

# Proposal for a intelligent and interactive architecture based in persuasion techniques to analyze the impact in power electricity consumers

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**Abstract.** From the study of persuasive technology Dr. Fogg [3] and the concepts of persuasion Dr. Cialdini[2], a gap as regards the lack of a model for development of persuasive systems using the concepts of both authors on an single architecture. This work aims to develop a ubiquitous motivational architecture involving the persuasive technologies and persuasion concepts in a single software. To validate this architecture was developed a prototype in which we evaluated the potential of persuasion and the impact of six types of triggers sent to three different users. Through this analysis of the results it becomes possible to realize users respond differently to each triggers and the adopted model to refine the choice thereof was satisfactory, in view of the significantly increased positive response.

**Keywords.** Fogg Behavior Model, Intelligent, Interactive, Persuasive Technology, Power Electricity, Smart Homes, Smartphone, Tablet, Mobile devices

## Introduction

Currently, is possible receive messages on almost all of mobile device, such as tablet or smartphone. The use of this technology together with the intention of alerting the people about something, can be a preventive action on format of message. For example, a equipment was forgotten on and has nobody in the residence. How to turning off this equipment at a distance?

Smart homes, can help this type of decision, such as, power on or off a electronic device the distance. The use of new technologies can bring for people more agility and simplicity to the execution some tasks of their daily routine [1][15].

There are doubts in the use of those mobile devices, and the real action among people. One of the questions is related with the behavior change that a person can have in a moment receiving a persuasive message. This issue is related to one of the areas

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of psychology, and can be called persuasion , this subfield of psychology describes the power that one person can have on another with a simple yes or no to someone else [2].

The persuasion concepts allied with the use of sending messages in triggers format, can bring, six different benefits for a person, these benefits can be checked in detail in section 2 of this article. The concept of triggers consists of something whose goal is to make the people to change his behavior at that time instant [3].

From the studies of persuasive technology of Fogg [3] and the concepts of persuasion of the Cialdini [2], has identified a gap in what concerns the lack of a model for development of a persuasive system, that uses the concepts of both authors in a single architecture. The proposal describes the development at architecture capable of interacting with different people, using the concepts of persuasion by sending triggers for a mobile devices.

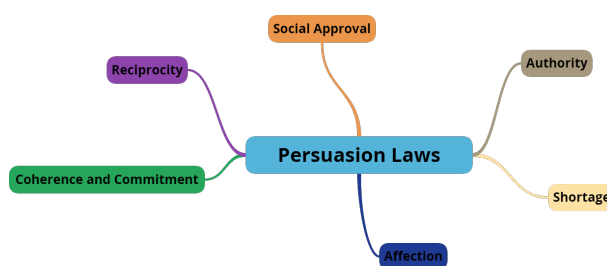
To validate the proposed architecture was developed a prototype whose goal is to motivate and educate consumers about the excessive consumption of power electricity.

This work is structured as follows : In section 2, is described the concepts and strategies of persuasion . In section 3, described the concept and the advantages of using the persuasive technologies. In section 4, described the Fogg Behavior Model (FMB) model and its main characteristics. In section 5, it is described the proposal for a ubiquitous motivational architecture. In section 6, described the prototype and the initial results. In section 7, the conclusion and future work are described.

## 1. Persuasion

The persuasion can be defined as an ability to induce beliefs and values on others people, thus influencing their thoughts or their actions. To that persuasion can be applied, it is necessary to define specific strategies, with the focus of inducing people to adopt different behavior [4].

The persuasion strategies are widely used by professionals in the marketing and web design. These strategies are used to convince people to buy products that are advertised. There are six laws of persuasion to describe succinctly these strategies [2]:



**Figure 1.** Mental map of the laws of persuasion.

1. Reciprocity: if we feel compelled to reciprocate, not always advantageously for us, a favor that the other person made us;
2. Coherence and Commitment: Once we make a choice, we faced the pressures to behave in a manner consistent with the commitment made;

3. Social approval: we seek in others signs of normal behavior, which are accepted by society;
4. Affection: we prefer to accept requests from people we know and we like;
5. Authority: we have an ingrained sense of obedience to one authority;
6. Shortage: everything becomes more valuable when it is least available.

