

Smuggling reduction of gas cylinders through the implementation of radio frequency identification technology



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ABSTRACT

Ecuador subsidizes fuels, the problem with this benefit is that, many citizens are dedicated to illegally market these resources in border cities,

among these fuels there are the cylinders of liquefied petroleum gas; the existing fragile control greatly benefits smuggling, representing a loss of resources for Ecuador.

There is no subsidy in neighboring countries such as Peru and Colombia, and unfortunately some citizens have chosen to engage in illegal fuel marketing, generating economic losses for the country. The actual cost of a 15 kilo gas cylinder is 12.00 dollars, however, it is sold at 1.60 dollar. It means that the government subsidizes 89% of the price of gas, with barely 11% being paid by consumers. (Diario el Comercio, 2013)

People who take advantage of the poor control of illegal marketing, reduce the number of cylinders in border areas of Ecuador and therefore increase the price, this situation has generated inconveniences for Ecuadorian citizens when they can not acquire gas cylinders. Currently, given the advance of technology in particular of microelectronics, it is very common to use portable electronic devices such as RFID (Radio Frequency Identifier) tags, for this project the active labels of 2.4 GHz allow the unique identification of each gas cylinder, as well as the portability of the information and the relation of belonging between gas cylinders and citizens, facilitating their monitoring and control.

Keywords: Subsidy, smuggling, RFID, Tags, frequency, microelectronics, fuel, energy.



Introduction

There is not a monitoring system using radio frequency monitoring for controlling the illegal fuel marketing. In this work, a control mechanism whose purpose has become an alternative of real and sustainable alternative technology its presented, it has been based on 2.4 GHz RFID technology and it has also been improved. Fuel subsidies and expenses are reduced both in the operation and in the tracking of smuggling.

A control mechanism is proposed, whose purpose is to promote a real and sustainable technological alternative, based on 2.4 GHz RFID technology, which, after its implementation, will reflect great economic benefits for the country, as well as strengthen the fuel subsidies and expenses will be reduced as much in operation as in follow-up to the contraband.



Fig 1. Illegal road of liquefied gas cylinders in border provinces.

Source. www.ElComercio.com, *El contrabando de combustible tendrá penas más leves.* 03/12/2016



According to the given data in the cities of Tulcán and Quito by the Agencia de Control de Hidrocarburos ARCH we can see in Figure 2. The monthly declared and real average destiny of Liquefied Petroleum Gas.

