

Re-Engineering of the Vending Machine in Saudi Arabia to Improve the Functionality of the System

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Summary

With the expansion of technology, the vending machine has become widespread around the world, as it saves time and effort for the customer and allows them to abandon the old systems that take their time and be complicated. Re-engineering is the examination and alteration of a system to reconstitute it in a new form. Also, the re-engineering process is considered as a software engineering methodology when the existing system needs to the evolution process. This research aims to re-engineer to improve the functionality; risk re-analysis, re-engineer of the requirements, and redesign the functions developments of the vending machine. This research proposes to add some features such as making multiple payment methods available and the ease of replacing, returning the product, and redesigned using the UML diagrams to demonstrate the development processes that are proposed. The development of the vending machine has been reached as it has become easier and more flexible to use and solve the most common problems while providing safety while using them. A questionnaire was conducted for the public to take samples and make suggestions, including adding the feature of replacing the product after leaving the vending machine and their approval rate was 76%, the other feature is sterilizing the products and the result of their support 95.6%, in addition to service to recover the remaining money their approval rate was 94%. And after collecting opinions, it was confirmed that our proposal is useful and appropriate for the development of the vending machine when applied to society to improve the functionality of the system.

Key words:

Software Engineering - Re-engineering - Requirements – Risk Analysis – UML (Unified Modeling Language) – Re-Design.

1. Introduction

The concept of technology is wider than just computers and engineering. Technology affects everything that people do every day, regardless of their interests. Technology can be defined as a branch of knowledge that depends on the innovation process, the use of modern technology means and linking it to daily life, society, and the surrounding environment. While painting on industrial arts, engineering, applied science, and pure science, technology can also be defined to get the job done using multiple methods and artistic and cognitive methods.

Through technology, people will be allowed to abandon traditional, complex, and difficult systems and replace them with modern technologies. Among these new technologies was the manufacture of self-service vending machines [1].

The first vending machine appeared in Japan in 1904, and it is related to a postal machine and related card. The machines were developed in Tokyo in 1956 and started spreading all over the world, and the customer can put the money in the port assigned to it and then click on the product code that he wants to buy to take it out directly from the port of the product, in this research, we will develop the self-selling machine in terms of increasing payment methods Your own so you can pay with a credit card, coins, and money-back [2].

This article aims to propose new features that improve the functionality of the system by using software re-engineering technology. The remainder of this article is arranged as follows. Section 2 presents the related work on vending machine development and re-engineering concepts. Section 3 describes the proposed methodology. Section 4 presents our results. Finally, Section 5 concludes our research work.

2. Related work

In [3], The authors have a design for selling self-service machines and they are connected to a mobile phone, so the user can check the presence of a vending machine near his phone, and vending machines are the future of e-commerce, and they achieve great social benefits for society and provide convenience to users, and to achieve this design was using GPS technology where it was the algorithm used to match the data in the fingerprint database, and the result of this study was that the selling device linked to the phone and the wireless network was designed using the neural network algorithm, which could be a preliminary solution the authors have linked the vending machine to the mobile phone and this idea is very good and wonderful as they have also integrated the location of the vending machines, in our research we have

a proposal for additional services in the vending machine so that the customer can exchange the product and return the money and be paid using the card fiduciary.

In [4], the authors considered the problem of selling ready-to-eat foods in light of the rapid developments taking place in this era. The self-sale vending machine is designed based on automatic invoicing that contains all information about the selected products and their final total and also depends on FMS, and also based on order cancellation and refund amount, FPGA based machines used in this way are used better than traditional machines. This method is characterized by being more flexible and we can program it, and one of the most importantly final results is that the FPGA-based self- service vending machines provide a quick response and an increase in sales and shopping when used by any ordinary person and can be used in different places such as restaurants, hotels, and food streets because of its advantages, in our opinion, this paper is very good for developing a vending machine to keep pace with the current development, especially when developing the requirements required for users, in our research we have suggested requirements such as refunding and canceling the process to provide a flexible and easy to use the system. Here are the similarities in the system that we want to develop and the system here to make the system flexible and easy.

In[5], The authors improved logistical vending machine systems and proposing a model for improving product allocation within the vending machine under constraints of fixed re-stock cases. Simulation of optimization leads to clear benefits for managing logistics operations. The simulation component provides decision-makers with a more comprehensive view of the actual implementation of the solution. Effectively, the combined use of simulation and optimization methods provides managers with improved information to decide both: (1) the most beneficial product group, and (2) the quality of the proposed restock schedules. However, it has not yet been specifically applied to logistical vending machine systems, but In our research, we have a proposal for additional services in the vending machine so that the customer can exchange the product and return the money and pay it using the credit card.