## **2. Persuasive Technology**

In the 70s, came the first persuasive technologies that aimed at changing attitudes and behaviors of people [5]. The persuasive technologies can be defined as an interactive software which is used to attempt to change human behavior [3].

Persuasive technology can take many forms and is not limited only to the Internet. Research has demonstrated the viability of these technologies in a variety of contexts, such as, in advertising [6], in healthy behaviors and prosocial [7-10], and in reducing energy consumption [11-14].

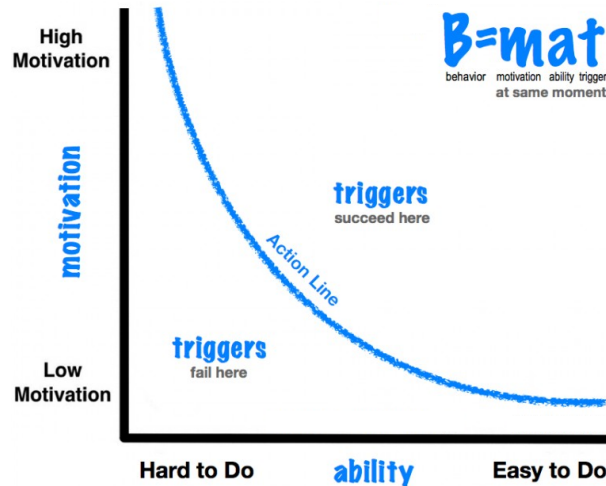
The main advantage of persuasive technology is interactivity, which allows the persuader adapt their strategies according to a person's behavior. The following will present some advantages of using persuasive technologies [3]:

- Persistence: machines do not get tired and do not get frustrated with negative reactions, and may persist indefinitely;
- Anonymity: it is easier to get information anonymously, through a system, than for another human being;
- Data manipulation: is the ability to access, store and manipulate data;
- Media: in some cases, how the information is transmitted become more persuasive than the information itself;
- Sizing: information processing according to demand;
- Ubiquity of technology: the ability to be in several places at once puts technology in places where the human could not be persuasive.

## **3. Model FBM**

The Fogg Behavior Model (FBM) describes human behavior as a product of three factors : Motivation, Ability and Triggers. For a learning behavior desire for one person, some trigger must have been actuated, this person must being motivated and having a ability to exercise desire behavior [14].

1. Motivation: simplifies a person's behavior change, and can be divided into three classes:
  - (a) Pleasure or pain: are motivators that has its action instantly, people usually meet such messages and not think before performing this type behavior;
  - (b) Hope or Fear: this motivation is aimed at encouraging the anticipation of a behavior. People perform a behavior in order to anticipate something good or prevent something bad. As can be seen in the everyday behavior of people, this can be more powerful motivator than pleasure/pain;



**Figure 2.** The Fogg Behavior Model has three factors: Motivation, ability and triggers. From [14].

- (c) Social acceptance or rejection: this motivation controls much of social behavior because most people are motivated to do certain tasks to be accepted socially.
2. Ability: is the degree of individual competence has to perform a behavior. Persuade a person to increase their skill is necessary that have the target behavior. This involves the relationship between six elements of simplicity. These elements should be optimized so that the person can increase their capacity, these elements can be described as:
    - (a) Time: If a target behavior requires more time, and unfortunately the time has run out, the behavior is not simple to achieve its target;
    - (b) Money: If a target behavior requires money and the budget is limited, then the behavior is not simple to achieve its target;
    - (c) Physical Effort: If a target behavior requires physical exertion, then the behavior may not be simple to achieve its target;
    - (d) Brain Cycles: If a target behavior requires the person to think too much, then the behavior is not simple to achieve its target;
    - (e) Social deviation: is the form of breaks the social rules of the world we live in;
    - (f) Non-routine: people tend to behave in a routine manner during their lives, however if a person facing a behavior out of their routine, does not know how to behave. Looking for simplicity, people sometimes keep their routines and avoid moving it.
  3. Triggers: resources are responsible for determining how person can effect their behavior, these triggers can be divided into three groups:
    - (a) Spark: is appropriate for people who have little motivation and high ability to perform a target behavior. The trigger must be done in a motivational element format;

