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A New Framework and a Model for Product Development with an Application in the Telecommunications Services Sector

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***Abstract*—**This paper argues that a product development exercise involves in addition to the conventional stages, several decisions regarding other aspects. These aspects should be addressed simultaneously in order to develop a product that responds to the customer needs and that helps realize objectives of the stakeholders in terms of profitability, market share and the like. We present a framework that encompasses these different development dimensions. The framework shows that a product development methodology such as the Quality Function Deployment (QFD) is the basic tool which allows definition of the target specifications of a new product. Creativity is the first dimension that enables the development exercise to live and end successfully. A number of group processes need to be followed by the development team in order to ensure enough creativity and innovation. Secondly, packaging is considered to be an important extension of the product. Branding strategies, quality and standardization requirements, identification technologies, design technologies, production technologies and costing and pricing are also integral parts to the development exercise. These dimensions constitute the proposed framework. The paper also presents a mathematical model used to calculate the design targets based on the target costing principle. The framework is used to study a case of a new product development in the telecommunications services sector.

***Keywords*—**Product Development Framework, Quality Function Deployment, Mathematical Models, Telecommunications.

I. Introduction

NEW product development is the only way to sustainable competitiveness of an organization. Because of the product lifecycles that are becoming shorter and shorter, organizations need to build product development capacities and to enhance creativity and innovation. Quality function deployment (QFD) is among the development methodologies that help capturing the needs of the customers and the concerns of the different functions of the organization [1]. QFD is mostly used in the development of goods. However, the tool is also useful in the development of services. QFD allows the development team to set design targets and other levels of application of the methodology enable the definition of different production parameters of the production process. A number of QFD software is available including web-based ones [2]. Other tools that build on concurrent engineering principles [3] but are not necessarily QFD based also exist for use in a physical or a virtual space. Among these are freeware technologies used for product development [4].

A product development exercise happens in a number of stages [5]. Stages may include idea generation, concept development and testing, marketing strategy and development, business analysis, product development, test marketing and commercialization. Product development also involves several decisions regarding a number of other aspects. These aspects should be addressed simultaneously in order to develop a product that will respond to the customer needs and that would help realize objectives of the stakeholders. In this paper, we present a framework that encompasses these different dimensions to be considered in a product development exercise. The framework is used to study a case of a new product development in the services sector. The author coached a product development team working on the development of a service in the telecommunication sector. The team used the framework presented in section 2. Section 3 presents the telecommunication sector in which the case study occurs. Section 4 presents the application of this framework in the case of offering a proactive mobile care service and the conclusion is presented in section 5.

II. A Product Development Framework

A product development methodology represents the basic tool which allows definition of the specifications of a new product. Through a tool such as the house of quality, the product design targets can be set. Creativity is the heartbeat that enables the development exercise to live and end successfully.

A number of group processes need to be followed by the development team in order to ensure enough creativity and innovation.

An important extension of the product is the packaging [6]. Packaging has a number of functions that should be considered in the product development exercise. A branding strategy is also a must to ensure customer loyalty on the long term. In today's competitive world respecting quality requirements including standardization enable penetration of

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different markets. Local, regional and international standards should be respected to allow entry to the respective markets.

Identification technologies are used with products for several reasons such as tracking and inventory management. Although bar coding is very popular, the use of radio frequency identification (RFID) is continuing to grow. RFID has more advantages as compared to bar codes. It is used in a wide variety of applications. Also, in addition to identification technologies, other types of technology are needed in a product development exercise. Technology is needed at two levels. The first level is to assist in the development of the product itself. We can think of CAD systems and collaborative technologies and other software that can help in this regard. The second level is the technology used in production. Knowing the technology that will be used will help deciding on process plans and estimating the cost of the product.

Finally, an integral part to the development exercise is the product costing and pricing. Target costing [7] helps guiding the overall development exercise. The principle of target costing stipulates that we determine a target price of the product, from which a target cost will be calculated.

The different aspects presented above constitute the different dimensions of a proposed framework that guides the team when applying the QFD methodology in developing a new product. They constitute complementary dimensions that can be viewed as extensions to the product and have to be decided upon in addition to the design targets which constitute an output of the application of the QFD methodology.

