Mobile Application Based on Crowd Computing and Operational Research for Optimization of Purchases

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ABSTRACT

This article aims to demonstrate the development of a mobile application to optimize purchases in supermarkets, through the use of crowd computing techniques and linear programming. The application developed has the characteristics of a mobile application, in according the great absorption of the population by this type of software, including the population with low purchasing power which suffers the consequences when an economic crisis presents itself. The tool uses Crowd Computing techniques to obtain price information and promotions. In addition, it uses Linear Programming concepts and algorithms to calculate the optimal purchase for the user, which does not require great knowledge in technology and economics. This application aims at the use of Information Technology and Operational Research to assist society, in periods of financial crises, with a focus on supermarkets purchases.

KEYWORDS. Crowd Computing. Cloud Computing. Crowd Sourcing. Operational Research

Introduction. Theoretical Reference. Materials and Methods. Results. Conclusion

1. Introduction

Is it possible, through the mobile applications (which are easy to handle and understand, but robust and equipped with technologies based on Operational Research and Crowd Computing), assist the population in an activity as important as grocery shopping?

The smartphones and cloud technology (also known as cloud computing) has been available for the layers of society, through the technology advances. Those elements allow developments of robust applications at low costs and, with the aid of crowd computing (an information provided by collaboration a people crowd for a particular purpose), those software can optimize daily – and important – tasks [Roughton et al. 2011].

Cloud and Crowd technology has brought great benefits to society. In addition to real-time information, information collaborations can influence daily situations. It is possible, e.g. the dissemination of information such as traffic accidents or congestions, relief to victims of natural disasters and other information of society's concern. In addition, the e-commerce increasingly relies on crowd computing technology to classify products and services [Viswanath et al. 2015].

Such as the logic of the collaborative network in e-commerce, the crowd computing can be implemented in physical stores such as supermarkets, entertainment services and electronics stores through a mobile application. This can be a way of influencing how the market establishes its prices and quality of services [Roughton et al. 2011].

Crowd Sourcing is source of information developed to be accessed and filled by a multitude of people through an open call for contributions [Tranquillini et al. 2015]. This concept is used by some websites, where anyone can contribute (e.g. Wikipedia is a collaborative encyclopedia) [Kucherbaev et al. 2012].

A technology based in concepts of Crowd Computing and Crowd Sourcing can assist in the classifications of services and prices practiced by the market. A platform for mobile technology can be focused for this purpose, making feasible to link information in databases and information mining, making surveys of elements that can contribute to the consumer to have products at more affordable prices and quality.

Among interactive media, mobile technology stands out, as it promotes interactivity associated to mobility and portability, besides grants the user communication [Pietrzyk et al. 2011].

In 2015, there was an absolute reduction in the number of users that accessed the Internet through a microcomputer, from 28.2 million households in 2014 to 27.5 million in 2015 in Brazil. By 2015, all regions began to browse the internet over the mobile devices. The North Region has the highest percentage of households that used the mobile Internet access (96.7%), followed by the Midwest (95.6%), the Northeast (93.9%), the Southeast (91,5%) and the South (88.2%) [IBGE 2016].

The Brazilian economic crisis in 2014 is the consequence of a combination of supply and demand shocks, resulting in errors in economic policy management [Orair and Gobetti 2017]. Brazil has 51% of the adult population (over 66.3 million people) with complete elementary education in 2016 and 50 million Brazilians (25.4% of the population) are in the poverty line [IBGE 2017]. This demonstrates the need for savings at the time of purchase.

Considering the aforementioned problems, this article aims to demonstrate an evaluation of the application of crowd computing in daily actions. This analysis focuses on the consumption of customers in supermarkets and counts on statistical analyzes, experiments with prototypes and a proposal of optimization based on operational research. The specific objectives are:

- Analyze the target-market and estimate the demands to be met through Crowd Computing;
- Evaluate the dynamics of operation that can be performed with an application based in Crowd Computing;
- Perform the requirements survey for the development of a prototype;
- Test and verify the results that the prototype presents for the proposed objective;
- Analyze viability of information consolidations, possible behavioral effects of users and social impacts;

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- Research feasible optimization methodologies, based on Operational Research, for the process of analysis of purchases and promotions.