In [6], the authors started their research by how vending machines started from London to be used to sell postcards. Currently, most countries use vending machines are Japan, Malaysia, and Singapore. The purpose of this research is to design a reliable vending machine easy to manage. The payment process is done by selecting the customer, entering money, delivering the product with the possibility of returning the rest of the money as needed as they successfully designed it like that. In our research, we proposed similar machine features as it will be very helpful due to its availability at all times and places and

can be easily reached. Also, not forgetting to mention that in comparison with old school selling shops, vending machines are running without high operating and maintenance costs.

In [7], The authors showed in this study about the culture of a vending machine through services that have already been provided or may be implemented in the future. Also, they discussed future possibilities for an advanced sales culture around the world. The sales increased because the self-selling machines enabled the purchase over the 24 hours, so many ideas were put forward that help in using the machines more, such as serving the elderly and the handicapped, by making the vending machine characterized by an easy and comfortable design for customers. We think that this study is good and we hope it will be applied in all countries of the world to achieve comfort and security for society and raise the level of sales. But in our research, we have a proposal for making the vending machine coexist with the community by providing comfort and services commensurate with all customers by adding some other features and developments.

In [8], the authors in this study mentioned about the role of price in buying healthy meals and low-fat meals from vending machines. The importance of this study lies in limiting the purchase of harmful foods and testing their success in motivating the consumer to purchase healthy foods, and preventing or delaying the development of diseases resulting from chronic malnutrition. This experiment was conducted at the university for 10 weeks in cooperation with university food and sales services. Nine vending machines were targeted at four locations and the results were outside total sales. Vending machine sales significantly increased when prices for healthy meals were reduced. We think that this study is good and we hope that it will be applied in health facilities and clubs to suit it with members of the health and sports community. In our research; we will provide complete freedom for the user to choose what he wants to buy and provide the convenience for the user and make it easier for him to buy what he wants in the way he wants and not to commit to a specific type of mandatory food or a mandatory payment method by providing the user with new services such as the full return of the product and cashback service to the user. Replacement of the product in case the user mistakenly chooses another product. The user recovers all of his money. Providing the user with more payment options in this study, we strive to serve the freedom of users of vending machines.

3. Methodology

We propose the reverse engineering model that includes three phases: In the first phase we analyze the risk for the system. In the second phase, we re-engineer the

requirements. Finally, in the third and last phase, we re-design the system using UML diagrams showing the new function that proposes. In the figure (“Fig.1”) a flowchart is designed for describing the process of the proposed system functions, where the blue functions represent the new functions that are proposed in the system(vending machine).

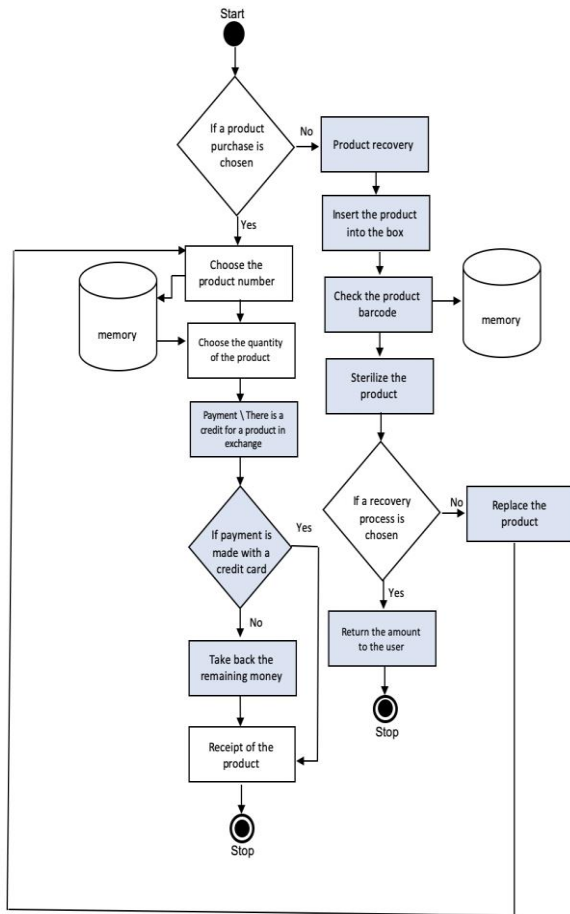


Fig. 1 A flowchart describing the process of the proposed system functions.