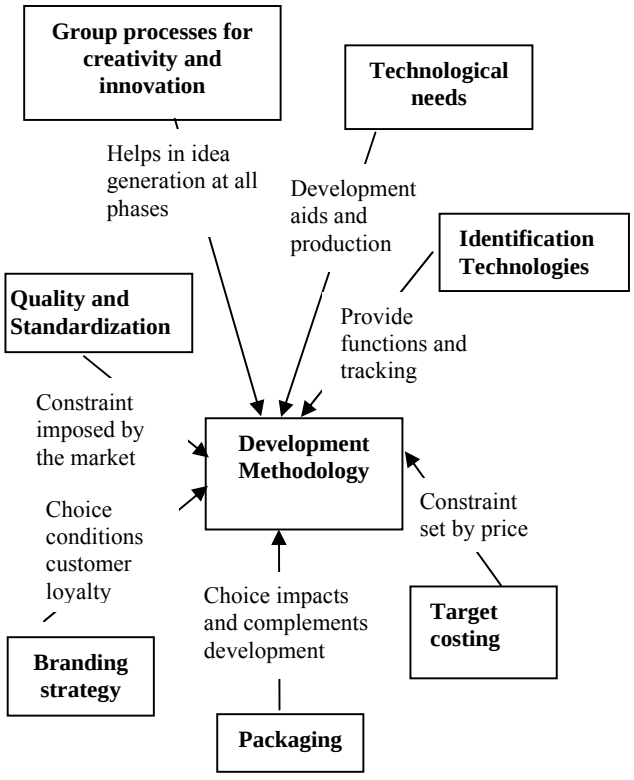


Fig. 1 Framework for product development

III. Telecommunications Sector: A High Potential for Service Development

The development of electronics and related applications in medicine made it possible to transmit and process many vital parameters of the human body. A very important signal for monitoring and analyzing humans' health condition is the electrocardiography (ECG) signal. This is especially important for the patient suffering from the cardiac disease where it is very important to perform accurate and quick diagnosis and for this continuous monitoring is needed. It is today possible to monitor the ECG signal through the latest generation mobile telephones.

Direct transmission of ECG in real time for few minutes or few hours is called telemetric ECG. An electronic equipment (including sensors and transmitter) is mounted on the patient's body permitting continuous monitoring of the heart activity and sending the ECG signal to a receiver located in a remote center. The signal is monitored on a central monitor in real time. The transmission can be made either through wires or using wireless technology. The standard mobile telephone lines can be used for transmission of ECG signal. However, one disadvantage of the system is the limited radius of the patient's motions.

For monitoring actual and potential heart patients, available mobile telephone networks are used [8]. Mobile networks are spread allover the world and are accessible to many people. The greatest advantage of this system is practically the unlimited movement of the patients and unlimited covered area [9]. Usually three to four metal electrodes on the back of the standard cellular phone record the heart event and the data are stored and transmitted to cardiac monitor center. By using the LBS (Location Based System) under GSM networks or in the future the GPS built in mobile phones it is possible to determine the exact location of the patient. In the case of emergency the nearest medical center can be contacted and by the LBS technology and the patient can be found and saved. This allows the development of the proactive mobile care services.

Today modern electronic and telecommunications equipment permit us to transmit and record ECG signals. Miniature ECG machines having many possibilities and advantages are offered to physicians and patients. They are much smaller and lighter than old ECG machines used in telemetry. It is no more necessary to connect cumbersome ECG cables and to apply ECG electrodes, because of the new recorders. By simply placing sealed metal contacts against the patient's chest the user can record a real-time ECG signal. The users can carry ECG devices in their homes, while working, traveling or driving a car. Thus, no matter where the user is located, when he feels heart irregularities, he has the ability to record and to transmit the ECG signal by only pressing a button.

For transmitting the ECG signal the communication path used is the mobile phone network. The ECG signal is transmitted to a monitoring center. The physician is provided with continuous access to essential information about the patient's state of health. Trained medical staff at a remote monitor center can interpret the ECG signal, receive the

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patient's symptoms over the phone and provide real-time diagnosis, immediate consultation and clinical advice. Another concept in telemedicine avoids direct doctor-patient contact. Instead, the concept uses a Virtual Doctor, a sort of smart software capable to mimic several ordinary procedures known from medical practice [10].

