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SIMPLE DETECTING SYSTEM OF SLEEP APNEA

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Abstract

Nowadays, all the people are pursuing health for longevity. Thus, well sleeping is the extremely important physical need in our life time; however, there are 6 million people who have suffered from the Sleep apnea. The research shows that Sleep apnea has the relation between cause and effect to many diseases such as metabolic disease, obesity, and cardiovascular disease. Sleep apnea has to be diagnosed by polysomnography in some specific hospital sleep center; however, the testing equipment is expensive and not widespread currently. Therefore, the simple Sleep apnea detector is highly convenience and low cost should be expend on all the market directly. Our design takes the HT66F70A from Holtek Semiconductor Company as the overall control core; equipped with perfect functional user interface, assemble infrared sensor, temperature sensor and triaxial accelerometer to detect breathing, heartbeat, and blood oxygen saturation, according to all these data to inspect the symptom of Sleep apnea. This product which possesses advantages of high convenience and low cost is good to be promoted especially in the county side which is lack of medical resources.

Keywords*: Sleep apnea, triaxial accelerometer*

Introduction

Sleeping is supposed to be the most simple and comfortable activity; however, sleep disorder is caused by the unhealthy lifestyle, stress, or disease in today's world. One of the sleep disorder is sleep apnea.

Most people go to the sleep center in hospital to check their sleep quality; nevertheless, making an appointment in checkup will cost 6 months to 1 year. Furthermore, the most of sleeping test is not by the health insurance pays which costs 5 thousands NTD further to 10 thousand NTD for once.

For this reason, we expect the people who have sleep apnea could check their sleep by our simple detecting system on their own home and submit the testing data for doctor to analysis if they need the further checkup or not. Furthermore, the problem of lacking medical equipment and costly expense could be solved.

Background

Symptom like long-term sleep snoring; drowsiness in the daytime or light sleeper might be the patient of Sleep apnea. Therefore, mounts of hospitals set up medical sleep center continuously to inspect the precise polysomnography inspection these years. A number of clinics set up the small sleep disorder screening center as well. However, the consultation rate still is pretty low because of the multifarious inspection and insufficient alertness. Having pulse oximetry test in the nearby clinic or recording the breathing sound are the simplest ways to confirm the anoxia during sleeping or recording the sounds of breathing in the nighttime by itself; nevertheless, self-recording is not the precise way.

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The following are two common inspection methods:

I. Sleep center in hospitals

The polysomnography includes air flow, EEG, EOG, ECG, EMG, respiratory effort, blood pressure, blood oxygen saturation, heart rate and sleep gesture. Patients have to schedule the time with sleep center and sleep for one night at the sleep center. Sticking monitoring patch on the body to detect the data of brain waves, eye movement, heartbeat, and myoelectricity; wearing hemoximeter on fingers, respiration sensor on nose, ears and chest, sphygmomanometer on arms. The following is the test data graph (Fig. 1).

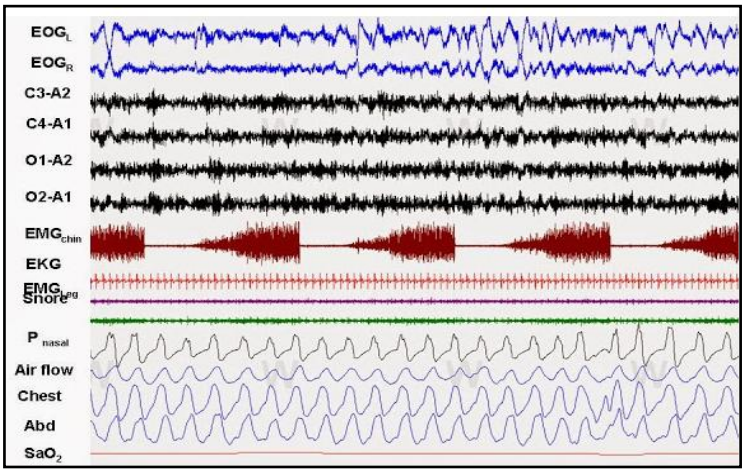


Fig. 1. Test data graph

Sleep medical team is formed from the doctors of *pulmonary medicine, ENT dept., psychiatry, and neurology. according to the data of inspection, different medical treatment would be given to different patient.*

However, sleep center is possessed of comfortable and individual space for inspection. Complex testing instrument and paramedic might cause the physical and psychological discomfort. Moreover, costly expenses and long queuing time are also difficulties for patients.

