

RESEARCH ON THE DEVELOPMENT OF A DISPENSER FOR TABLETS

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ABSTRACT: This case study is based on the innovation of a product used for medical purposes based on a business strategy that has helped to identify the needs of potential customers and competing products. Also, market segmentation and target profile were an important factor in performing the functional analysis. Thus, the conceived concepts support the users by streamlining the way of administering the drug treatment.

KEYWORDS: dispenser, medicines, product development, innovative products.

1. Introduction

Medication consumption is an indicator that reflects both the health of a country's population and the efficiency of its health system and services. The data shows that Romania is a country with a low consumption of medicines, at least if we compare it with other countries in the region and the European average. According to Eurostat data from 2014, the percentage of medicines consumed in Romania is almost half of the European average. This conclusion is maintained for both prescription and over-the-counter medicines. (self-medication)[1].

The main objective underlining the development of this product was to base the research carried out within the master's program in Engineering and Management of Complex Projects on the development of an innovative product that integrates three main subsystems - mechanical, electrical / electronic and software. Also a factor that influenced the choice of this product "SMART-Pillbox Watch" was the support it can provide to the elderly.

The aim of this development was to innovate and create a medication device that is accessible for the use of people in need and to help monitor their self-medication behavior by caregivers and pharmacists.

2. Business strategy

2.1. Need analysis

For this analysis, the main needs that the device must meet have been identified. At the same time, a questionnaire was developed to identify the needs of potential users of the device. The questionnaire was distributed to a sample of 300 people, of whom 182 responded.

The characterization of the expressed needs / requirements is presented in table 2.1, as follows.

Table 2.1. Need Analysis

Expressed need	Parameter	Associated value
Be affordable	Price	< 300 RON
To provide me with the treatment for the necessary period	Storage space	14-30 compartments
Be easy	Mass/material	Max. 500g
Autonomy of 48 hours	Battery capacity	3300mAh
To be able to schedule my dose of medications Not to forget to take the medicines	Digital alarm clock No drawers	1 unit Min 3 alarms
Cannot be used by children	Locking system	1 unit
Not to recharge it very often	Recharge time	after 2 days
To alert me when I need to take the medicine	Sonorous Vibration	70 dB 120 Hz
Display the time	Digital screen	1 unit
Not to damage the drugs	Comprising	Appropriate hygiene rules
Not to mix up the drugs Taking the right medications	Automatic opening system	-
Connectivity	Association	Bluetooth connection

2.2. Functional analysis

Functional analysis is a method of researching the functions of a product and consists of identifying / determining, characterizing, ordering, ranking and evaluating functions. It can be used as an independent method in solving logical problems or as a method associated with Value Analysis in the design of a product [2].

The environmental elements and the connection of these elements with the product proposed for development are presented in Table 2.2.





Table 2.2. Functional analysis

Environmental elements	Actions of the environmental element	Main functions/ constraint
User	Helps to achieve the main function	FC1- Make it easy to use FP1-Provides protection of medicines
Watch storage place	Ensures storage of the watch	FC2- Ensures efficient compartmentalization FP2- Dosage of drugs according to an appointment
Charger	Ensures battery charging	FC3- To be ergonomic
Stored medications	Helps to achieve the main function	FC4- To be airtight
Eye	Helps identify the design	FC5- Keep your medications safe
Water/dust	Helps identify materials and protect them	FC6- To have a durable material
Medicines in compartments	Helps identify external material	FC7- Allows charging the battery
UV light	Helps identify external material	FC8- To have a pleasant design

2.3. Competing products

Following the research and documentation phase, 4 competing products out of the 30 analyzed both from the Romanian market and other states were among the most relevant products comparable to the present idea, as shown in table 2.3. [8].