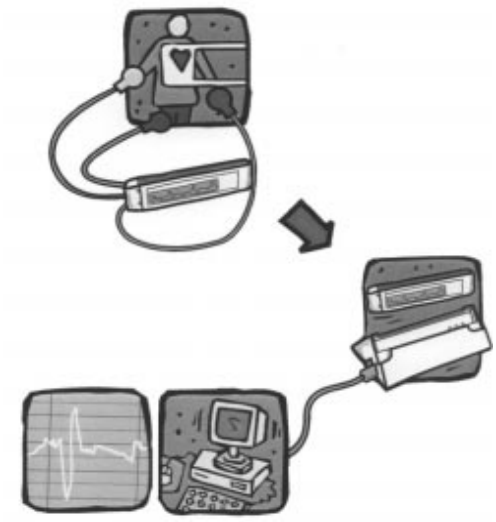


Fig. 2 Schematic representation of remote ECG monitoring through standard telephone line (Source: Đaja, Reljin and Reljin, 2001)

The next step is to organize a remote cardiac center, where ECG signals are received. The services of the cardiac monitor center are profit-based. The patients pay monthly a certain amount for the service and benefits they get. With an appropriate number of users the costs can be affordable. In Egypt, we estimated it to be in the range of 300-500 EGP/Month.

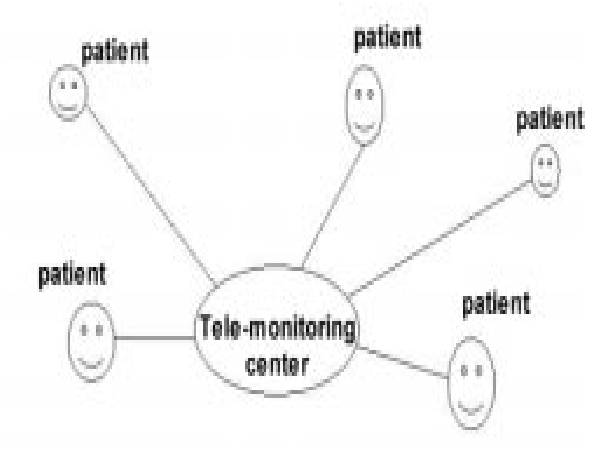


Fig. 3 Remote Center (Source: Đaja, Reljin and Reljin, 2001)

The use of telemonitoring of ECG signals has many advantages such as covering many patients at the same time, covering a large area, real-time information, faster diagnosis, faster therapy and prevention. With the support of health institutions the ECG transmission by mobile phone can be a reality in Egypt soon. The future development depends on new investments.

IV. Development Exercise

This development exercise sheds light on the possibility and the profitability of establishing such a project in Egypt. The exercise took about 3 months before setting the design targets and deciding upon all related aspects of the project.

A. Group Processes for Creativity and Innovation

The team followed the QFD methodology in developing the service. Throughout the duration of the exercise, the team members adopted the following group processes on a regular basis to foster creativity and innovation:

- Searching and reading about the product idea and its applications all over the world to gain a full perspective
- Conducting focus group meetings with cardiologists, physicians and families. This served as an input representing the voice of the customer.
- Conducting focus group meetings with mobile telephones operators to include the ideas and recommendations they could give for the service.
- Scheduling group meetings on a weekly basis to brainstorm, plan, divide and track progress, and practice some innovation exercises. A project scheduling software was used to set the project plan, assign resources and to do the follow up on project progress.
- Practicing exercises to develop communication skills in order to optimize the team's communication effectiveness.

B. House of Quality and Model for Design Targets

The house of quality presented in Fig. 4 was developed using the voice of the customer from surveys with 20 families and 5 physicians. Technical requirements were then established. On another plan, the following activities took place. The team met with the head of Products and Services development of one mobile telephone operator in Egypt. The following main points were concluded:

- Idea is creative and promising.
- Pioneering service in Egypt and the region.
- Company willing to pursue the project.
- Company's potential benefits include new market segment penetration and increasing usage of the mobile telephony services.
- SWOT analysis was suggested.
- Feasibility analysis was requested for with a promise to present it to higher management.