Subsequent sections of this article are organized as follows: Second section presents a theoretical referential, besides platform with similarities to the proposed system; Third section presents materials and methods; Fourth section presents results; Fifth section presents the conclusion and references.

2. Theoretical Reference

In the research, references were used that address concepts of Crowd Computing, Software Engineering and Mobile Programming.

2.1 Software Engineering and Mobile Applications

According to Pressman and Maxim [2014] software engineering is defined as a layered technology, being represented by tools, methods, process and focus on quality. Based on the process layer, Software Engineering keeps the layers of technology in harmony and feasibility for software development in a planned and time-set manner.

Software engineering involves a set of methods, process and a range of tools that allow the development of high-quality software [Pressman and Maxim 2014]. As stated by Pressman and Maxim [2014], software engineering provides exceptional software quality (what motivated its use in the solution developed).

Mobile applications are software developed for handsets such as smartphones (considered small computers). These applications have specific considerations for their development, allowing the availability of real-time interaction of people as for example in social networks [Murray et al. 2010]. Due to the increase in the purchase of a mobile device, it is growing more and more developing applications, which makes its development more profitable due to this growth.

2.2 Crowd Computing

Crowd Computing is a term that defines thousands of tools. They allow the sharing of ideas and non-hierarchical decision making [Viswanath et al. 2015]. It is the full utilization of the enormous global cognitive capacity, making feasible the collaboration in large, sometimes global, projects. Crowd computing brings together the strengths of Crow Sourcing, automation and machine learning [Parshotam 2013].

There is no widely held definition within the computing literature for the term Crowd Computing, but it combines mobile technology and social interactions [Li et al. 2015]. Crowd Computing performs an important role in society as it can influence business decisions and helps society itself with public information such as storm warning, accident and others [Vishwanath et al. 2015].

Kittur et al. [2013] presents a structure that represents the organization of works based on computing elements, that can be supported by crowds, as shown in Figure 1. Such a diagram demonstrates the elements that are present in Crowd Computing. In the case, such a structure of work is focused in a task demand and resides in a platform. In this point, there is a decomposition of tasks to be performed (as well as the assignment of each one of them). In the same structure in Figure 1, in also represented are the workers, each with their motivation, who contribute with the resolution of each task.

With the components already aligned, there is the process of assigning tasks, collaboration and guaranteeing the quality of the results, which defines the proposed workflow, generating the output (or final answer). This theory bases and summarizes the solution developed in this article.

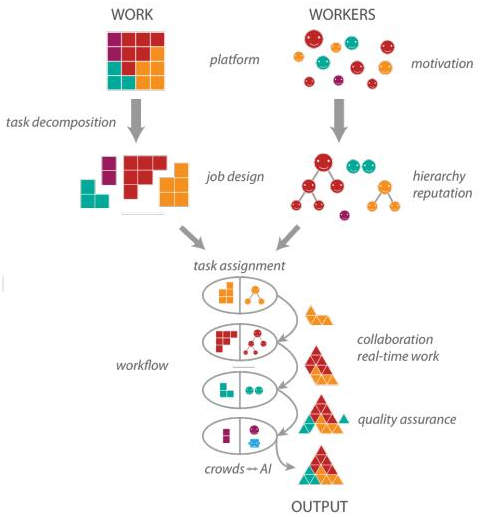


Figure 1 – Crowd Computing Framework

2.3. Related Works

Some related works address the methodology proposed by Crowd Computing, such as Honeybee and Open-Phylo which are academic bias works and PagPouco, Whereabouts, and Waze in which it has market bias.

