Taipei Smart Medical Package
Experience of A Telehealth Model

Mei-Ju Chen, M.D.
Community Medicine Division,
Taipei City Hospital,
Taipei, Taiwan
DXD41@tpech.gov.tw

Polun Chang, Prof.
Aging and Health Research Center, National Yang-Ming University

The authors would like to thank the National Science Council of the Republic of China, Taiwan, for financially supporting this research under Contract No. NSC 100-2627-E-010 -002 & Ministry of Economic Affairs, R.O.C. for funding (project 100-EC-17-A-31-I2-HC001) & InfoExplorer Co., Ltd for technical assistance.
• In 2009, cerebrovascular disease and cardiovascular disease ranked second and third among the ten leading causes of death in Taiwan [1].

• According to the Department of Health, 1.45 million people live with heart disease and one in every five of the population over age 65 suffers from heart problems.

• As heart disease is getting more prevalent among the younger generation in recent years, prevention of cardiovascular disease has become an important issue.
Introduction-2

• Health expenditures constitute 5 percent of the gross domestic product (GDP) in Taiwan, relatively low compared with 15 percent in the United States. However, it is necessary to curb health care spending and one of the strategies is to introduce telemedicine [2].

• Healthcare Information and Management Systems Society (HIMSS) defines mobile health as delivery of healthcare services via mobile communication devices, such as smartphones, mobile phones and satellites.
• TECHNAVIO reported that market value of mobile health was worth $1.7 billion in 2010 and estimated to reach $4.1 billion in 2014. Its growth rate between 2010 and 2014 would be as high as 24% [3].

• Smart medical home is a concept of integrating several types of technologies to provide telemedical services.

• The technologies commonly utilized in smart medical package include physical signal measurement, signal transmission, virtual vision, data mining and storage, communication and privacy. The telemedical services incorporate individual health care, social welfare, health assistance and others [4].
A number of smart medical homes have been developed in different countries [5,6]. All of them emphasized the technologies, services of health management and assistants. Various evaluation methods have been developed in order to verify the effect of smart medical home [7,8].

The results showed that smart medical home provided a humanistic way for learning and monitoring personal health condition.
• Evaluation of smart medical home in several countries also found its financial benefits [9,10].

• Although smart medical home is useful and helpful to aid health management, it remains a complex and arguable issue.

• It is equally important to conduct user evaluation in order to deal with the differential demands due to different social structures [4].
• In Taiwan, a small client base of telehealth is unable to offer economies of scale. One of the reasons is high cost. A set of telemedicine terminal costs nearly USD 3,223 and results in high amortization cost.

• Currently, the smart medical package applies an ARM (Advanced RISC Machine)-based operating system with very limited hardware support [11].
• Thus the whole package becomes expensive on one hand and difficult to expand on the other, making it unattractive to customers.

• To run this system, a separate main computer room has to be set up, again increasing maintenance cost and instability.

• The aim of Taipei Smart Medical Package is to develop a mobile, low cost and stable telehealth model.
A. The Architecture

Investigators of this project obtained IRB approval from the Taipei City Hospital before conducting the research.

Our system used AA battery-powered X86-based SoC for industrial embedded platforms.

The consolidation offered cost-effectiveness of ARM-based architecture, high compatibility of PC system, stability of fanless design, low power consumption of AA battery, convenience and mobility.

Unlike common smart medical package which was energy consuming, environmental-unfriendly and noisy, our system had a quiet, energy saving and environmental-friendly module.
Figure 1. Service Model of Taipei Smart Medical Package
B. Biological Signal Measurement
C. Expert System

Cardiovascular Status Evaluation

- ID: IBME5271
- Gender: ② male ① female
- Age: ② 55
- Height: ① 175 cm
- Weight: ① 90 kg
- Waist Circumference: ① 105 cm
- SBP: ③ 128 mmHg
- DBP: ② 90 mmHg
- HR: ② 72 bpm
- Treat for Hypertension: ① Yes ② No
- PR Interval: ① 160 mSec
- Significant Murmur: ② Yes ① No
- Prevalent Heart Failure: ② Yes ① No
- HDL cholesterol: ① 45
- Total cholesterol: ① 150
- Diabete: ① Yes ② No
- Smoke: ② Yes ① No
- LVH: ① Yes ② No
- History of Diabetes(or Family): ① Yes ② No (Have been or sibling, parent with diabetes)

Cardiovascular Status Evaluation

Hi, IBME5271 Local Time : 2010/04/16 9:53

您的健康状况如下—

◆基本:
  ▲ BMI：29.38 (您的體重有過重的傾向，請控制飲食，多運動)
  ▲ 血壓狀況：高血壓-第一階段 (您已屬於高血壓族群，請洽專業醫師進行血壓控制)