The voice of the customer revealed the following needs:

- Enhanced Patient's Mobility
- Reliable Service
- Reliable Equipment
- Fast Response
- Qualified Staff
- Affordable Service Price
- Easy to use
- Regular Feedback on the patient's case

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The most important among these requirements were:

- The service cost.
- The reliability of the service.
- The staff competence.

The technical requirements were:

- Accuracy of allocation (LBS technology)
- Coverage and reachability of the mobile network
- Highly qualified Physicians
- Mobile devices of high quality
- Devices cost
- Service Support Centre and technology used
- Operating and maintenance cost
- Size, weight and fitting of devices
- Highly qualified operators

The most important among the technical requirements were:

- Operating and maintenance cost.
- The accuracy of allocation (LBS technology).
- Service centre support and technology used. It reflects the type of equipment, the support processes and the technologies used to support these areas.

A target has been set to each of the technical requirements as follows:

TABLE I
DESIGN TARGETS

Technical Requirement	Target
Accuracy of allocation (LBS)	50 – 75 m
Coverage of the mobile network	90% of habituated areas
Highly qualified physicians	100% Ph.D. holders and 5 years experience
Mobile Sensor devices of high quality	Certified quality producer (ISO certified).
Devices Cost	Avg. unit price < 6000 Egyptian Pounds
Service Support Centre and technology used	80% of equipment < 1.5 yrs old, state of art technologies and equipment.
Operation and Maintenance	< 1.5 million/month
Size, Weight and fittings of devices.	< 6 cm width, < 15 cms long, < 200 gms
Operators having university degree and excellent command of English	100% university degree and excellent command of English

The team has applied a competitive intelligence research, which concluded that there are no current intentions in the 2 other mobile operators networks to apply any major services in the tele-medicine field. Accordingly, the company can acquire the first mover advantage. However, competitor's imitation is expected to be fast.

In the roof of the house of quality, some technical requirements support each other like the accuracy of allocation with the coverage of the network. Also there are some technical requirements that impede each other like the device cost and the device's quality.

In order to specify a value of the target for each of the technical requirements the following mathematical programming model was used. The concept of target costing guided the development of the model. The target cost presents a constraint enabling the determination of values for the different technical requirements. The table above shows a proposal for the definition of the values of targets. However, it is through the respect of the cost constraint that we can determine the feasibility of the choice. The model enables the verification of different scenarios for the values of the technical requirements while ensuring that the cost limit and the minimal technical requirements defined by standards are respected.

The following notation served in developing the model:

i = index identifying each technical requirement $i = 1, 2, \ldots, j$.

c_i = unit cost associated with the modification of the value of technical requirement i.

w_i = weight assigned to the technical requirement i and determined by the priorities set by the targets calculation in the house of quality.

D_i = maximum feasible value of the technical requirement i.

M_i = minimum feasible value of the technical requirement i.

T = Target cost.

s_i = parameter taking the value of 1 if the direction of improvement is to increase the value of x_i, and (-1) if the direction of improvement is to decrease the value of x_i.

x_i = variable indicating the number of the units giving the value of technical requirement i.

$$\text{Maximize} \sum_{i=1}^{j} s_i w_i x_i \quad (1)$$

Subject to:

Target Cost Constraint:

$$\sum_{i=1}^{j} c_i x_i \leq T \quad (2)$$

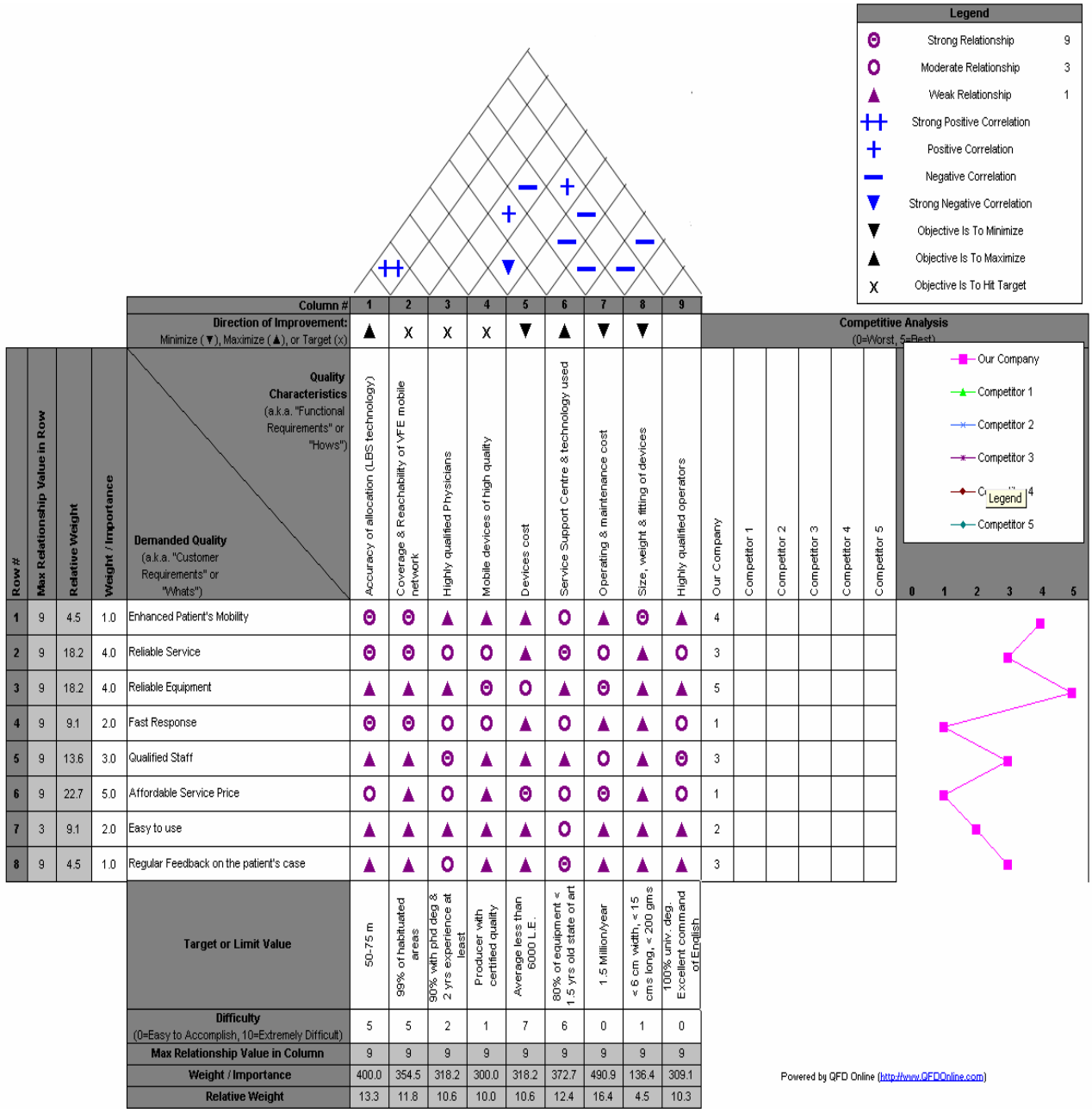


Fig. 4 House of Quality for the monitoring service

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Maximum Technical Feasibility Constraint:

$$x_i \leq D_i \qquad \forall i \qquad (3)$$

Minimum Technical Feasibility Constraint:

$$x_i \geq M_i \qquad \forall i \qquad (4)$$

Non-negativity Constraint:

$$x_i \geq 0 \qquad \forall i \qquad (5)$$

The objective function maximizes the customer satisfaction by increasing/decreasing values of the different technical requirements. The constraints ensure that the objective maximization happens within the target costing constraints and the minimum and maximum technical feasibility constraints. The last set of constraints is for non negativity.