- (b) Facilitator: This type of trigger is suitable for people who have high motivation, but lack ability. The goal of a facilitator is to trigger the behavior while trying to make the most natural behavior, making this way, in a target behavior;
- (c) Signal: this trigger works best when people have both the motivation and the ability to perform the target behavior. The signal does not seek to motivate people or simplify the task. It just serves as a reminder.

Figure 2 is composed by a vertical axis representing motivation and horizontal axis represents the ability of that person. If the motivation and ability is low, that person had not behavior change. If the person has a motivation and ability at high levels, this person is closer to achieve the target behavior.

Finally, for the attainment of the target behavior, it is necessary that a trigger be sent at the desired time, and so that person can receive this message and change their behavior in a spontaneous way. The best time is defined as time Kayros [14], which is described as a non-linear time in which something special happens, that is the appropriate time to persuade a person is hit the target behavior, in which the person is already motivated and has some ability.

The model presented can be used as basis for the development of technologies persuasive. The application of the model was used as the basis for the development of the proposed architecture and is described in the section of Architecture Proposal.

#### 4. Architecture Proposal

The proposed architecture is based on the ubiquitous motivational architecture, where describing a ubiquitous system that a person is also an element that composes the system and its activities are monitored transparently. The elements of architecture are modeled following the model of behavior described by Fogg [14] and the concepts described by Cialdini [2]. The following Figure 3 shows the modules which make up the proposed architecture for this persuasive system.

- User: human element that the system attempts to persuade;
- Sensor: element responsible for capturing and sending environmental data;
- Perception: element that receives the sensor data, processes and displays the status of the environment where a person is inserted;
- User Model: This element was developed from the two axes of the FBM model (Motivation and Ability, Figure 2) describes the change in behavior that occurs when a person is motivated and has the ability to perform the requested action:
- Sapiens: element responsible for providing two types of output (trigger and intelligent actions);
- Smart Action: element that sends automatic commands to the actuators;
- Triggers: element that provides resources according to the FBM model.

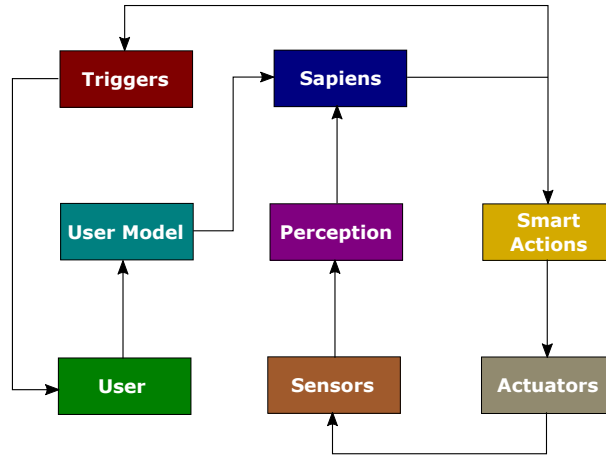


Figure 3. Motivational Ubiquitous Architecture.

## 5. Results and Discussion

This work has as main objective of development of an architecture for create a persuasive systems, in order to enhance the degree of persuasion of a trigger using the concepts of Fogg [14] and Cialdini [2]. For to validate the architecture described in section 5, was implemented and tested a prototype in a laboratory of Federal University of Rio Grande with real users for this proposed. The prototype was developed using Raspberry PI 2 as hardware infrastructure and four main components that allows the development of a web application in an embedded system: REST API, nodejs, Express and MongoDB. The operating system used for this application is an open source version called ArchLinux, which provides a platform with the necessary resources for its implementation. With this prototype, it was possible to evaluate the potential impact and six types of triggers sent to three different users.