Honeybee, a multi-user mobile application based in collaboration for searching, viewing, image checking and comparison, audio transcription, data processing, information gathering, and other related active or passive user collaboration [Fernando et al. 2012]. Open-Phylo is a crowd computing platform available to all scientists to share to thousands of collaborators to solve some fundamental problems related to Genomics, which is the study of complete DNA sequence [Kwak et al. 2013].

PagPouco is an application developed by Bruno Fernandes and Ricardo Forte. After finding 5 different prices of a product in several supermarkets, it has been seen the need to develop an application that can help the citizen at the time of purchase [Exame 2017]. Aonde Convem is a platform developed by the ShopFully group, an advertising platform that offers information about promotions to consumers, with points of sale near their home [Aonde Convem 2017].

Waze is a mobile device application to guide drivers to the best route to their destination, taking into account traffic, accidents, police, hazards, events and the possibility of saving time on the route, showing available (but unkown by the user) routes [Waze 2017].

QQCusta is an application that makes comparison of prices through queries. This application uses the users as collaborator to feeds information of the invoices generated through the QR code. The company started in February 2016 through startup system, but not limited to the price comparison of supermarket products, also includes price of gasoline, medicines and other products [QQCusta 2017].

The most similar applications to the proposed solution are PagPouco and QQCusta. The PagPouco resembling, therefore, it offers products with supermarket prices. However it does not allow the user to contribute with price information as they focus on the sale of consumer feedback through the B2B. The QQCusta feedback allows the user to contribute with values of the products by reading the QR code of the invoices and making shopping list using comparisons through collaborative information, but there is not an optimization in the purchase recommendation process.

So, the proposed application has, as main differences to the others, a characteristic of focusing on the contribution of users in relation to prices and product promotions in addition to presents an optimized purchase recommendation (based in Operational Research concepts and algorithm).

3 Materials And Methods

This research intends to study about Crowd technology and its applicability. The understanding of this branch of computing, may provide the guidelines to understanding of the feasibility of applying Crowd Computing in a software based in mobile applications to supermarkets. The following is the detailed work guidelines:

1. Market demand assessment and the applicability of Crowd Computing;
2. Elaboration of feasibility research of the project, taking into consideration the society collaboration;
3. Definition of application requirements;
4. Simulation of prices and costs.

Through the research method (activity 2), it is intended to demonstrate if the community is willing to collaborate with information for the application. A positive result can allow the development of a software based in the proposed fundaments. In this demand research, an investigation was conducted that considered the questions that assess whether there is availability and interest of the people in collaboration (information and updates) for their own benefit (and the others users), through a mobile application [Roughton et al. 2011].

So, in activity 3, it was performed a Prototype Development: First, the application requirements were defined for the prototype to be developed, implemented and tested. For the development of the prototype of the mobile application, was applied the Java language for the Android operating system (Android Studio as IDE). During the survey of requirements for the operation of the application, were evaluated resource issues and taken into account the functionalities of the application (and its requirement for operation) [Roughton et al. 2011]:

A - Dynamics And Business Rules: The focus of the solution are customers who have the need to know which supermarket is best for them to make their purchases, with better prices. With the possibility of divergence, the users can contribute by providing the values of the products (what involves the mobile technology and crowd computing, connecting all this to the application). The 3 main user communications with the application will be in the price comparison, assembling the shopping list and updating of obsolete prices. The flowchart in Figure 2 demonstrates the main business rule of the application: the user can use two main paths, create a shopping list and compare the price of the same in several supermarkets (according to their location), or he can check the price of item to item, choosing whether or not to update the price of the item (in case it is obsolete). After checking the price of the product, the user can add the same to one of his shopping lists.