C. Packaging Concept

Packaging concept is generally used for goods for identification and protection purposes. Packaging also has a lot of other functions such as collecting and providing information about the content [11]. Packaging is considered an extension to the product and it should be addressed concurrently with the development of the product in order to increase competitiveness [6]. In case of the service developed in this exercise, printed material is needed to show safety and use instructions for the devices. A packing strategy for such a product can be broken down as follows. There are two co-products that need packaging; the SIM card and the Mobile Sensor Phone device. For the SIM card, the current packaging of mobile telephony service provider in Egypt will be used. It is a thin, hard plastic cover like the one used to protect CDs. It is identified by the company's logo and an attractive picture. It includes, inside the SIM card, the barcode and a small instruction plastic plate attached to the SIM card to guide the user in the activation process. For the Mobile Sensor Phone device, a red colored hard cartoon box will be used. It will be wrapped with an attractive cover identifying the brand, the barcode and the name of the service. The box will contain foam to protect the sensitive electronic device. A manual written in both Arabic and English languages will be included. The manual includes everything about the basic operations of the device as well as a number of elaborative diagrams and pictures. There will be a small CD which will contain the manual documentation and elaborative presentations. The box will also contain a small brochure with all instructions to activate the service and the support center contacts.

D. Branding Strategy

Technology-based services are great candidates for benefiting from superior brand management practices [12]. In general, the rate of innovation is high in technology-based industries and subsequently this makes the rate of uncertainty in the purchase decision also high. This basically includes the risk of functional performance. Thus branding is vital in such industries.

In the case of the product studied in this paper, it will be offered by a mobile telephony company which is already well established and which is known by the customers. Since customers trust the company and are already familiar with their work, they are expected to have trust in the proposed service.

The service provider has a positive image and customers are emotionally attached to their brand. The functional risk for the customer is almost eliminated. The company's strong brand authenticates the source of the goods, and promises good value. So the proposed care service is co-branded with a strong brand. This is an asset that provides a competitive advantage. A high rate for customer retention is hence expected.

E. Quality and Standardization Requirements

Quality and standardization requirements are analyzed. Certifications of the standardization bodies will be needed. A continued commitment to high performance standards will be guaranteed through annual re-certification audits. The implementation of a continuous improvement program will also enable the company to provide world-class support to their customers. Benchmarking the service operations against best in class organizations and best practices is a must to further enhance performance. The team suggested that the following major elements are required to be in place to operate successfully:

- **Customer Feedback**

Activities associated with collecting, analyzing, and acting on customer feedback are important.

- **Usability and Design**

Considerations include content localization, personalization, and accessibility of services.

- **Planning Strategies and Processes**

Through effective planning, development of sound service strategies and processes the company ensures that the services contribute to overall customer satisfaction which means life or death situations.

- **Security and Privacy**

In order for service offerings to be safe and secure for customers, the physicians will be taking an oath to keep all information transmitted through the call center confidential.

- **Interactive Services**

These services enable customers to directly communicate with service personnel who will deliver valuable information.

- **Self -Help Services**

Self-Help services enable customers to access tools and information such as product documentation, and other related information.

In light of elements presented above and by establishing goals and objectives for key measures of success and monitoring performance against the goals, the company will

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be in a strong position to enhance the performance of the services offered. Although service standards are gaining importance and increasingly being acknowledged as an important area of standardization by industry, consumers and standards circles, it is widely recognized that much more work and promotion needs to be done before service standards receive the same legitimacy and importance on the international level as traditional goods standardization. The following international ISO standards are considered to be important requirements for offering this service:

TABLE II
TELECOMMUNICATIONS ISO STANDARDS

33.030	Telecommunication services. Applications Including supplementary services, service aspects and associated legal traceability aspects
33.070	Mobile services
33.050.01	Telecommunication terminal equipment in general
33.050.10	Telephone equipment
33.050.20	Paging equipment
33.200	Telecontrol Telemetering
	Including Supervising, Control and Data Acquisition System (SCADA)

The Egyptian standardization requirements for telecommunication services that will be addressed by this product are:

TABLE III
EGYPTIAN STANDARDIZATION REQUIREMENTS

3035/2006	Method of Measurement on radio receivers for various classes of emission, Part 4: receivers for frequency-modulated sound broadcasting emissions.
5070/2006	Compatibility of mobile phone to basic restrictions related to human exposure to EMF (from 300MHz to 3 GHz).
5442/2006	Safe levels of human exposure to EMF with frequencies ranging from 3 KHz to 300 GHz.