Table 1 describes the triggers that were sent in message format to the users. The persuasion column was built according to the elements of Cialdini [7], the message column represents types of messages sent to users and the trigger column was built according to Fogg rating [14]. The following symbols in messages were used:

- < *D* >: connected equipment;
- < *R* >: consumption in Brazilian reais (R\$);
- < *U* >: consumer who forgot the connected equipment;
- < %*CO* >: reducing of *CO*<sub>2</sub> (in percentage);
- < *SM* >: number of times that the consumer turned off the device;
- < %*C* >: number of consumers (in percentage);
- < *W* >: Equipment consumption.

The Table 2 describes the results of each trigger for each user. The column of users describes the names of people involved in this prototype. The column ID message describes the responses of each person for the six message type described in Table 1. Note

**Table 1.** The six triggers the described prototype.

ID	Persuasion	Message	Triggers
1	Reciprocity	"< U >, < D > is consuming < W >. You can save < R > if you turn it off (a) regularly this month!"	spark and facilitator
2	Commitment and Consistency	"Have you ever turn off < SM > < D > this month! Do not forget to turn off again."	signal and facilitator
3	Affection	"< U >, do not worry because I'm taking care of their devices. In fact, you forgot < D > turn on (a)."	signal and facilitator
4	Scarcity	"Let's reduce greenhouse? Turn off device for to reduce its CO2 emissions by < %CO >."	spark and facilitator
5	Social approval	"< %C > of our customers turn off (the) < D > right now!"	signal and facilitator
6	Authority	"My experience in managing devices ensures that there is no problem shutting them down with my commands. Trust me and disconnect < D > right now."	signal and facilitator

**Table 2.** The user response to each of the triggers which were described in Table 1.

		ID Mensagem					
		1	2	3	4	5	6
Users	Mr. Diego	Turn Off	Keep it On	Keep it On	Turn Off	Turn Off	Keep it On
	Mr. José	Keep it On	Turn Off	Turn Off	Keep it On	Keep it On	Turn Off
	Mr. Carlos	Turn Off	Keep it On	Turn Off	Keep it On	Turn Off	Turn Off

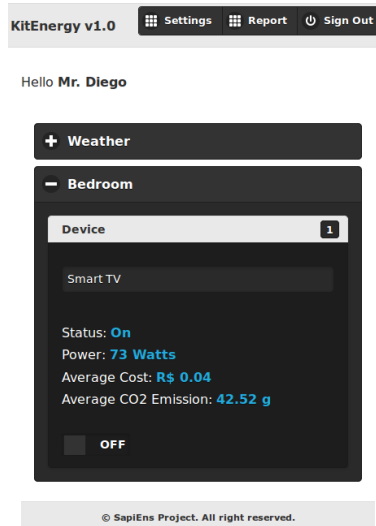
that the response "Turn off" takes a positive role for the system, ie there was persuasion. Already the answer "Keep it On" takes a negative role, as there was no persuasion.

Figure 4 shows the main interface of the prototype, featuring a weather flap, an ambient flap, a devices tab, buttons turn on or turn off, settings, reports, and logout.

1. Climate: Is responsible for informing climate conditions of the city that the prototype is installed;
2. Environment: Is the location name where the sensors are installed;
3. Device: Is the sensor name or the device name that connected on sensor;
  - Status: Is the state of the sensor, on or off;
  - Consumption: Is the power in watts being consumed from device connected to the sensor;
  - Average cost: Estimates the cost of the consumption<sup>2</sup>;
  - Average CO2 emissions: Is estimates CO2 emissions in grams, related to power consumption<sup>3</sup>;
  - Turn on or turn off: Allows the user to turn on or off the sensors.