3.1 Risk analysis

In this section, the risk analysis is proposed as the first phase of the re-engineering stages. The risk is analyzing in the following table (Table.1) indicating the proposed risk, risk description, the probability, and the effects that are expected. The probability of risk takes the values: Low, Moderate, High according to the percent of occurrence. The effects of a risk take the values: Tolerable, Serious, Catastrophic according to the effect of the risk.

Table 1: Risk analysis of the vending machine system

Risk	Possible Risk	probability	Effects
Political	Failure to obtain approval or permission to do some necessary work on time	Moderate	Catastrophic
Organizational	A competitive product is marketed before the the system is completed.	Moderate	Serious
People	Key staff is ill and unavailable at critical times.	Moderate	Serious
Organizational	Organization financial problems force reductions in the project budget.	Low	Catastrophic
Tools	Software tools cannot work together in an integrated way.	High	Tolerable
Requirements	Change to requirements that require major design rework is proposed.	Moderate	Serious
Political	Failure or agreement with the municipal authorities, city councils, or other political bodies.	High	Catastrophic

3.2 Requirements Re-engineering

This section indicates the requirements re-engineering that is the second phase of the proposed system re-engineering including the following stages: Analysis of hardware and software resource requirements and the system requirements development

3.2.1 Analysis of hardware and software resource requirements

In this section, the list of hardware and software resource requirements are analyzed.

- Providing an additional device in the vending machine to provide credit card payment service.
- Add control buttons so that the user can choose the process such as a replacement or a refund of the remaining money.
- Add an outlet in the vending machine so that the user can retrieve the remaining money.
- Add a device that sterilizes products before they are received and after they are retrieved by the user.
- Add a laser device that reads the returned product barcode.
- Adding software that helps calculate the remaining money paid if it is available.
- Add a program that checks the barcode for the

product to be retrieved to know if it was opened and used by the user or not, and show a message to the user via the screen in case the product is open.

3.2.2 System Requirements development

In this section; the system requirements are developed to the following categories: Functional requirements, Non-functional requirements.

3.2.2.1 Functional requirements

The functional requirements that are proposed to add or updated are listed in the table (Table 2) below:

Table 2: User and system requirements

User	System
1- Selecting product	1.1- User will choose the product number 1.2- User will determine the quantity 1.3- The user confirms the product by choosing OK
2- Paying needed amount	2.1- User will enter the needed amount
3- Collecting the selected product	3.1- User will open the box to collect the requested product
4- Returning the amount change if any	4.1- User will collect the returned amount change if any.
5- Returning the product	5.1- Users will have an option to return the product.
6- Sanitizing the returned product	6.1- User will put the product in the returning box and the machine will spray sanitizing liquid over the product.
7- Allowing usage of the remaining balance or returning back	7.1- Users will have two options, either to rebuy another product or to return the balance.

3.2.2.2 Non-functional requirements

Non-functional requirements are defined as a condition that defines a standard by which the system can be judged, but does not specify a particular behavior. The non-functional requirements are categorized into product, organizational and external requirements.

-Product requirements

The product requirements are listed below:

- The interface design is easy and clear to provide ease of use and flexibility for the user and effective performance.
- It provides flexibility and ease in handling orders.

- Responding to and prompt execution of purchase requisitions.
- Clarity of the ordering process to the end of the process.
- High security in the available payment methods.

-Organizational requirements

The organizational requirements are listed below:

- The machine does not accept the non-Saudi currency
- The product must be delivered on time and not delay
- The deity must be compatible with the surrounding community, for example in the Islamic community. The deity should not include forbidden foods or contain inappropriate posters. Also, for children when the vending machine is close to a children's school, there should be no harm to their health or thought.

-External requirements

The external requirements are summarized as; The method of storing foods in the machine complies with the standards of the Ministry of Health in the Kingdom of Saudi Arabia for storing foodstuffs such as temperature, air conditioning, ventilation, and classification of foods.

3.3 Re-designing the vending system

In this paper, we have redesigned the vending machine, so that after what has been discussed in section 3.2 with the requirements, redesigning has been done: Class diagram it explains the system structure and relationships between the system objects and also has been designed Use case that it explains the scenario of the system and also the relationships in the system.