◆評估情況
  ▲ 您在十年內發生心房顫顫(AF)的機率約 3.57%
  ▲ 您的心臟年齡推測約為 68 歲
  ▲ 您十年內發生心血管疾病(CVD)的機率約為 16.05%
  ★其中發生嚴重中風的機率高達 5%，請多加注意

Reference: Framingham Heart Study
D. Case Management

活動紀錄圖

體適能檢測紀錄

日期：2009年3月1日

備註說明：期初

身體組成

期初 70

體適能檢測

期初 76

BMI：30.9

理想體重：58.1公斤

體脂百分比：140.5%（理想範圍：90~110%）

體位判定：肥胖

體脂百分比：31.7%（理想範圍：15%~20%）

柔軟度：9.6公分（坐姿體前彎）

肌耐力：36次（仰臥起坐）

心肺耐力：65.7（三分鐘登階）

1'00''~1'30''：49心跳數

2'00''~2'30''：43心跳數

3'00''~3'30''：45心跳數

健康生活習慣評估

日期：2009/3/1

說明：期初
EVALUATION-1

• **A. Evaluation Method**

• In order to understand people’s opinions on the Taipei Smart Medical Package, this study carried out an acceptability questionnaire survey.

• The researchers conducted surveys in three different settings (hospital, private health center, electronics shop) to understand the demand for equipment and service of Taipei Smart Medical Package. Among 437 questionnaires that were completed, 155 came from the private health center, 147 from the city hospital and 135 from an electronic shop.
In the beginning of the interview phase, volunteers were shown a short introduction film about Taipei Smart Medical Package, and asked to complete a paper-based survey.

This study used SPSS for Windows (version 17.0) as data processing and analysis tool. Prevalence and Chi-square test were calculated for each item.
### B. Evaluation Results

<table>
<thead>
<tr>
<th>Items</th>
<th>No willing to pay</th>
<th>Willing to pay</th>
<th>Uncertain</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 155)</td>
<td>(n = 164)</td>
<td>(n = 95)</td>
<td>(N = 414)</td>
</tr>
<tr>
<td></td>
<td>χ²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LMD</td>
<td>4 2.60%</td>
<td>46 27.90%</td>
<td>95 100.00%</td>
<td>145 34.90%</td>
</tr>
<tr>
<td>E-shop</td>
<td>41 26.50%</td>
<td>85 51.50%</td>
<td>0 0.00%</td>
<td>126 30.40%</td>
</tr>
<tr>
<td>Hospital</td>
<td>110 71.00%</td>
<td>34 20.60%</td>
<td>0 0.00%</td>
<td>144 34.70%</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>65 42.80%</td>
<td>88 53.70%</td>
<td>32 34.00%</td>
<td>185 45.10%</td>
</tr>
<tr>
<td>Female</td>
<td>87 57.20%</td>
<td>76 46.30%</td>
<td>62 66.00%</td>
<td>225 54.90%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-30</td>
<td>44 28.60%</td>
<td>25 15.20%</td>
<td>19 20.20%</td>
<td>88 21.40%</td>
</tr>
<tr>
<td>31-40</td>
<td>46 29.90%</td>
<td>59 36.00%</td>
<td>23 24.50%</td>
<td>128 31.10%</td>
</tr>
<tr>
<td>41-50</td>
<td>26 16.90%</td>
<td>51 31.10%</td>
<td>28 29.80%</td>
<td>105 25.50%</td>
</tr>
<tr>
<td>51-60</td>
<td>28 18.20%</td>
<td>22 13.40%</td>
<td>19 20.20%</td>
<td>69 16.70%</td>
</tr>
<tr>
<td>&gt;60</td>
<td>10 6.50%</td>
<td>7 4.30%</td>
<td>5 5.30%</td>
<td>22 5.30%</td>
</tr>
<tr>
<td>Items</td>
<td>No willing to pay</td>
<td>Willing to pay</td>
<td>Uncertain</td>
<td>Total</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------</td>
<td>----------------</td>
<td>-----------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td>(n = 155)</td>
<td>(n = 164)</td>
<td>(n = 95)</td>
<td>(N = 414)</td>
</tr>
<tr>
<td>n</td>
<td>n %</td>
<td>n %</td>
<td>n %</td>
<td>n %</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;=USD263</td>
<td>9 6.20%</td>
<td>9 5.80%</td>
<td>8 8.70%</td>
<td>26 6.60%</td>
</tr>
<tr>
<td>USD263~623</td>
<td>65 44.50%</td>
<td>35 22.70%</td>
<td>28 30.40%</td>
<td>128 32.70%</td>
</tr>
<tr>
<td>USD 623~967</td>
<td>44 30.10%</td>
<td>51 33.10%</td>
<td>22 23.90%</td>
<td>117 29.80%</td>
</tr>
<tr>
<td>USD967~1,289</td>
<td>21 14.40%</td>
<td>27 17.50%</td>
<td>10 10.90%</td>
<td>58 14.80%</td>
</tr>
<tr>
<td>USD 1,289~1,934</td>
<td>2 1.40%</td>
<td>9 5.80%</td>
<td>4 4.30%</td>
<td>15 3.80%</td>
</tr>
<tr>
<td>&gt;=USD 1,934</td>
<td>5 3.40%</td>
<td>23 14.90%</td>
<td>20 21.70%</td>
<td>48 12.20%</td>
</tr>
<tr>
<td>Items</td>
<td>No willing to pay</td>
<td>Willing to pay</td>
<td>Uncertain</td>
<td>Total</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------</td>
<td>----------------</td>
<td>-----------</td>
<td>--------</td>
</tr>
<tr>
<td></td>
<td>(n = 155)</td>
<td>(n = 164)</td>
<td>(n = 95)</td>
<td>(N = 414)</td>
</tr>
<tr>
<td></td>
<td>(n)</td>
<td>%</td>
<td>(n)</td>
<td>%</td>
</tr>
<tr>
<td>Private Insurance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>38</td>
<td>27.10%</td>
<td>20</td>
<td>12.80%</td>
</tr>
<tr>
<td>Yes</td>
<td>102</td>
<td>72.90%</td>
<td>132</td>
<td>84.60%</td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>0.00%</td>
<td>4</td>
<td>2.60%</td>
</tr>
<tr>
<td>Do you take health exam regularly?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>40</td>
<td>29.20%</td>
<td>28</td>
<td>18.20%</td>
</tr>
<tr>
<td>Yes</td>
<td>97</td>
<td>70.80%</td>
<td>120</td>
<td>77.90%</td>
</tr>
<tr>
<td>Uncertain</td>
<td>0</td>
<td>0.00%</td>
<td>6</td>
<td>3.90%</td>
</tr>
</tbody>
</table>
**CONCLUSION-1**