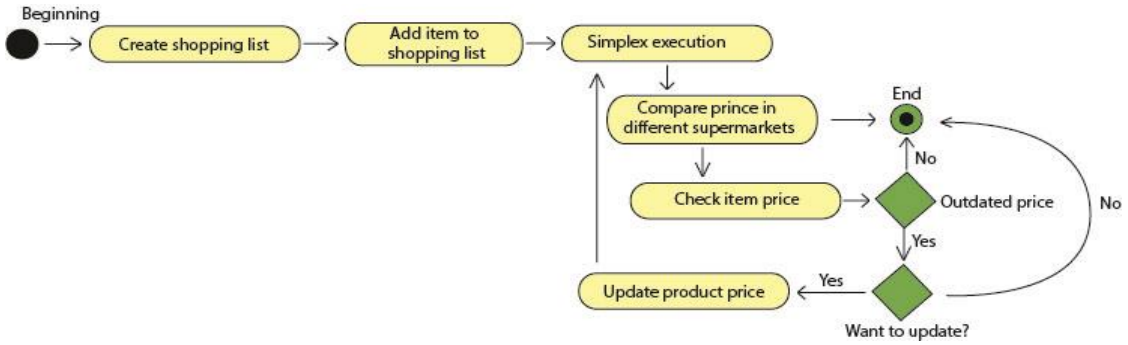


Figure 2 – Application Business Rules Flowchart

B - Evaluation of Programming Languages: For this project was chosen the programming language Java, because it is a native language. The IDE defined was Android Studio that is official of Android. To determine the version the percentage of use is used, the minimum being 4.x, called Ice Cream Sandwich, because it is the most used and indicated minimum version by Android [Android 2017].

C - Analysis of Interface Requirements: The interfaces to be included in the application should provide the user the possibility to register, enter the system, create a list, view profile and edit prices. As functional requirements, it can be measured the demands of interfaces of:

- Login; Registration; Create list; Profile; Display list; Edit prices.

Non-informal interface requirements:

- Database must have only one administrator; Login response time must not exceed 30 seconds; The system must be in Java for Android and development time of the prototype should not exceed 6 months and functional application in 6 months after the prototype.

D - Infrastructure Analysis, Providers And Business Rules: For the database platafform, it was selected the SQLite. It is an in-process library that implements a transactional SQL database engine, in which it does not require a server or specific configuration. For in-app authentication, Firebase was used which has online authentication services to access the application. The main justify of those selections: the SQLite is the most used in applications in the world (because, as already mentioned, does not require a server) [SQLite 2017] and the Firebase belongs to the same development group and makes this service available in degrees and compatible [Firebase 2017].

E - Data Mass Estimate: In an estimation of the mass of relevant and active data in the system, there are the supermarket information that will be registered (such as address, telephone number, zip code, hours of operation) and, within each supermarket, their products. There are too the products groups, as can be seen in the following sets: Wine Cellar, Alcoholic Beverages, Non Alcoholic Beverages, Snacks, Meat and Fish, Cereals and Dairy, Frozen Products, Chocolate and Confectionery, Confectionery and Antipasti, Cold and Dairy, Grains and Farinaceous, Hortifruti, Milk and Yogurts, Cleaning, Pasta and Soups, Sauces, Seasonings, Breads and Cakes, Hygiene and Utilities (the main groups of products in a supermarket [IPEAD 2017]). Finally, the users information's as: profile (that must contain name and email); preferences (should contain maximum distance from the supermarket to the user's location), favorite supermarket and accepted variation; lists that should contain the relation of products and quantities.

Based on the prototype developed and research, each item has a maximum of 100 characters (100bytes) and a gif (30kb), meaning each item has an average of 30.1kb. Medium-sized supermarkets have on average 4500 items, hypermarkets just over 10000 items. Estimating based on supermarkets included in the prototype, the database will average 1.15 gigabytes (calculations made with 2 hypermarkets and 4 supermarkets, ignoring the fact that supermarkets share the same products), $((2\times10000) + (4\times4500)) \times 30.1$ kilobytes = 1.15 gigabytes.