II. Oximeter

The normal oxygen content is 98% to 99%. However, for the man who has a moderate or severe Sleep apnea sufferer might reduce to 86% or even lower. Long-term (for long periods times of) substandard blood oxygen content (lower than 80%) should be treated right away to avoid sequelae. Oximeter displays the present data of blood oxygen content and heart rate. Wearing the oximeter could record the variation of oxyhemoglobin saturation overnight.

After interpreting the data through computer by doctor, the level of anoxia would be identified. It is appropriate for initial checkup. Further, the diagnostic data would be more accurate because of patients could get more relax situation while sleep. The price of an oximeter is around 5-6 thousand dollars and is easier to buy it online or in the medical supplies shop. The following is the sleep test comparison table between having a check in hospital and at home. (Table 1)

Table 1. Comparison of detection mode

	Hospital	**Home**
Advantage	Professional and complete checkup and follow up	Easy, convenient. No hospitalization
Disadvantage	Long queuing schedule	Initial checkup only

Product description

Characteristic

This product takes the HT66F70A microcontroller as the overall control core with advantages in high convenience and low cost. It emphasizes that is easier in use for every users. Users could wear the simple type of detectors include IR sensor, LM35DZ temperature sensor and triaxial accelerometer to record breathing, heartbeat, blood oxygen saturation, body temperature and chest variation. Alarm of the device will go off to wake the user up when apnea occurs. Additionally, the chest variation data could be the basis of determination of neurological apnea.

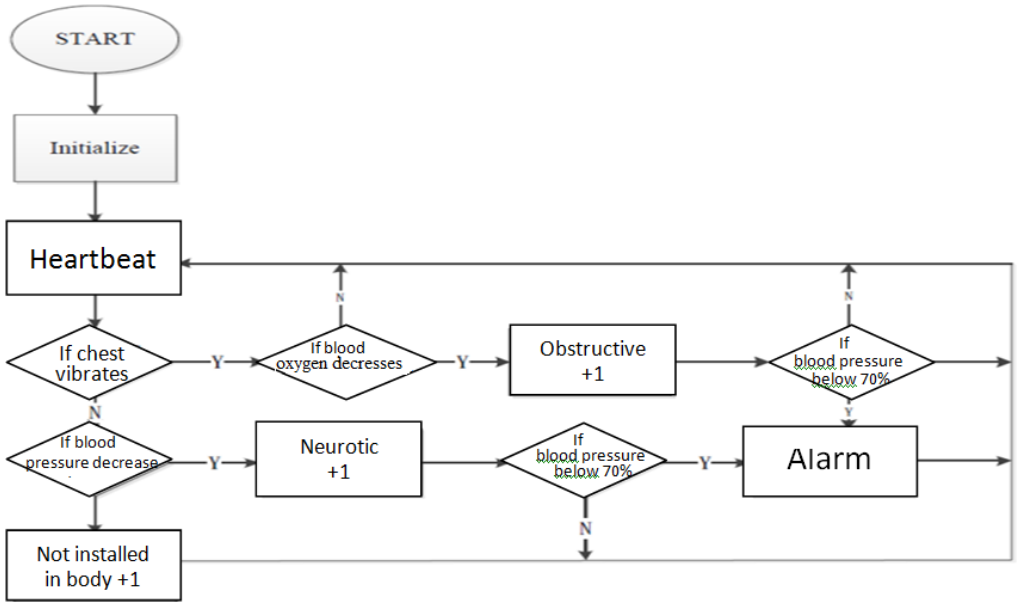


Fig. 2. Inspection flowchart

This product possesses five modules:

1. Screen module:

This product has easy operation and function with human-computer interaction in LCD panel which displays each in formation like breathing, heartbeat, blood oxygen content, or body temperature (Fig. 2).

