business model is positively associated with care performance, and the influence of RPM technology on the business model is positively moderated by alertness.

Our study results also support the previous findings on the effectiveness of RPM services [4, 6, 16, 17]. The conceptual model of the RPM technology and business model are of particular value to those concerned with competency development in health care organizations. The study possesses several notable strengths as follows:

First, RPM technologies offer a means of making care more affordable, which has been shown to support patient self-management, co-operate with caregivers, shift responsibilities to nonclinical providers, and reduce the use of emergency services for hospitals. Because transformative technologies (e.g. RPM) offer major opportunities to advance national goals of improved quality and efficiency in health care, it is important to understand their evolution, the experiences of early adopters, and the proper business models that may support their deployment.

Second, the service model could effectively monitor the risk of disease occurrence when patients were at home and provide an emergency transfer instantly. Moreover, compared with traditional care service models where only passive information was provided, we provided new services in which healthcare professionals could intervene by RPM technology.

In this study, we provided an IT-intervened service model, which could extensively improve the efficiency and effectiveness of patient management in the future. The resulting RPM technology and evolving business model can then guide the relevant activity in relation to knowledge requirements. The healthcare administrator can also take advantage of such a profile to assist in making succession-planning decisions by evaluating the levels and development needs of their healthcare organization: Implementing the RPM technology would be beneficial for promoting care performance when evolving proper business model [7].

From the viewpoint of managerial implications, our findings have important implications for healthcare

Figure 3. The moderating effect between RPM technology and Business Model
administrator involved in efforts to introduce RPM into their hospitals/facilities. The development and setup of the RPM platform is the core of this service model. In the future, with the application of proper business model, the integration of the available healthcare services will become easier, and the elasticity and efficiency of innovative services will increase. They reinforce the importance of institutional factors on the heightened levels of care performance. While numerous advocates have prescribed such a collective responsibility as a normative guideline, our research provides empirical support for this prescription.

Another important implication of our research is the finding that the influence of RPM technology on the care process is positively moderated by alertness. Our results revealed that the complementary relationship between the business model and RPM technology gains importance for care performance when a firm finds itself in turbulent healthcare environments. This implies that alertness to the external environment is helpful to enhance RPM technology adoption on the business model. For instance, requests for reimbursement regulation from government or competitive advantage pressure due to other hospitals implementing the RPM technology and superior care models.

While our exploration study provided interesting insights, it has several limitations that also represent opportunities for future research. First, a potential limitation of our study is its cross-sectional design. Since implementing RPM usually involves a period of time delay. Second, although the sample in the study was small because it is an exploratory case study, the following recommendations could serve as some general principles for researchers who would like to experiment with RPM adoption in similar contexts. Furthermore, it would be recommended to collect enough samples to examine the cyclical reference relationships among the identified research variables in the future. Third, since the model was validated using the sample data gathered in Taiwan, interpretation of the findings should be made with caution when generalizing to other systems or countries. Other samples from different nations, cultures and technological environments should be gathered to facilitate more effective RPM adoption to today’s e-health environments. We hope that our theoretical perspective and findings will stimulate and encourage more research into this important phenomenon.

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