F - Risk Analysis: Risk analysis helps in gathering positive and negative information from application for analysis and then updates or attention, as follows:

Positive analysis: Interaction with society; Interference in product quality and prices; Competitiveness to provide services; System in mobile platform; Online price update.

Negative analysis: Boycott of companies with false price change; Wrong information of prices by customers; Failure communication with internet; Access loading overhead; Failure to update product prices; Possible cracking of data.

Through the generated data, an analysis will be made to measure the information reported by the users and to try to verify some type of pattern, as the same user always updating, preference for a supermarket far from the residence, discrepancy in the values of the products, repeated emails and dubious update. With this analysis, changes will be proposed to improve the security and reliability of the application.

G - Business Trial Rule for Viability: A A price survey should be done in supermarkets to demonstrate the variation of product values and simulation of spending, taking into account the fuel used in the process. The research was carried out in popular supermarkets and hypermarkets in the metropolitan area of Belo Horizonte, were selected BH Supermarket; Verdemar; EpaPlus; Super Nosso; Carrefour e Extra. For the calculation of the gasoline expense, it is necessary divide the consumption by the value of the gasoline and multiply by the distance [G1 2016].

For testing applications, will be following the black-box tests that consist of testing all inputs and outputs, which does not consider the code itself. Installation test to know if the

application is running on the installed device and operational test to verify the time of application operation (without error).

4 Results

The results were classified into 5 strands. First, the research considerations with the customers were evaluated. Next, the issue of fuel expenses was estimated. Then, the structure developed to compose the optimization of expenses and the evaluation of the prototype were performed. So, considerations about the solution behavior and possible expansions were presented.

4.1 Customers Research Results

The first result of the research has a statistical bias for confirmation, analysis and understanding of the real demand and behavior of the customers. In the interviews with customers, questionnaires were presented to understand: the need for an application for supermarket shopping with a shopping list, which are the priorities when going to the supermarket, the age range of customers, the possibility of contributing information, evaluation of prices with other supermarkets, information of the lowest price and if this customer already has been some contribution to some application. The research took place from January to June 2017.

A relevant fact, of the 426 responses, 92% of them came from Smartphones, 8% from personal computers or laptop, 0% from tablets and 0% from other devices. These numbers demonstrate that, by majority, users are using more and more Smartphones, being favorable to the surveys [IBGE 2016].

In Question 1: "Would you use an application on your mobile phone with price comparisons between supermarkets?", it was noticed 69.7% of people are willing to use the application, 30.3% are not.

In question 2: "Do you think that this application could contain shopping list for you to make your own list and compare preferred or cheaper supermarket prices in your region? ", It is noticed that 98.9% said yes.

In question 3: "When you go to the supermarket, do you prioritize what situation(s)? ", In this question, more than one option can be selected, it was noticed that the main 3 are price, location and promotions.

In question 4: "What is your age group? ", It can be seen 50.9% are people between 19 and 30 years and 27.8%, from 31 to 40 years, representing 78.7% of the base, with 22.3% in other age groups.

In question 5: "Would you be willing to contribute with price information, if the value varies, from the application? ", In 89.4% of cases, the people are willing to contribute.

In question 6: "What is your satisfaction (on a scale of 0 to 10) in knowing that an application can inform you the cheapest value among supermarkets? ", 66.9% of the people said they made an expressive difference, being classified in 10, 15.1% classified in 8 and 18% the other options.

In question 7: "Have you contributed information to any application? ", It was seen that 73.5% never contributed.

In question 8: "If the previous answer was 'yes', please inform which application.". There were several answers regarding this topic, highlighting the Waze application that was quoted 24 times representing about 39.3%.

From the data collected, it's possible realize that most people are willing to contribute to the application with price information, even in case of values different from the real.

A relevant fact, most never contributed any application, or at least had no knowledge about the contribution. As most had smartphones, 94% answered through the mobile device, probably using some application like Waze or Google Maps, but it was not known that they were contributing passively, being part of the network communities of these applications.