- The Taipei Smart Medical Package boasted several advantages.
  
- **First,** it supported Linux on SoC (System on a Chip) platform from Intel running on x86 architecture, which ensured stability and saved investment on hardware and software R & D. AA battery combining industrial fanless design reduced maintenance cost.

- **Second,** the mobile terminal equipment allowed convenient installation and budget transportation.
CONCLUSION-2

• Third, cloud hosting was an economic, maintenance-saving and effective solution. Working with a large cloud computing company provided substantial reliability and stability.

• Capacity could also be easily increased or adjusted to meet user’s need. It eliminated the up-front costs of building a self-hosting infrastructure and helped reach the breakeven point within a very short time.

• Finally, service charge could be further reduced when the program takes advantage of the consumer product industry that offers a variety of services.
CONCLUSION-3

- Healthcare service in Taiwan has often been limited in one hospital with limited users.

- Therefore economies of scale were difficult to take place. This project created a platform across multiple branches and effectively introduced a mode of healthcare to a wider population.
CONCLUSION-4

• The study created a mechanism that adequately bridged health risk assessment and health checkup. This strategy also differentiated the service from traditional health screening.

• Clients of health screening centers who experienced the trial service received a report of health risk assessment a month after checkup.

• The report would be followed by continuous advice and services. Differential services were made available for those at higher risks and lower risks, as a strategy to sustain utilization.
CONCLUSION-5

• The system offered diversified income-generating services in other fields such as e-books, educational games, movies, useful information, household services, cosmeceutical products, restaurant information, call-a-cab, etc., to meet various demands of users.

• The Taiwan experience indicated that cost remains a decisive factor in the success of telemedicine facilities.

• Our research discovered the strength of combining insurance and health screening.
CONCLUSION-6

- Collaboration among healthcare facilities, health screening centers and insurance companies is expected to consolidate the market while integration of health screening, ICT and consumer products generates multiple sources of income.

- The most unique feature of the project is a common platform where healthcare facilities can join hands to expand the market share by providing differential, mobile, stable, scalable services, including health risk assessment, and thus stand out among competitors.
Thank you for attention!!

Mei-Ju Chen¹
Community Medicine Division¹, Taipei City Hospital
Taipei, Taiwan

DXD41@tpech.gov.tw
REFERENCES