F. Identification Needs

The service to be offered is accompanied with co-products. To provide the service, an electronic profile carrying the patients' information is needed. This profile will be mainly identified by the customer International Mobile Subscriber Identity (IMSI) and linked with the device serial number. This method is used to identify each subscriber through the Subscriber Identity Module (SIM) on any mobile operator by a unique number. Bar coding system will be used on the contract issued to identify the IMSI of the associated SIM card for each subscriber. The bar coding system will be also used on the contract issued to identify the device serial number of the associated phone for each subscriber.

The IMSI will be used in the customers' database to build customer profiles since it will be unique worldwide. Barcode readers will be used for reading purposes. HLRs (Home Location Registers) will be used on the Global System for Mobile Communication (GSM) network to identify subscribers' data according to IMSI and eligibility to use the service. We can also use a separate database to authenticate the user instead of using the HLR.

G. Technological Needs

Specific telecommunications tools by commercial companies can be used in the design and testing of new services. Keynote SIGOS System offer tools such as the Wireless Quality Manager (WQM) [13]. In the case of the proposed service, it is used to design different test cases with different scenarios that can apply in different geographic locations. The tool can help in detecting any problems regarding the service and in its enhancement. The tool also helps verifying conformance with the international standards. In addition, it provides detailed graphic reports indicating all measurements and statistics used in the telecommunication field to give a view about the performance of the service and the weak areas to redesign. Tele-ECG System REMOS represents another technological need for delivering the service [14]. The software REMOS receives stores and processes the data sent by the telemedical devices. ECG data will be forwarded automatically to predetermined recipients by email, FTP or by telefax. The software allows ECG measurement and interpretation.

Currently the LBS technology can be used and hopefully in the future GPS technology can be used. There are current restrictions in Egypt for security issues. Software for call center management and some hardware servers and stations to monitor the patients are also needed. The patients will have with them the mobile phones with the monitoring devices [15] and will be trained to use them in the proper environment to ensure maximum benefit.

H. Product Costing and Pricing

Awareness of the benefits of such a service is a primary target to developers to ensure getting an appropriate number of customers making such a project feasible. This involves getting the support of renowned physicians and gaining the trust of the ministry of health. Surveyed families and physicians showed interest in the product and expressed wants that guided the development of the house of quality and the determination of the design targets. However, a closer look to the market is needed in order to take concrete steps towards the offering of the service.

- **Market Overview and Analysis**

It is clear that the market need for this service is rising as presented in Figs. 5 and 6. The figures indicate the number of chronic patients in Egypt. The market segment of the upper-middle class and the upper class in the greater Cairo area is targeted.

It is obvious from the current trends that the number of patients of Cardio Vascular Disease is constantly increasing. These represent the targeted market segment. About 20% of this number live in urban areas and belong to the high socio-economic class. Hence the total market size can be estimated

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to be about 1.3 million patients. It is noticed in the figures of the last 6 years that there is a constant increase of the total market of almost 9% yearly. Other diet related chronic diseases, such as hypertension, diabetes, triglycerides and cholesterol, are also common in Egypt and they contribute to a general poor cardiac health condition.

The fact of the increased numbers of deaths due to stroke, gives a strong justification for the customer needs to proactively identify their chronic cases and quickly responding to it with appropriate intervention and with high accuracy and reliability.

Also, such a service satisfies needs for researchers and physicians who want to study chronic and serious cases by having accessibility to their patient's data anytime and in an easy way. These are all latent needs. Being a first mover in the market to provide such a service can result in a huge market skimming of the thirsty market. This will also help in achieving customer-brand loyalty against competitors.