Table 2.3. Competing products

Product	Features	Advantages	Disadvantages
 <p>E-pill 4</p>	<p>Dimension: 14.6 x 11.4 x 7.6 cm Material: plastic Number of compartments 4</p>	<p>The lids tightened on each pill box ensure that your pills do not drop when you are on the move. The set alarms will be repeated automatically every day.</p>	<p>Small pill organizer The duration of the alarm is 15 seconds. The material does not withstand stress Short battery life</p>
 <p>Ezy Dose</p>	<p>Size :14.5 x 14.5 x 4.2 cm Material: plastic Number of compartments 7 Bluetooth</p>	<p>Setup is simple, but requires some technical knowledge. The alarm is loud enough to wake you up.</p>	<p>The lid is not easy to close securely. The rotation does not lock, it can rotate freely. Very small compartments</p>
 <p>MedQ Daily Pill Box</p>	<p>Material: plastic Number of compartments 14</p>	<p>Provides treatment for 14 days Visual warning to indicate</p>	<p>It has no compartment locking system One to two alarms can be scheduled per day price</p>
 <p>Live Fine Bluetooth Pill Dispenser</p>	<p>Material: plastic Bluetooth Dimensions: 23.5 x 23.5 x 7.6 cm</p>	<p>It can be set up for up to 4 weeks The digital interface is very clear, and the lock cover prevents unauthorized access to the pills</p>	<p>Works with batteries It allows the transfer of several pills from one slot to another, allowing a patient to overdose on a drug.</p>

Following this analysis, it was found that none of the identified products offer the safety system with which the dispenser proposed by the authors will be equipped/innovated with.

2.4. Market segmentation

Market segmentation is a marketing term that refers to the division of customers into groups or segments with common needs. Dividing into smaller parts allows potential producers to target different categories of consumers who perceive the value of certain products or services differently. Segmentation is, in fact, a supplement to market research that seeks to identify target groups in order to design a product and its brand in the most attractive way possible for the group [2].

Therefore, analyzing the culture of major countries, it was observed that there are no different habits in the use of the product for the administration of pills, and that regardless of race or religion, customers who buy the dispenser pursue the same way of using these products. Thus, it was concluded that there is no need to segment the market geographically for the proposed product.

2.5. Target customer profile

According to statistics, both females and males have the same degree of interest in purchasing a pill box watch because they feel the need to maintain a healthy lifestyle. In conclusion, the most favorable market segment for the sale of our product is made up of potential customers in the category of people older than 55 years, because they have a much higher degree of interest than the other categories, having a much higher need for themselves as well as for those close to them.

In addition, revenue is an important element in terms of its acquisition. Also, other potential buyers are nursing homes and hospitals, this product helping to distribute medicines in an easier manner for their patients, thus streamlining the internal distribution of medicines.

3. Development of technical solutions

The selection of the concept is often done in two stages, as a way of handling the complex process of evaluating dozens of product concepts. Sorting concepts consists of a rough and quick assessment of some viable alternatives. Conceptual evaluation is a more accurate evaluation of a few proposed concepts in order to choose a single concept, with the maximum probability of leading to a successful process [3].

In an attempt to identify the concepts, all team members developed their own concept, these are shown in Figure 3.1.