Therefore, it is possible to conclude the feasibility to create an application that makes a list of supermarket's products, which can offer a low price, promotion and locality, besides provide a means to contribute with the values of the prices informed by the people, if there is some divergence of values.

Even though the requirements for service, parking and accessibility are not in the main priority, they had a percentage between 25% and 33%, a significant number, and can be used as a way of evaluating the analysis of feeling, considering such establishments requirements.

In the research done to users, there was a prioritization of price values and the location of the supermarket. Through the data reported in the research and the possible crossings with behavioral data (in relation to preferences maintained, as location and prices) made through the application, it is possible to measure changes in relation to the behavior through pattern, such as frequent choice in price and location. This behavior can impact how the supermarket will act, as in the price survey. The research was carried out in supermarkets Epa Plus, BH Supermarket, Carrefour, Extra, Verdemar and Super Nosso. It was verified that the BH Supermarket has the lowest price in the list presented (in which it can dictate consumer loyalty), but as the location was as the second prioritization, this can impact, taking into account the fuel expense and/or travel time.

In the BH Supermarket, it was the cheapest among them, the purchase was based on the following items: Rice Prato Fino 4 kg, Carioca Pink Beans 1 kg, Salt Globo 1 kg, Vilma spaghetti's 500 gr, crystal sugar 4 kg Delta, broth of chicken Kinnor 6 cubes, meet type beef 1 kg, milk Itambé 1 liter, soybean oil 'Soya' 1 liter, coffee ground 3 Corações 500 gr traditional, butter Itambé 200 gr, tomato Vida Longa 1 kg, Potato English 1kg, Wheat Flour Vilma 500gr, Banana Caturra 1kg, Pomarola tomato sauce 340g, Pork 1Kg, Coca cola 2 liters, soap powder 1kg, detergent Ypê 500ml.

The total of R$ 125.02 in the BH Supermarket was the cheapest, representing 8% savings over Extra, 11% savings in relation to Epa Plus, 12% in Super Nosso, 13% in Carrefour and 31% in Verdemar.

4.2 Products and Gas Price Search

For the price survey and subsequent simulation of comparison, a survey was made on May 25, 2017 in the supermarkets and hypermarkets Extra, Carrefour, Super Nosso, Verdemar, Epa Plus and BH Supermarket.

The list of 20 products was based on the survey of the Institute of Economic, Administrative and Accounting Research of Minas Gerais (IPEAD) from the Federal University of Minas Gerais (UFMG), because there are items available in the basic basket [IPEAD 2017].Some other products were added so that the list could be more diversified, however, it demonstrates a feasible simulation, because each person can buy different products according with their favorite brands or price. For this research, only specific marks are considered so that we can have more accuracy of the difference of values.

The gasoline prices were raised in the metropolitan area of Belo Horizonte by the ANP (National Agency of Petroleum, Natural Gas and Biofuel) website. Such as it was updated the fuel price information, it was available on the website. After surveying the products and their prices, the sum of the products was added to record the amount spent, taking into account that the simulation was done based on the purchase of a unit or size available. By the research done, the following result was obtained in order of lowest final price (table 3): BH Supermarket: R$ 125,02; Extra: R$ 135,48; Epa Plus: R$ 140,06; Super Nosso: R$ 142,77; Carrefour: R$ 143,97; Verdemar: R$ 180,75. It can be noticed that there was a difference of 44.58% in relation to the BH Supermarket and Verdemar corresponding to R$ 55.73 in savings. This proves that it makes a difference in prices depending on where the purchase is being made.