3.3.1 Use-case diagram

The proposed system is designed as a use-case diagram that is one of the UML diagrams. In the use-case model: we design one actor called a customer and six cases present the proposed features. Figure 2 (“Fig.2”) shows the design of a use-case diagram for the proposed system.

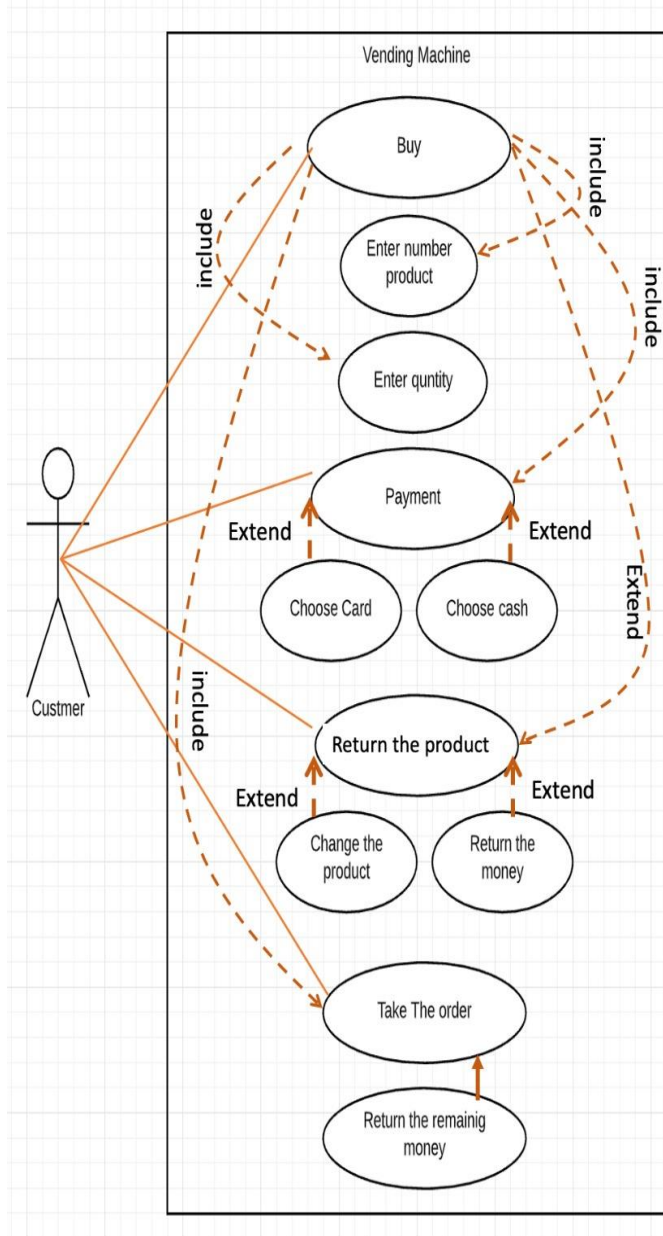


Fig. 2 Use-case for the proposed system.

3.3.2 Class diagram

The proposed system is designed as a class diagram which is one of the UML diagrams that present the structure of the proposed system and the proposed relationships. Figure 3 (“Fig.3”) shows the class diagram that is proposed.

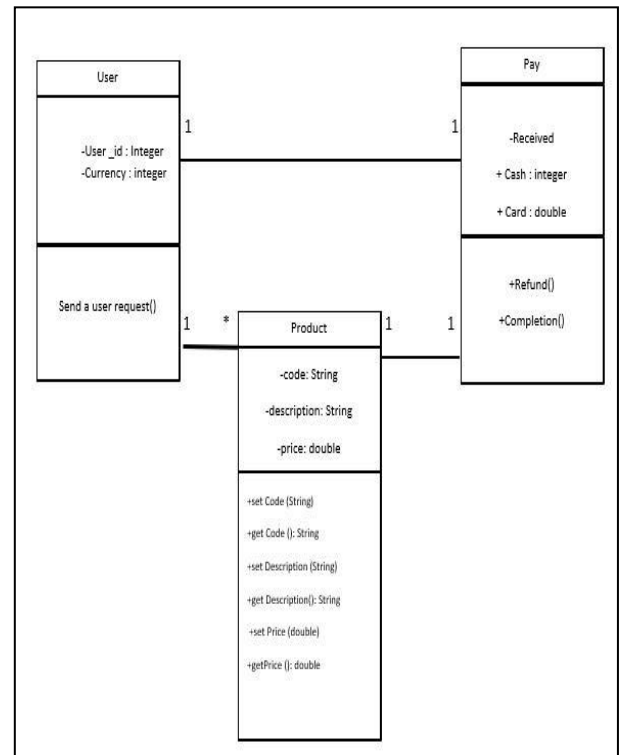


Fig. 3 Class diagram for the proposed system.