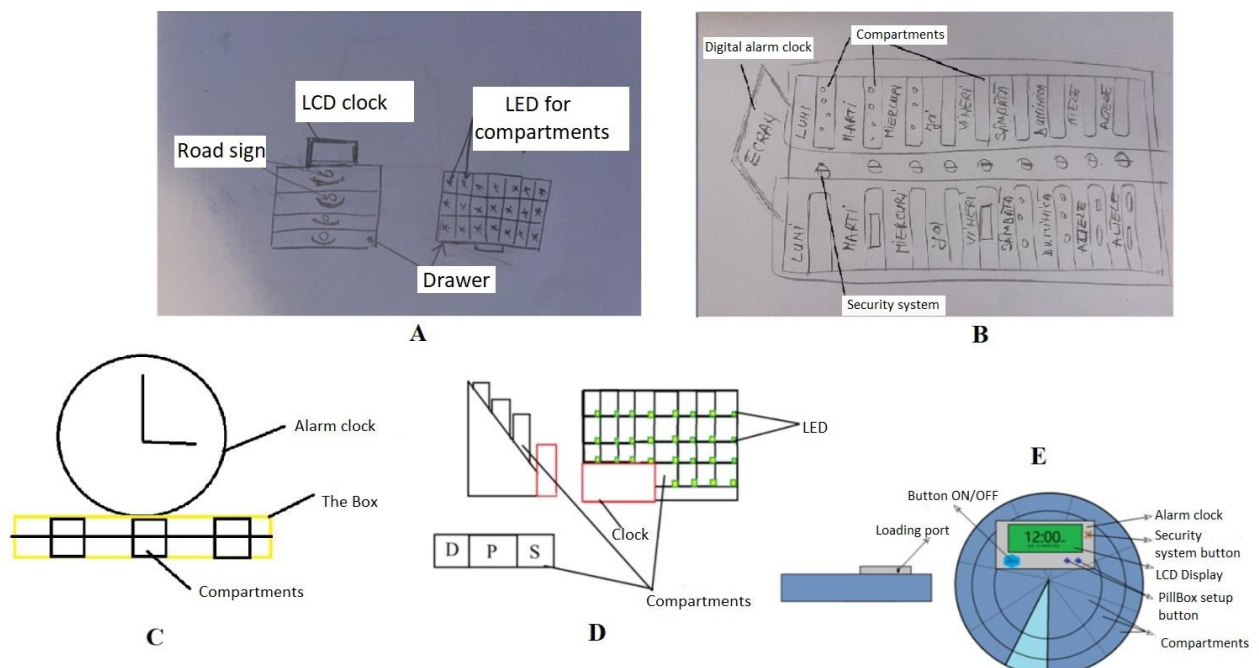


Fig.3.1. Concepts

In order to choose the concept for development, a hierarchy of concepts was made based on certain criteria, namely:

- Criterion 1 - Component production costs
- Criterion 2 - Drug safety system
- Criterion 3 - Type of drive
- Criterion 4 - Product design
- Criterion 5 - Use of software

After ranking the criteria and concepts, their comparison was made, as presented in table 3.1.

Table 3.1. Comparison of technically possible concepts

Criterion	%	Concept A		Concept B		Concept C		Concept D		Concept E	
1	33.3	5	166.5	5	166.5	5	166.5	2	66.6	3	99.9
2	33.3	4	133.2	4	133.2	2	66.6	3	99.9	4	133.2
3	13.32	4	53.28	5	66.6	3	39.96	4	53.28	5	66.6
4	6.66	3	19.98	4	26.64	1	6.66	5	33.3	3	19.98
5	13.32	4	53.28	5	66.6	1	13.32	3	39.96	2	26.64
Ranking		20	426.24	23	459.54	12	293.04	17	293.04	17	346.32

Following the analysis of the concepts and their comparison, the number two concept was chosen for further development, taking into account the most expressed needs of consumers. It offers generous partitioning, and is also designed to meet the primary need, with a mechanical-electronic drive, equipped with an LCD screen. In addition, an automatic safety system is desired, so the compartments are opened by the integrated system.