In relation to gasoline, the average price is R$ 3,58 per litre. The lowest price is at the Posto Center Norte Ltda - Mepor R$ 3,299 and the highest is at the Posto Minas Shopping Ltda post (for R$ 3,997). Taking into account that person X, living in Rua Henrique Furtado Portugal, 140 - Buritis, Belo Horizonte - MG, CEP: 30493-175 and it want to use the application, this user will make your list to look for which supermarket cheaper, basing the list in table 1. The gasoline

consumption will be used to measure if the economy remains the same. Also, taking as reference the address of person X and the supermarkets nearest it's home, and taking into account the consumption of 13.4 km/l in a compact car such as the Fiat Uno Evolution [G1 2016], we obtain the following behavior in table 1.

	BH Supermarket	Epa Plus	Carrefour	Extra	Super Nosso	Verdemar
Distance(km)	5	3.6	8.4	8	3	3.2
Spent (R$)	1,34	0,96	2.24	2,14	0,8	0.85

Table 1 – Consumption

This calculation and demonstration should be available in the application prototype.

4.3 Prototype

The development of the prototype took into consideration the research done with the user and applied the possibility of generating the best supermarket, taking into account the average expenditure of fuel (gasoline). In figure 3, there is a diagram of the screens that have been programmed into the application prototype. The screens are: login, register, main menu, main screen, shopping list, my list, supermarket, about, best prices and detailed list.

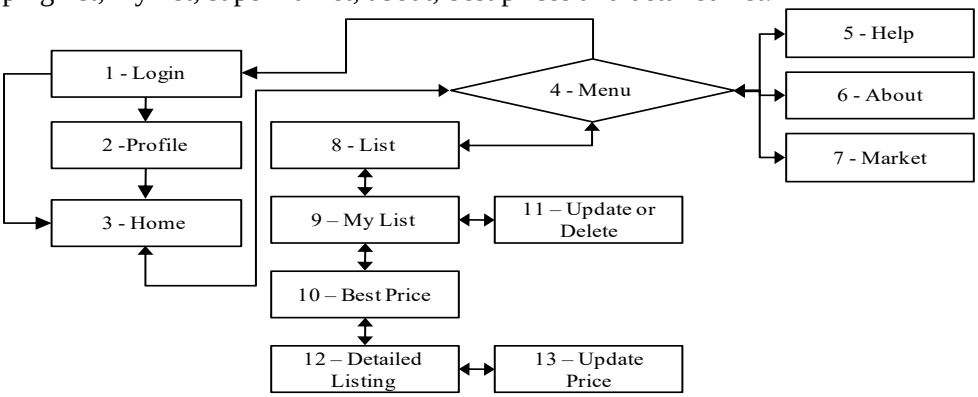


Figure 3 – Prototype Diagram

4.4 Optimization of Expenses

For evaluation of shopping list optimization to be made available to the user, the simplex method, in add to a mathematical modeling based in linear programming, was tested [Karloff 2008]. The technique was used for modeling a minimization problem, where it was considered factors such as the products selection, quantity of product and minimum value that the consumer desires to spend on the purchase through the list:

$$Minimize\ \mathrm{L} = \sum_{i=1}^{n} \mathrm{p_i x_i} \quad (1)$$

Subject to:

$$p_1 x_1 + \cdots + p_n x_n \leq GM \quad (2)$$

$$x_j \geq LI_j; \qquad \forall j, j \in \{1, \ldots, m\}\ where\ X_j, LI \in \mathbb{R}^+ \quad (3)$$

$$x_k = LI_k \forall_k, k \in \{1, \ldots, q\}\ where\ X_k, LI \in \mathbb{N}^+ \quad (4)$$

$$x_i \geq 0;\ p_i \geq 0,\ \forall i, i = \{1, \ldots, n\}, \quad n = m \cup q \quad (5)$$

Where i is the product index, n are all product i (and n is the union of q and m), x_i is the quantity of product i, p_i is the price of product i, LI_i is the lower limit of quantity of product i , m

is the set of product j with fraction of quantity (e.g. 3.45kg, 0.789mg), q is the set of products k with integer quantities (e.g. 1 beer), GM = Maximum Expenditure. A relevant comment is that inequality (2) prevents a pre-established maximum expenditure. Inequality (3), however, manages lower boundaries, but in real numbers, while equation (4) treats integer numbers. This represents optimization with real and integer values, which adds complexity to the problem. Inequality (5) prevents negative numbers from being considered during optimization.