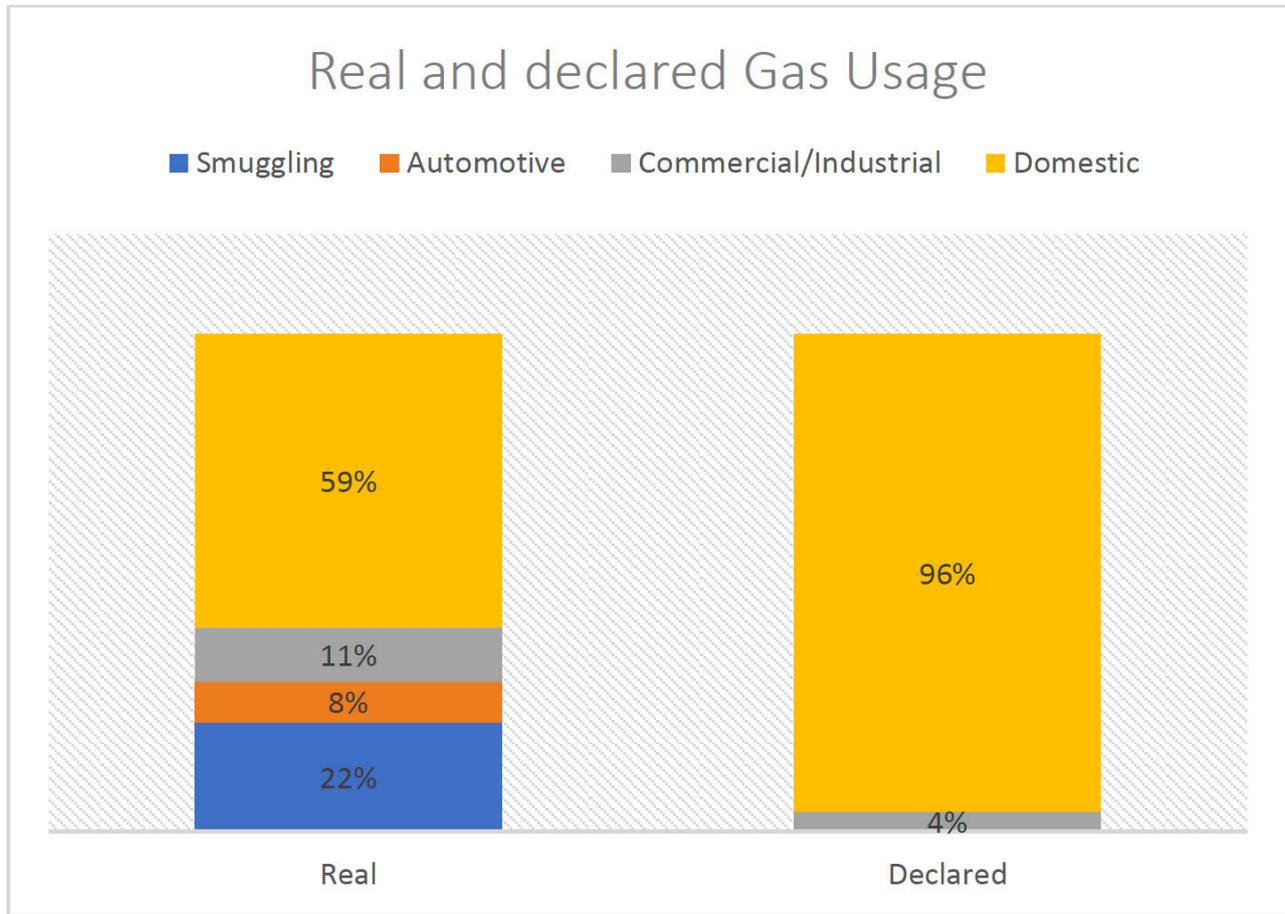


Fig 2. Monthly average destiny of real and declared usage of liquefied petroleum gas.
Source: Authors

The development of an information management system, the implementation of RFID readers, the RFID labeling in liquefied petroleum gas cylinders, the definition of communication protocol and the presentation of statistical reports are the specific objectives to be fulfilled in the project.

As a general objective, the project is shaping up to the eradication of the contraband of liquefied petroleum gas cylinders using RFID technology.

The start-up of the project is progressive due to the fact that it must comply with the following stages:

To determine strategic sectors as support and maintenance points in border cities.

- Definition of main communication nodes.
- Obtaining current data in Ecuador on fuel consumption:
 - Suppliers
 - Dispensers

- Service Stations
 - Users
 - Transport
 - Monitoring points.
- Tabulation of information and generation of Databases.
 - Configuration of readers and RFID tags.
 - Labeling of the liquefied petroleum gas cylinders.
 - Development of a centralized main monitoring system and its remote application.

As can be seen, the execution and start-up of the detailed stages could be carried out in the medium term.

With the implementation of a system based on active RFID labeling on liquefied petroleum gas cylinders, fuel smuggling would be significantly reduced and significant savings of resources would be obtained for Ecuador.

2. Materials y methods

With a small size, the devices known as RFID tags are similar to a keychain, or an element designed to adapt to any application and surface, these can be attached or incorporated into a product, control device, or a subject such as a person or an animal.

Its structure is composed, among other elements, of antennas that are frequently adaptable in Ecuador. They date their operation in 2 main elements: the RFID transmitter and the RFID receiver. Active labels require internal electrical power, unlike passive ones that do not need it.

One of the advantages of the use of radiofrequency (instead, for example, infrared or bluetooth) is that there is no need for direct vision between emitter and receiver, therefore, it will be possible to monitor and register individual gas cylinders and in large quantities such as those of a cylinder transport vehicle.

The type of research based on RFID Technology is applied, this solves a social problem clearly denoted in the border cities, where there are several disadvantages in the acquisition of cylinders of liquefied petroleum gas.

It represents a field investigation since its application is carried out directly and in the field where the fuel containers are located, as well as in the dispensers in the border cities of Ecuador working with the personnel in charge of the distribution of this vital service towards the citizens.

The work of monitoring the smuggling of fuel is a very delicate issue for its development since it is the livelihood of many families dedicated to the illegal

acquisition of resources, therefore, its nature is considered as action, the reality of the problem that affects society.