4. Results and discussion

Through our research, we achieved good results than those used by traditional methods, as well as those discussed in previous studies. We also provided ideas and solutions to the problems many users face to make using vending machines easier and more flexible. Our proposal has been done among phases to add some features, such as the availability of many payment methods and the ease of replacing the product and returning it. The payment method has been developed as cash or card to make payment methods more flexible for the customer, non-commitment to a particular method, and the ability to complete the purchase process easily and conveniently. To ensure the quality of the services provided, the product replacement or return service has been put in place, and to verify the safety of the products that are to be returned or replaced, a transparent cover and bar code is placed on all products so that if the customer wants to return or replace the product, it will be placed in the box designated for it and verify the product by scanning the barcode, sterilizing the product, returning it to the product queue, and returning customer benefits to it. Redesigned the UML template to demonstrate user development. We designed a flowchart that shows the progress of operations. It results

of the questionnaire that was conducted for the public to take samples and make suggestions, 76% agreed to return the product after leaving the vending machine, and they added the feature of replacing the product, and the other feature is sterilizing the products and their support result 95.6%, in addition to the remaining recovery service, the approval rate was 94%. After collecting opinions, it was confirmed that these suggestions are useful and appropriate for developing the vending machine when applied to society to serve the system. We can say that we can develop vending machines to provide the best service in the future for their customers.

5. Conclusions and recommendations

Finally, in light of the rapid developments, we aim in this research to develop a self-service vending machine to provide many new features and services that help in the use of food vending machines further while solving the most common problems experienced by most people when using machines, and we also aim to develop to give the user complete freedom to choose the appropriate payment method and not to adhere to the specific payment method, we also seek to add the sterilization feature in the food receipt box and provide new services to the user as I mentioned previously such as the full return of the product and the cashback service, and the replacement of the product if the user chooses another product. By mistake, the user recovers all of his money and provides the user with more payment options. The system becomes flexible and easy to use system with these modern features. In my opinion, as a researcher, We think the availability of vending machines is important in all public and private facilities, and we recommend in the future that they are deployed in all places on a wider scale and that all facilities and installations contain vending machines.

References

- [1] https://mawdoo3.com/%D8%AA%D8%B9%D8%B1%D9%8A%D9%81_%D8%A7%D9%84_%D8%AA%D9%83%D9%86%D9%88%D9%84%D9%88%D8%AC%D9%8A%D8%A7 (access on 6/6/2020)
- [2] K .Segrave, "Vending machines: an American social history" ,McFarland, 2015.
- [3] L .She, "Design of removable vending machine and research on the key implementation technology." ,The Journal of Engineering 2019,13 (2019): 402-405.
- [4] A.Monga,S. Balwinder, "Finite state machine based vending machine controller with auto-billing features." ,arXiv preprint arXiv:1205.3642 (2012).
- [5] H.Grzybowska, "A simulation-optimisation genetic algorithm approach to product allocation in vending machine systems." , Expert Systems with Applications 145 (2020): 113110.
- [6] A.Gondane, R. K.Saw, J. M. Walde, S. J. Bhandekar, N. J. Pathan, "Snacks and Cold Drinks Vending Machine. International Journal of Research", 3(3), 560-563. (2016).
- [7] T.Yokouchi, "Today and tomorrow of vending machine and its services in Japan." ,2010 7th International Conference on Service Systems and Service Management, IEEE, 2010.
- [8] F. Simone, "A pricing strategy to promote low-fat snack choices through vending machines." American Journal of Public Health 87.5 (1997): 849-851.
- [9] <https://www.linkedin.com/pulse/%D8%A3%D9%86%D9%88%D8%A7%D8%B9-%D8%A7%D9%84%D9%85%D8%AE%D8%A7%D8%B7%D8%B1-%D9%81%D9%8A-%D8%A7%D9%84%D9%85%D8%B4%D8%B1%D9%88%D8%B9-abdelrahman-gayel> (access on 3/4/2020)