For this problem, we implemented the simplex method to experiment with the above modeling and analyze its results. Table 2 shows a purchase of 12 basic products, where the available budget would be R$ 300.00 and there were limits of quantities of products.

As the result, the simplex demonstrated that it is possible to spend a value equal to (or less than) what has available with the quantity given (in this simulation, the maximum amount of expense was R$ 300.00), but it was verified that it is possible to spend R$ 267.66 this purchase. With the experiments performed, simplex is characterized as a viable optimization option. However, it is presented as a future study the implementation of the algorithm in the structure of the application, in order to present an online optimization for the user.

Term	GM	**R$ 300,00**	**Result (Simplex)**	**R$ 267,66**		
i	Banana (kg)	Butter (unit)	Soy oil (unit)	Flour (kg)	Coffee (unit)	Rice (unit)
P_i **(R$)**	2,98	7,98	2,78	4,98	7,98	10,98
LI_i	12	2	1	1,5	1	1
x_i **(Result)**	12	2	1	1,5	1	1
i	Sugar (unit)	Bread (kg)	Milk (unit)	Potato (kg)	Tomato (kg)	Meat (kg)
P_i **(R$)**	11,90	6,90	1,98	3,98	1,98	11,98
LI_i	1	6	7	6	9	6,5
x_i **(Result)**	1	6	7	6	9	6,5

Table 2 - Simplex result

The application informs the user when there is an unfeasible situation (a GM that does not allow the desired purchase), so the user can redo his shopping list with considerations. It is worth mentioning that this can be done in your own home, avoiding the trip to the search for better prices, consequently avoiding the expense of time and fuel (besides avoiding an embarrassment to select the product during the purchases and have to return to the shelf, because it verifies that it can not pay for the product at the time of paying the purchase - very common in supermarket chains).

4.5 Others Perspectives

In view of the above, some prospects of expansion for the developed software were observed. Firstly, the target audience can be expanded to those with higher purchasing power, since the restriction of the values used in the purchase does not have a maximum value for the purchase. In addition to the fact of the user with the profile glimpsed can also contribute with the information consolidated by Crowd Computing in supermarkets aimed at a different purchasing power. Other profiles that can be approached would be restaurants and fast-food owners, that also demand information from suppliers, in this case, supermarkets.

Secondly, it was possible to expand the proposed structure for a multiplatform web application, for greater comprehensiveness, with compatibility with other computing devices, such as computers (with different configurations and platforms). Such approach demands an expansion of the planned structure.

5 Conclusion

Through this work, it is possible the demonstration of the feasibility of applying the concept of crowd computing and operational research (through simplex) to optimize a product list, offering a better option through optimization, was concluded. This result is reinforced by the statistical analyses obtained through the field research, in which 70.5% of people stated that they

are willing to use a pricing application between supermarkets and 90.2% to contribute price information if the value varies from the application. A trend is the use of mobile device technology applications and information input, in which it can influence the market and favor the consumer.

Among the contributions that the work presents, the availability of a technology as robust as the Operational Research in a simple application can be cited. The simplicity achieved is a gift, considering the education level of the low-income population. It is possible to infer that families in situations of financial crisis (and even unemployment) may have more efficient purchases and monthly savings, which may help both in financially complicated periods and in periods of abundance. However, this analysis allowed to verify (and evaluate) that there is a great permeability of the mobile technology in almost all the layers of the society and the tool developed hides any and all complexity of the user.

As future studies, a better integration of map software with fuel prices is required, so that the optimal purchase has a better analysis of product values and fuel consumptions. Another bias that can be analyzed is the price of parking lots that require payment.

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