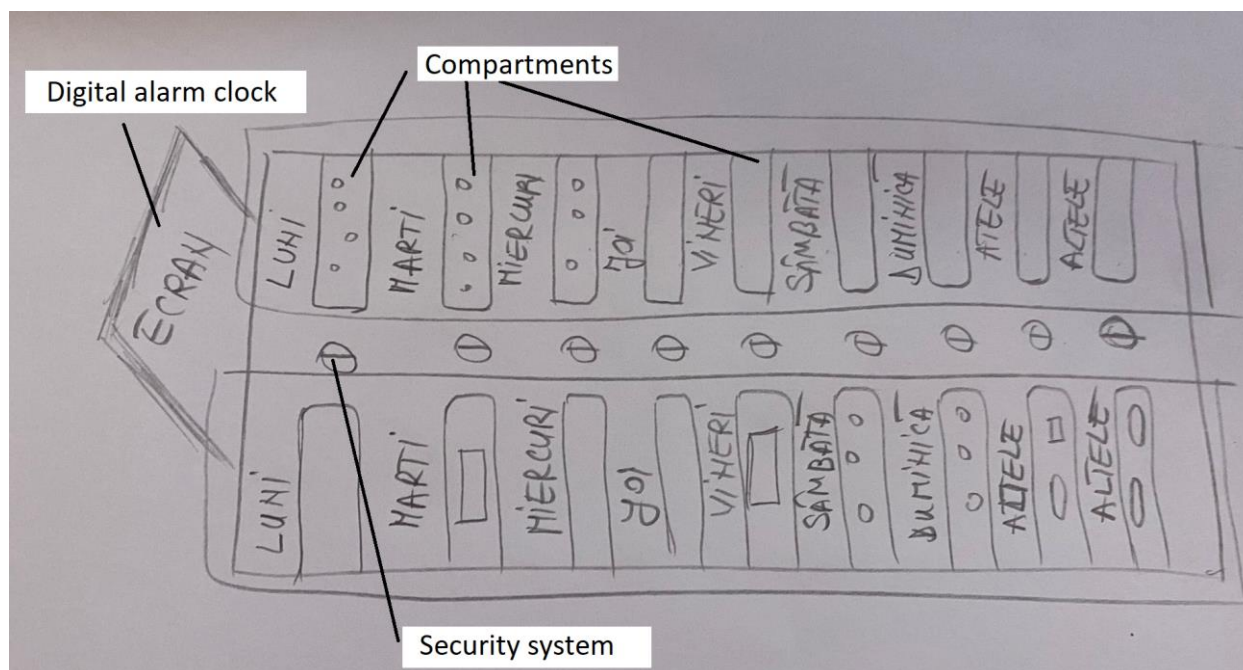


Fig.3.2. Concept B

4. Design of the chosen concept

The product "Smart Dispenser" consists of the appropriate box, medicine compartments, and each space contains an LED to indicate the drug to be administered, a clock-style screen that is equipped with a software system for setting alarms, and the system implemented to secure the compartments, to prevent them from being easily opened by children.

A first iteration of the technical solution design is shown in Figure 4.1. The compartments are operated by a mechanical system, so the user can administer their medication by pressing the lock button that will allow it to open.

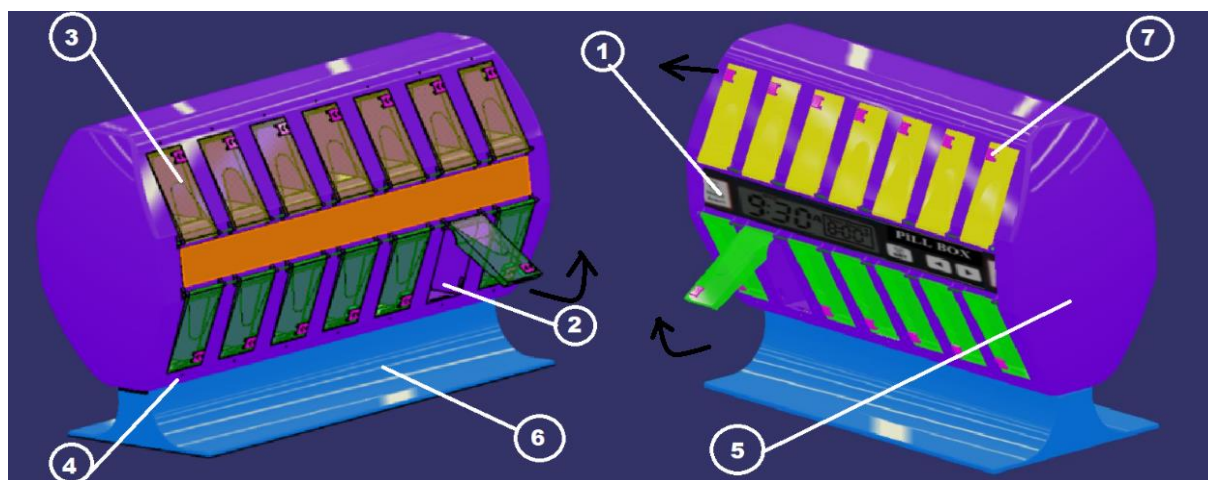


Fig.4. 1. Concept B- the first iteration

The components of the concept are shown in Table 4. 1:

Table 4.1 Components of the concept

Item No.	Components	Component description
1	Digital clock	Component to be integrated as a whole
2	Compartments	It is made of a material that protects the medicines from moisture, so as not to degrade. Its main function is to keep the drugs safe.
3	Transparent covers	It ensures the sealing of the compartments, having a not very hard polymer material.
4	LED	Indicates the subdivision of the drug to be administered according to the scheduled alarm
5	Housing	It is made of a solid material, which has the primary role of protecting the dispenser components.
6	Support	It is made of a hard material, which has a supporting role so that the housing does not degrade. Its main function is to keep the housing safe.
7	Compartment locking system	Functions automatically
8	Microcontroller	It is designed to be programmed to control dispenser operating modes (ESP32 D1 Mini)

It was also identified another technical solution by which the dispenser can dispense the medicines in a more efficient way, namely: the compartments at the top are provided for storage, and with the help of a magnet-operated pallet will allow the passage of a single tablet to the bottom. The main components of this device are shown in Table 4.2.

