Abstract: This study aimed to design an information system model for Disease Management (DisMan) that met the requirements and needs of a consumer electronics manufacturer. The diseases included in this study were diabetes, hypertension, and tuberculosis. Data were collected by interviewing the company’s human resources department and occupational health provider. Study of literature and online research were conducted to collect the health standards and information system standards on existing DisMan. These standards were then compared with consumer electronics manufacturer’s DisMan. The model was designed by utilizing class diagrams, use-case diagrams, and sequence diagrams. The result was an information system model of registry system that can support DisMan in a consumer electronics manufacturer. The registry system included alert management system and self-monitoring system. Self-monitoring system was supported by an alert management system, which could help DisMan’s staff to monitor patient’s adherence to the health care plan and could also notify patients to control their lifestyle.

Key Words: information system model, disease management, self-monitoring, alert management system, medical care plan.

1 Introduction

An industry would generally need human resources to support the achievement of their goals beside non-human resources. Employee productivity has a significant impact on company profits. Therefore, employee issues are of great concern in a company; one of the important issues involves their well-being.

In dealing with employee health issues, companies cooperate with work health service providers. Since the company subunits often oversee its own work-health, the providers offer services such as on-site clinical facilities as well as preventive and clinical treatments. These services are implemented as an effort to build employee awareness and interest in their own health.

One of the services in treatment is disease management to handle employees with chronic illnesses. The role of disease management is to prevent those diseases from progressing into a more advanced stage.

Chronic Care Model (CCM) that was proposed by Wagner [1] is a form of disease management. CCM is used as a conceptual framework to handle patients with chronic diseases. CCM has the following components: Self-Management Support, Decision Support, Delivery System Support, Clinical Information Support, Organizational of Healthcare, and Resources and Policies [2-8]. CCM was developed in the USA and is currently implemented by WHO.

This study aimed to propose an information systems model as a support for disease management such that employees with chronic diseases (specifically hypertension, diabetes, and tuberculosis) can have their health monitored and prevent disease progression. Consequently, the employees would be able to maintain and enhance their productivity.

2 Problem Formulation

Disease management (DisMan) aims to prevent the progression of a disease. Its implementation is through the increase of employee interest in their own health conditions. The DisMan staff plays the role of providing care during routine medical appointments for each employee. However, the DisMan staff could not ensure the employees’ attendance during these routine appointments, resulting in the inability to optimally conduct DisMan.
The absence of an information system capable of monitoring the employee’s compliance during DisMan has given rise to the following problems: (1) How to monitor a patient’s attendance of the DisMan routine medical appointments within the predetermined time frame; and (2) how to increase patient compliance, given the medical recommendations.

3 Problem Solution

Literature review was performed to obtain a guideline for the designed system through the comparison of health care standards that are currently implemented in various consumer electronics manufacturers worldwide; the specific foci were on diabetes, hypertension, and tuberculosis (TB). The result of this study is an information systems model that supports the care of diabetes, hypertension, and TB within the populace of a consumer electronics manufacturer’s employees. This proposed model would also include the monitoring of employee meal intakes, regular training, health program participation, and weekly consultation with a doctor. The administration of this system is expected to provide better information for DisMan staff and their patients.

3.1 Current DisMan System

Figure 1. Current DisMan System

Figure 1 depicts the current DisMan system implemented in a consumer electronics manufacturer. Employee categorized as a member of the DisMan plan is obligated to participate in the medical care plan mutually agreed upon with the DisMan staff. Medical care plan includes targets that must be attained by the employee, variety and quantity of nutrition that must be consumed, physical activity duration that must be accomplished, following a prescheduled DisMan program to raise knowledge on their illness and the treatments, its medication, and the consultation schedule.

Currently, employees would generally visit special physicians assigned by health care provider once every week. Employees are also permitted to consult physicians outside of the medical care plan, provided that they report any additional prescribed medications and their dosages. The main focus of the current DisMan program at the consumer electronics manufacturer is the monitoring of sodium levels in meals.

DisMan staff are required to check employee’s conditions and assess whether the medical care plan targets are on track or not. During consultation, DisMan staff will investigate the reason for an employee’s non-compliance with the predetermined medical care plan. After obtaining the information and evaluating the examination results from consultation, DisMan staff will file a report and conclude further steps to be taken in regards to the subsequent medical care plan revision for the non-compliant employee.

3.2 Proposed DisMan System

Figure 2. System Workflow

Figure 2 describes the proposed design of the DisMan system under this study. IT Role in supporting Chronic Care Model focused on Clinical Information Support namely Registry System that is consisted of Electronic Health Record, Alert Management System, and Self Monitoring System. Alert Management System and Self Monitoring System aimed to support patient self-management. Patient education as a patient treatment step could be supported by scheduling information and electronic guidelines. The designed system would be web-based.