2. Alarm module

This alarm is composed of core chip and buzzer. The critical value is basic of medical reference data, compare to the detecting data of blood oxygen content and heartbeat. The core chip will activate buzzer when detecting exceed Critical Value data (Fig. 3).

3. Infrared rays module

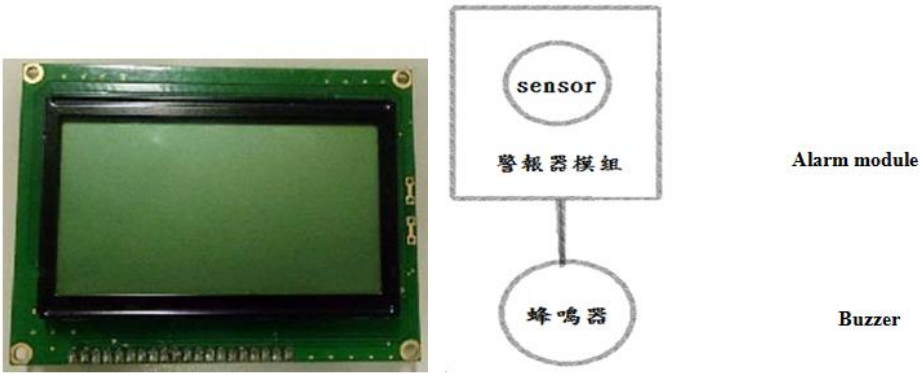
Through the infrared rays could sensor the heartbeat while the blood oxygen saturation will be converted because different blood oxygen content will be absorbed by different infrared rays' band (Fig. 4).

4. Temperature sensing module

A sensor which place on arm to detect body temperature and transmit the data back to screen of device (Fig. 5).

5. Triaxial accelerometer module

A sensor which place on chest to detect chest variation to determine the breath condition and sense the sleeping turns. These data could be the referral for sleep quality.



(a) (b)

Fig. 3. (a) LCD panel screen, (b) Buzzer alarm

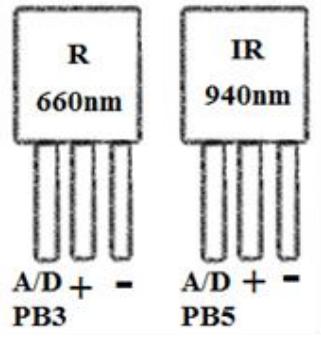


Fig. 4. Infrared ray module

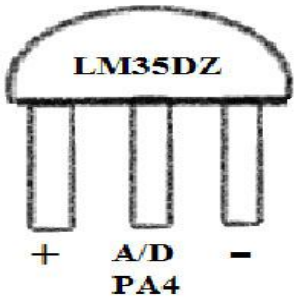


Fig. 5. Temperature sensing component

Difference

The following is the comparison table between the commercial oximeter and our product.

Table 2. Comparison of home-style devices

	Oximeter	**Detecting device**
Advantage	easy and convenient	Easy, convenient, and portable / with alarm
Disadvantage	Costly expense	Incomplete checkup (compare to hospital)

Cloud personal health management system

This product links to self-configuration cloud database management system which records mass data for different users with online platform for users self to read and medical terms. Furthermore, this product could linking to the system to informing emergency unit if the user doesn't respond to the emergency alarm (Fig. 6).