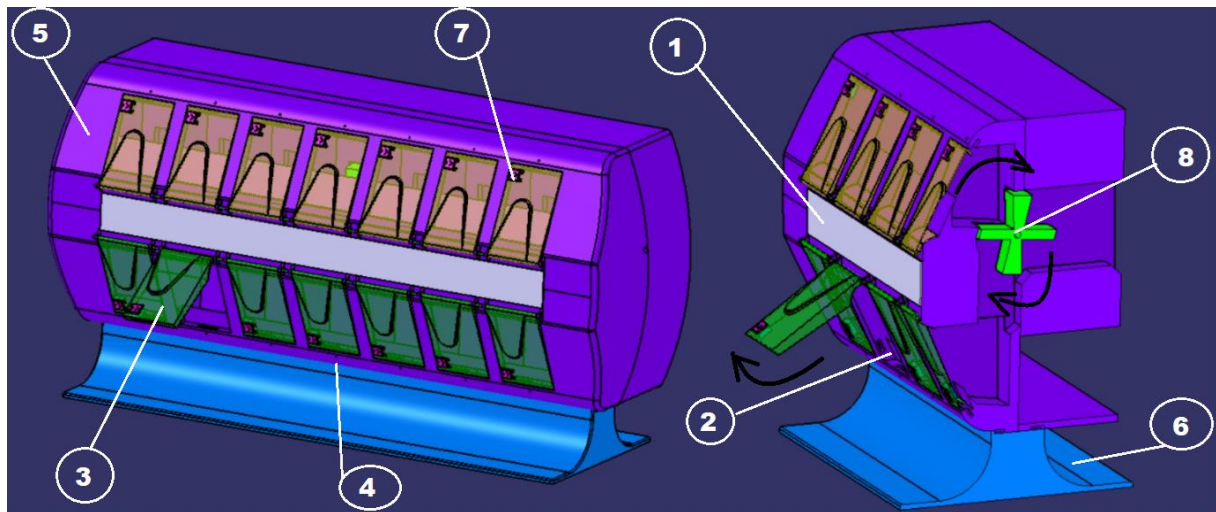


Fig.4.3. Concept B- second iteration

Table 4.2. Components of the concept

Item No.	Components	Component description
1	Digital clock	Component that we want to purchase and adapt to our system.
2	Compartments	It is made of a material that protects the medicines from moisture, so as not to degrade. Its main function is to keep the drugs safe.
3	Caps transparent	It ensures the sealing of the compartments, having a not very hard polymer material.
4	LED	Indicates the subdivision of the drug to be administered according to the scheduled alarm
5	Housing	It is made of a solid material, which has the primary role of protecting the dispenser components.
6	Support	It is made of a hard material, which has a supporting role so that the housing does not degrade. Its main function is to keep the housing safe.
7	Compartment locking system	It works automatically
8	Palette	Helps with the dosage of drugs
9	Microcontroller	It is designed to be programmed to control dispenser operating modes (ESP32 D1 Mini)

Finally, the two technically feasible conceptual solutions presented above should be able to be supplied with (compressed) drugs, be scheduled, release a dose of drugs according to a schedule, give certain notifications during operation and operate in optimal parameters.

5. Conclusions and perspectives

The project is based on the development of a smart dispenser product to support people undergoing medical treatment.

In the first part of the paper, the identification of needs and the choice of a product idea through a criterion analysis was made. Following the needs analysis on the chosen product, these

needs were identified and conceptualized based on answers to the questionnaire by its potential users.

Following the analysis resulting from the segmentation of the market and the choice of the target segment, it was proposed to achieve the profile of the target customer, according to well-established criteria. Also, there are no competitors on the Romanian market for this type of product, finding the US market as a competitor, this fact emerging from the analysis of the competition.

Putting into practice the previously obtained data, we developed five concepts to meet the needs for this product, and following the ranking of criteria and concepts, as well as their comparison, a concept was chosen for further development in CAD type software.

The concept chosen in the current stage is integrated in the development of the technical solution. The design and development of the electronic subsystems and the definition of the working modes to be programmed are to be completed. Next year we will try to experiment and test the functionality of the main subsystems and also prepare a prototype that best reproduces the proposed functions and services.

Finally, an optimized technical solution will be developed through several iterations in which we develop, design, dimension, test and prototype, to respond to every requirement we set out to fulfill.

In conclusion, the main target of the research was to obtain a product in line with current technological requirements, a device that will come to the aid of numerous people both in Romania and Europe.

6. References

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