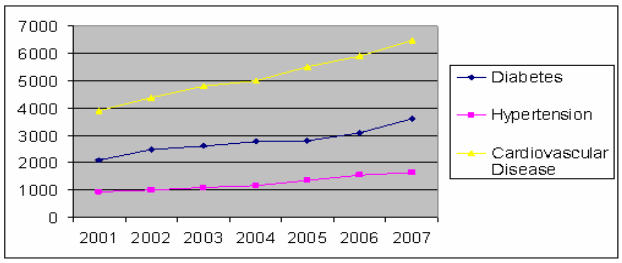


Fig. 5 Trend in CVD, Diabetes and Hypertension in Egypt, from 2001 to 2007 in (000s) *(Source:* National Centre of Health and Population Information, Egypt)

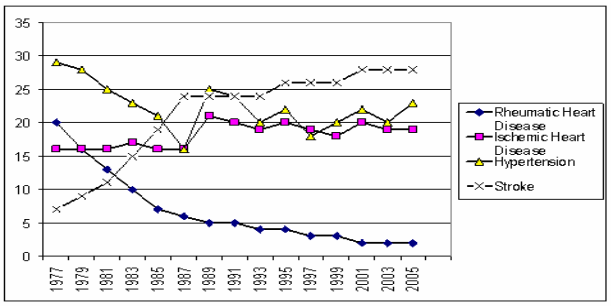


Fig. 6 Trend in CVD mortality rate in Egypt, 1977 to 2005 *(Source:* National Centre of Health and Population Information, Egypt)

- **Rough Proformas**

A cost estimate sheet was used to calculate the overall cost of the service. The assumptions of the numbers used in the calculations were based on actual surveys and actual data regarding the cost of the different goods used as well as the cost of the labor, etc. In the calculations, a 24/7 operation of the support center including the number of physicians and operators was considered. The expected level of profit over the next five years was analyzed and the results are very promising showing that positive net profit is achievable after the first year of operation.

- **Break-even Analysis**

The break-even analysis shows that upon reaching the first 877 units, the fixed and the units' variable costs will be covered. Monthly revenues come from renting and selling and service fees. These include the devices selling price such as the loop recorder and the events recorder and also renting fees of the devices together with the average monthly service fees/unit.

Estimates for the different cost elements were used based on actual market price. Cost naturally included, rent, utilities, depreciation, maintenance, general and administrative, overheads and labor cost.

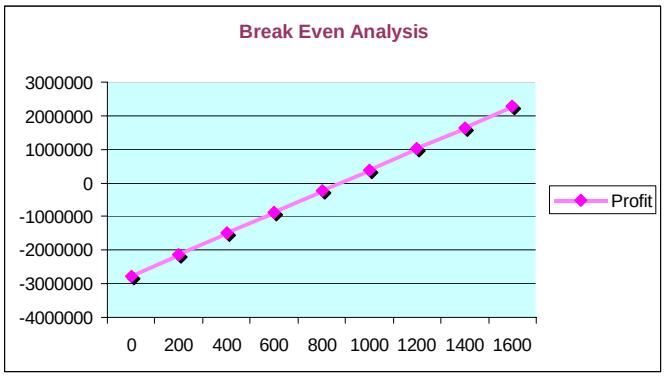


Fig. 7 Break-even analysis

This paper presented a framework to guide product development activities. In addition to the quality function deployment practiced through the house of quality tool, a number of important dimensions are highlighted. These include creativity for which group processes need to be followed by the development team. Packaging is also considered to be an important extension of the product. Branding strategies, quality and standardization requirements, identification technologies, design technologies, production technologies and costing and pricing also constitute integral parts to the development exercise. These dimensions form a proposed framework that was used to study a case of a new product development in the telecommunications services sector and results of the application indicate that the tool allowed finalizing the product development exercise in a short time period. Members of the team confirmed creativity enhancement and better information structuring and exchange within the framework proposed. It is also worth noting that the team worked for an international operator having a culture supportive to learning and to the introduction of novel methodologies. We hope for finding this service in the Egyptian market soon. Future research includes a post analysis study for the application of the framework in a number of industries and eventually the proposal of modifications. This experience as lived by the team indicated that the capacity for producing more ideas and more work and bringing a project to an end was enhanced. Hence, we can expect that the analysis of a number of potential product developments can be done more easily. This gives the company the chance of having a number of projects to choose

from and helps it getting armed facing an increasingly competitive market.

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