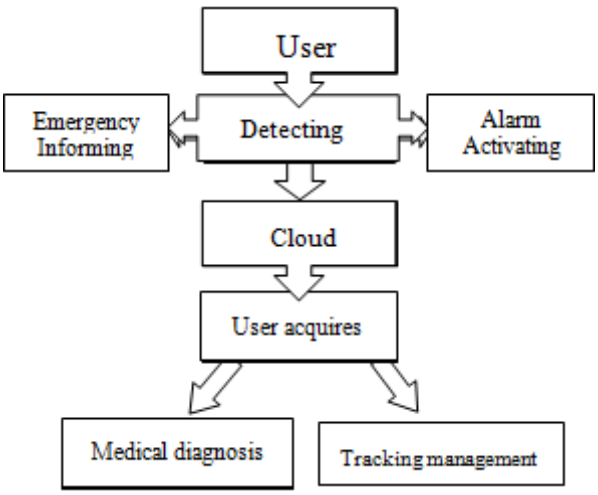


Fig. 6. System framework diagram

Business model analysis

The following is our strategies of business mode.

I. Short-term business strategy

Our short-term strategy is cooperating with large-scaled hospital. Patients who make schedule with sleep center could rent this product and detect by themselves at home. After all the data has been recorded, it could simply classify patients in different triage. Further to use the medical resources concentrated on severe patients. Cooperating with large-scaled hospital could assist the medical resource supply and demand balance. Moreover, the product could be promoted by interaction between doctors and patients.

II. Medium-term business strategy

Our medium-term strategy is cooperating with dealers who promo this product to community clinics and advance the marketing density. Propagating this product a home-style medical detecting equipment and promote its function and demand to families.

III. Long term business strategy

Positioning this product as home-style medical detecting equipment like sphygmomanometer or blood glucose meters and cooperate with pharmacy to sell.

All the users could get a cloud account after purchasing this product. The detecting data will be uploaded to cloud recording system for users to read anytime. The data could also be downloaded as reference for doctor.

Feasibility assessment

Analysis of business mode and customers

Analysis of target customers

a. Large-scale hospitals: Promoting this product to every large-scale hospital further to let doctors could acquire basic sleep data record and expedite the diagnosis process.

b. Medical clinics: Depending on the demand of each clinic which could purchase or rent the devices. The lacking of equipment problem could be improved.

c. Family users: The people who care about sleep quality and further to follow up their breathing state in sleeping.

Marketing

a. Personnel sale: Face to face sale.

b. Medical appliance dealers: Expanding distributorship and marketing channels.

c. Electronic commerce: Building a website for product features description. Attracting potential customers for further inquiring and purchasing.

d. Hospitals and clinics: Cooperating with medical institutions. Placing the products in the public spaces for rent.

I. Porter five forces analysis

1. Bargaining power of suppliers: low

Our device of each components already have current market price. Furthermore, there are many domestic and foreign Original Equipment Manufacturers to choose, so that we could easily to compare the prices.

2. Bargaining power of buyers: low

There are not much alike products in the market yet now thus there is nothing people could compare with.

3. Threat of new entrants: medium

Medical equipment is keeping innovating with the ever-changing technology. People become more and more serious in sleeping health, new relative products are launched continuously is expected.

4. Threat of substitutes: low

Nowadays, the devices in each hospital sleep center are expensive and restricted to amount of beds. Therefore, the treat of substitutes is low.