The study done by Paganelli and Giuli [9] describes a home-based services application framework for monitoring and handling chronic conditions by providing the medical status
information of patients as well as an alert mechanism.

Alert Management System consists of two parts, namely alert creating module (Incoming Alert Monitor) and execution module (Outgoing Alert Monitor), in which the execution module is further divided into three sub-modules, namely: role matching module, alert monitor module, and priority urgency module [10]. The designed Alert Management System is shown in Figure 3.

![Alert Management System](image)

**Figure 3. Alert Management System**

In the Alert Management System, urgency level is classified into three levels as depicted in Table 1.

<table>
<thead>
<tr>
<th>Urgency</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Email and send SMS to patient</td>
</tr>
<tr>
<td>Urgent</td>
<td>Send SMS to patient</td>
</tr>
<tr>
<td>Critical</td>
<td>Send SMS to DisMan staff</td>
</tr>
</tbody>
</table>

Table 1 indicates that urgency function $U(t)$ is defined as follows:

$$U(t) = \begin{cases} 
\text{Normal, } t = T \\
\text{Urgent, } T < t < T + dt1 \\
\text{Critical, } T + dt1 < t < T + dt1 + dt2 
\end{cases}$$

where:

$T = \text{normal deadline (default)}$

$dt1 = \text{urgent deadline}$

$dt2 = \text{critical deadline}$

If patient fails to respond on a $T$ normal deadline, the urgency level will increase from normal to urgent and the initiation of resending alerts. Should there be no response after an urgent deadline, urgency level will be increased to critical level and resend alert.

![Alert Execution Flowchart](image)

**Figure 4. Alert Execution Flowchart**

Based on the urgency level, there are five scenarios:

1. System sends alert to the patient for checking their blood sugar levels (diabetes);
2. System sends alert to the patient for checking their blood pressures (hypertension);
3. System sends alert to the patient for medical check-up at the clinic (diabetes, hypertension, TB);
4. System sends alert to the patient for attending DisMan sport and education activities (diabetes, hypertension, TB);
5. System sends alert to the patient to self-administer medication (mainly geared towards TB patients).
Self-monitoring of blood glucose (SMBG) for patients aids in controlling diabetes by providing information of blood glucose development for every diabetic patients and Self-monitoring of blood pressure (SMBP) for blood pressure information of hypertension patients.

Data are obtained according to the determined schedule. For a case in which SMBG or SMBP data are not in line with the predetermined medical health care, the DisMan staff may directly consider the change in medical care plan with regards to meal consumption, sport activity, and medication intake.

With the presence of daily blood glucose and blood pressure information, it is hoped that patient awareness is developed to keep the pattern of their eating and physical activities.

Patients monitor the blood glucose level with a glucose meter device (Figure 5), which will send the data to the patient’s cellphone via Bluetooth. Blood glucose level is then sent via cellphone to the health care provider’s database. The utilized Bluetooth profile is the Serial Port Profile (SPP,) which controls data access by defining necessary procedures for configuring connections between bluetooth devices using RFCOMM.

User interface of the blood glucose meter shows blood glucose level, time taken, qualitative description (high or low), and a comparison of blood glucose level before and after meal. After that, patient is asked to send data to their cellphone by pressing the send button.

After receiving data from blood glucose meter, the cellphone user interface will show blood glucose level, time taken, description (high or low), and description of blood glucose level before and after meal. After that, patient is asked to send data to the DisMan database by pressing the send button.

Patient may see their blood glucose level for a certain period by inputting start and end dates on their cellphones.

Comparison of results obtained from measurement and the determined targets in a medical care plan period will develop patient’s awareness.

The process is the same in SMBP for patients with hypertension.

4 Conclusion

Results of this study is a model of a registry system that functions as an information system to support the implementation of disease management at a consumer electronics manufacturer. This system is capable of:

1. Daily monitoring of patient conditions. DisMan staff is able to find out when the patient conditions is out of track from the planned target, on which immediate action could be taken. The latest patient condition monitoring results may then be set as a guideline for revising the medical care plan.

2. Raise patient awareness to obey the given recommendations from DisMan staff. Patients will be reminded by the Alert Management System to do measurements according to the predetermined schedule. Patients may also see measurement results from the Self-Monitoring System and compare it with their targets.

Information obtained by the registry system is used as consideration for analysis by the DisMan staff to help determining subsequent medical care plan. This system aids in providing data as information for DisMan staff in monitoring patient conditions.

References