<sup>2</sup><http://www.ceee.com.br/pportal/ceee/Component/Controller.aspx?CC=1248>

<sup>3</sup><http://www.mct.gov.br/index.php/content/view/354444.html#ancora>



**Figure 4.** Main interface prototype.

4. Settings: Allows to administrator manage the system, adding new features and new users to the system;
5. Reports: Allows generation of reports average consumption in watts for each sensor. These reports can be generated referring to the day, week, month or year;
6. Exit: this component allows the users leave the system;

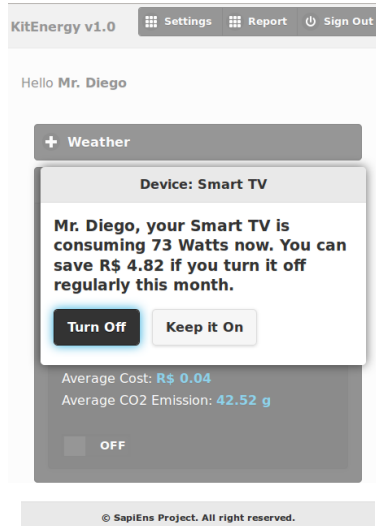
When the sensor does not detect a person in the environment and analyzes that there is a connected device, a trigger is sent for this person. The Figure 5 shows an example of a trigger the persuasion of type reciprocity that was sent to the user, after he get out ambiance and the user forgot the connected device.

From the results in Table 2, it was executed a refinement model in which the triggers who had positive results were selected and send again for users. The Table 3 shows the results from send again the triggers.

**Table 3.** Triggers send again for user.

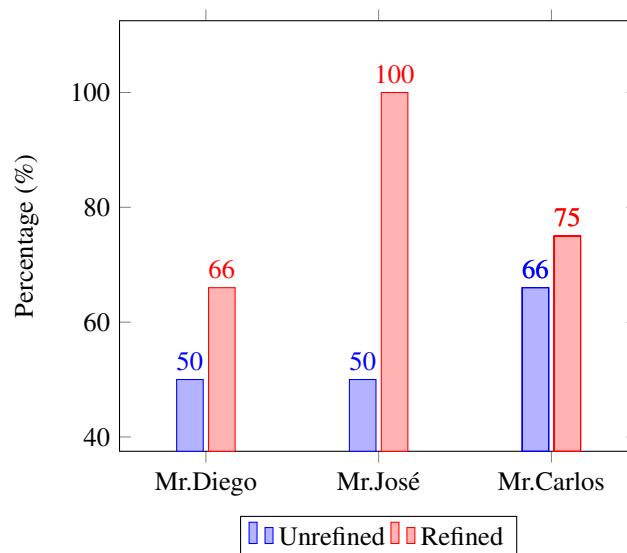
Users	ID Message	Answer
Mr. Diego	1	Turn off
	4	Turn off
	5	Keep it On
Mr. José	2	Turn off
	3	Turn off
	6	Turn off
Mr. Carlos	1	Turn off
	3	Turn off
	5	Turn off
	6	Keep it On





**Figure 5.** Trigger type reciprocity sent to the user.

From the analysis of the results in Table 2 and Table 3 you can see an increase in positive responses for users Mr. Diego, Mr. Jos and Mr. Carlos. This increase refers to the difference between refined and unrefined answers, these differences can be seen in Figure 6. It is possible to see that users of the system respond differently to each trigger and the model adopted to refine the choice is satisfactory, because it has significantly increased the positive responses.



**Figure 6.** Result per refinement of messages.

## 6. Conclusions

The results presented in this article demonstrate the various ways that each user can meet the different types of trigger involving the art to persuade. The model used to refine the choice of trigger type that can persuade a specific user has been satisfactory, due to the significant increase of positive responses generated during testing.

Therefore, persuasion concepts allies to sending messages in the format triggers, can contribute to the enhancement of persuasion trigger level for the user to disconnect the equipment if it has forgotten on.

As future work, we intend to analyze the impact of this architecture in the electricity consumption of residential consumers. Also it is intended to test the system in real residences, so the overall architecture performance can be evaluated and new software enhancements can be implemented.

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