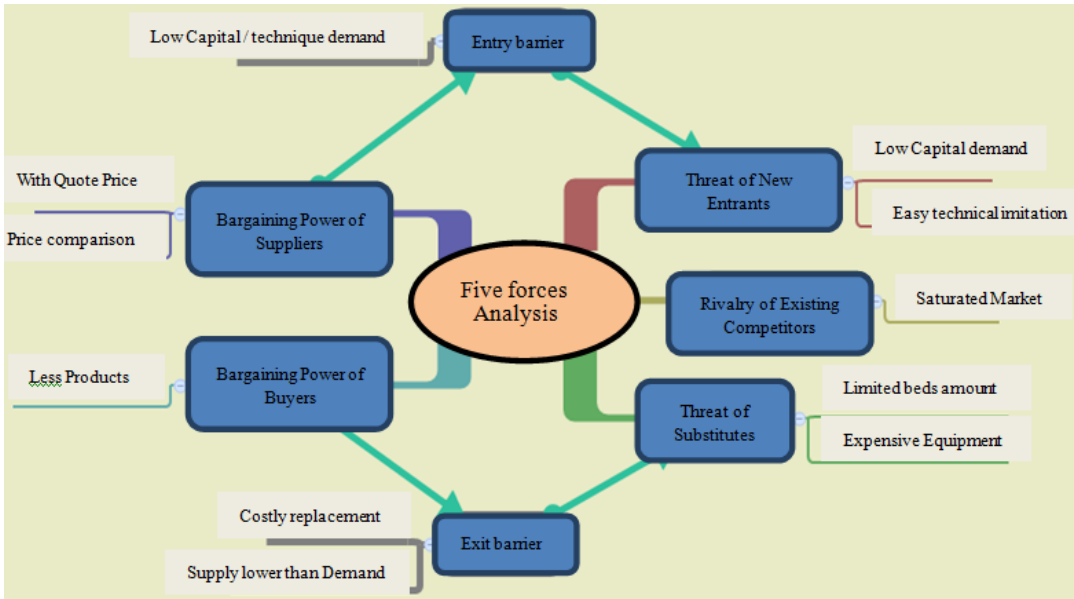


Fig. 7. Porter five forces analysis

III. SWOT analysis and adaptive strategies

1. Analysis

1.1. Strengths

a. Low cost.

b. Portable.

c. Shortening the waiting time of scheduling in hospital.

d. Data collating and analysis in Cloud.

e. Domiciliary care.

f. Bellwether (Market leader) of new product

1.2 Opportunities

a. People are paying more and more attention on related issues.

b. Demand increasing because of the increasing civilization diseases.

c. Department of health is promoting the Cloud medical health project.

1.3. Weaknesses

a. Low reputation / High promoting expense

b. New product / Small scale

1.4. Threats

a. Low entry barrier

2. Adaptive strategies

2.1. SO development strategy

This product possesses advantages of low cost and domiciliary care, reducing the detection cost, improving the lack of equipment supply. In addition, the design of Cloud database not only conforms to government's project but also conforms for future trend of Cloud health management.

2.2. ST maintenance strategy

Therefore, as a market leader of new product, there are not much competitors. Educating customers to become accustomed of our product or further new products. Not only cultivating the loyalty of customers but also raising the cost of reneging.

2.3. OW strengthening strategy

Although the reputation is low, the willingness of using is high because thevaluing issue, less supply, and low product price.

2.4. WT challenging strategy

We could decrease the difficulty of selling by deepening engagement with medical organizations and equipment suppliers.

IV. Marketing mix analysis

1. Sales strategy

The Sales strategy is focused on cooperating with medical institutes. The medical institutes bought the products to rent or sell for potential buyers. We also cooperate with medical appliances suppliers; collocate with promotion project such as trade exhibitions, TV advertisements and programs, and related forums to avoid the earlier stage risks of labor cost and lack of experience.

2. Promotion strategy

Considering that the low acceptability in the earlier stage and increasing the exposure rate of product, we will have the promotion sale from the very first year. We will design the renting promotion package for medical institutes to enhance the cooperating willingness of medical institutes. The Cloud database is our key point of our business; the customer could get the Cloud user key as the member account after purchase our product. The member who binds his/hers personal information to account could acquire the latest information and product upgrade services.

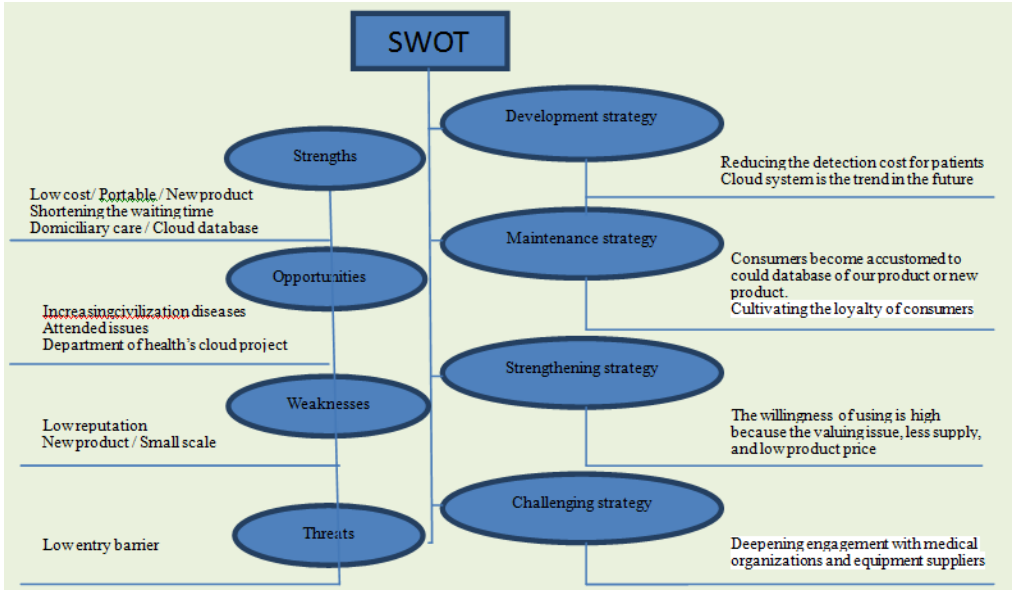


Fig. 8. SWOT analysis

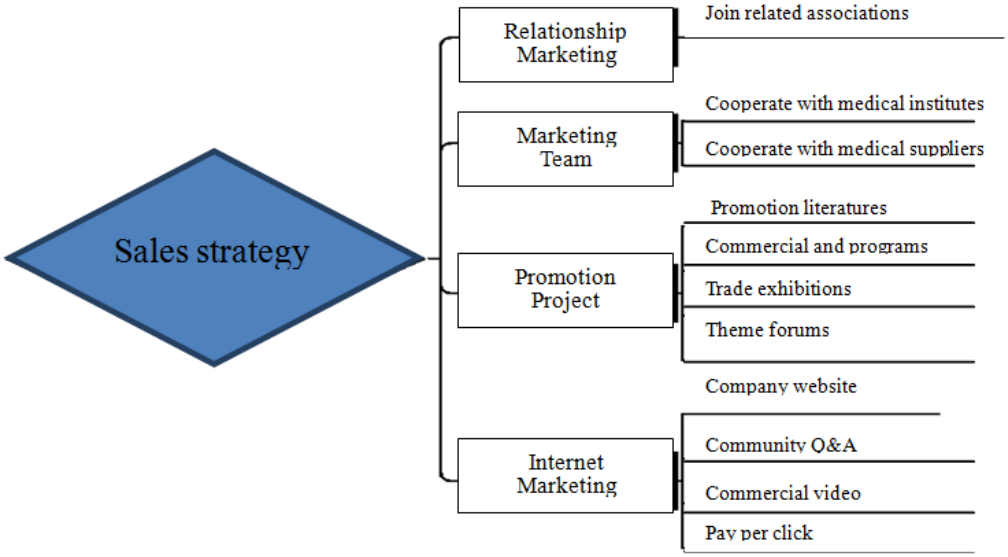


Fig. 9. Sales strategy

Economic benefits and risk management

I. Economic benefits

1. Direct economic benefits

1.1 Our product named Simple detecting system of Sleep apnea is running a procedure of applying the patent. Cooperating with medical institutes to rent or have a sale; increasing the incentives to purchase, reducing promoting cost.

1.2 This "Simple detecting system of Sleep apnea" is the improved product with patents. Not only has the better detection efficiency than other products but also higher convenience in data

colleting with the Cloud database. Binding the member account to strengthen the using habit of the customer, raise the cost of renegingand cultivate the loyalty of customers.

1.3 Cooperating with related industry Original Equipment Manufacturers to enlarge production and reduce the cost of manufacture.

2. Indirect economic benefits

2.1 Having long-term cooperation with large-scale hospitals, small and medium sized clinics to promote people renting this product. Not only saving the waiting time for seeing the doctors but also decreases the medical resource waste.

2.2 The long-term sleep data which recorded by our product could be the basis of research and health management. Improving people's sleep quality is what we expected.

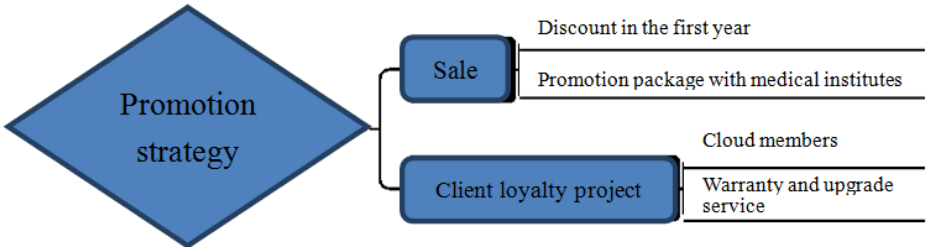


Fig. 10. Promotion strategy

II. Risk management

Until now, the sleep detection products market isincomplete. Due to the high expense of the existing product and not popularized concept of Sleep apnea to people, the most of general public still doubt in self-detection therefore people are more likely to go hospital for the detailed inspection. The acceptance of our product may be low, however, the production of this kind of device's market is not saturation yet and the demand is getting higher and higher. Thus, the following are the risk planning of our product.

1. Market risk

Most people choose to have a fully checkup in hospitals at the present days. In order to increase the cognition in demand of in-home detection, we will hold product briefing with suppliers or association activitiesco-operate with doctors to popularize and enhance the familiarity of our product for customers. Comparing to other detection product, oursadvantage is in lower cost. Oximeter is accessible; however, it with wide range of price difference and the function is not complete. Thus, ours contains the function of detecting, recording and warning, with long-term health management educating to increase the willingness of purchasing.

2. Legal risk

We insured Liability Insurance for this product to protect customers and also apply second-class medical device license (In Vitro Diagnostic) formanufacturing according to laws.

3. Financial risk

We cooperate with Original Equipmen0t Manufacturers in this product to reduce the purchasing cost of plant and equipment; To avoid the cost of stock up and idled machine all the production depend on the orders; reducing the machine maintain cost to lower the operational risk. Furthermore, our team will apply the "Youth entrepreneurship loan" from government as the working capital in the early stage of operation, the financial risk is low.

4. Technical risk

Acquisition of technology is gained from each co-organizer. The technique of goods delivery and delivery charge is needed to cooperate with logistics companies and related financial institution.

5. Intellectual Property risk

Thisresearch andproduct development in public technique is all standard of laws; moreover, we hadalready applied patent for it and it is on the procession, therefore, we have no Intellectual Property risk currently.

Conclusion and discussion

Allotting medical resources efficiently and systematically is becoming an important topic because of the economic development, lifestyle changing, rapidly increasing chronic and long-term care needed patients, further to medical system burden; people are paying more attention on health management and disease care. Through Communication infrastructure of health and Cloud concept applying to improve medical health condition of entire people. Further to integrated between hospitals, clinics and health service providers' resources is one of the development directions of National policy.

Due to the trend of medical in Cloud, we build a system of medical data digitization; detecting, transmitting, recoding and saving data in Cloud. For medical care, the data could be reference for doctors. For long-term care, the user could save and read the data immediately. It is strongly improved the convenience of health care management.

It is expected that the medical procedure from medical service seeking to diagnosis would be much simplified after the Cloud concept applying for one thing; for another thing, the product possesses the alarm function to notify when emergency occurs for double prevention.

Our company will maintain the advantages of high concept expansibility and low cost; develop different services to more different demands, and continue the operation in the future.

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