This study has an experimental scope since it frames the great majority of citizens, at present the citizens do not have a monitoring system of their consumption, this affirms



the implementation of a computer system based on RFID technology, attempts have been made to control smuggling by reducing the sale of fuel to citizens, a situation that is not in accordance with the subsidy and with the National Plan for Good Living of Ecuadorians.

2.1. Operation of RFID. - The connectivity and data transmission needed to monitor the fuel containers basically consist of 4 elements: the active Transponders (TAGS) of RFID and the RFID readers, the Communication Protocol and the Middleware (Administrator System).

An electromagnetic field is emitted by RFID readers through its antenna. When an RFID tag installed in the cylinder passes through this field and transmits the information stored through the communication protocol back to the reader. The transmission and reception of information occur simultaneously.

To eradicate fuel smuggling, the use of a monitoring system based on RFID radio frequency technology is proposed, where RFID tags and RFID receiver devices with a frequency of 2.4 GHz (Active, non-passive) are continuously related, transmitting and receiving data from users and their gas cylinders, then, when a cylinder has an RFID tag implemented, the personnel in charge of the monitoring will use an RFID tag reader that will have connectivity with a main system; each RFID tag has a unique and irreplaceable code that, when it is less than 50 meters away, will transmit complete data about the monitored cylinder.

If a citizen wishes to purchase a gas cylinder, he will proceed to take an empty cylinder to the distributor, where he will deliver a cylinder with an RFID tag, this label has a unique code that relates the following information in the database:

- Unique identification encryption code per cylinder and per user.
- Distributor address.
- Time of departure of the distributor.
- Identification of the transport vehicle of the total cylinders.
- Personal data of the driver of the transport vehicle.
- Number of cylinders.
- User to whom the new cylinder is sold.
- Date on which the cylinder was delivered with RFID tag.

When the user wants to replace their empty cylinder with one with fuel, user will take their empty cylinder to the supplier, who will verify with the RFID tag reader the received cylinder and will check the consumption time and the cylinder's belonging to

the citizen who is acquiring. Each citizen will be responsible for a number of cylinders assigned, for which the cylinders can not be used badly.



Fig3. Main elements for the implementation of gas cylinders monitoring

Source: Authors

The stability in the operation of this technology based on Radio Frequency is ensured, since it will allow real-time tracking of the routes, origins and destination of the fuel, it will be recorded from boarding to dispatch, thanks to the RFID labeling on the cylinders of liquefied petroleum gas. For the transport of large quantities of cylinders, the RFID tags will be active and will allow their mass reading, this will avoid lowering the cylinders of the vehicle and raising them again.

RFID Maintenance

The active RFID TAGS, support extreme environmental conditions and can last several years because they are hermetically sealed in their container, The security of the RFID TAGS is very robust since it has a unique code with very low probabilities of being falsified, it is also known that it can not be erased or modified. In this way each RFID TAG is completely



maintenance free and has an unlimited lifetime.

A unique aspect of RFID systems that is important to mention is that, RFID TAGS mounted on metal parts, holes in metal or wood areas or that are subject to products with a single exposed surface, can be detected and read, including with unprecedented read speeds.

Planning

If the implementation of RFID technology wants to be taken, it has to comply with several stages that are described in a very general way.

- Analysis of the existing system. - The platform on which the fuel smuggling control system (ARCH) currently operates will be identified, which is based on a smart card system and will determine the field in which security will be included under the radio frequency identification. This step will surely determine the correct functioning of the system due to the strategic location of the labels on the liquefied petroleum gas cylinder.
- Design and Production of RFID tags. - The acquisition of RFID label producing machines will be carried out, as well as in this activity the container material of the RFID device will be identified, it can be made of resistant plastic or metal.
- Development of the computer system to manage information. - It will depend on the existing database of consumers and producers on the ARCH's computer platform at national level, it would perfectly serve for the portability of the data; this would also include the registration of all the unique codes of the RFID tags to be monitored.
- Infrastructure implementation.
- Maintenance and performance tests.

Results

To establish communication between the transmitter and the RFID reader, no contact is required, since it is based on the use of active tags, which can be read at distances of up to 50 meters. So also the labels store information since they have a small storage capacity.

The Ecuadorian government annually spends about seven billion dollars in subsidies. According to the office figures, 68.74% of the total corresponds to the fuel subsidy, which represents in monetary terms 4 539 million dollars. What does this mean? That the annual damage to Ecuador represents 146.65 million dollars for gas, 251.54 million for diesel and 123.02 million for gasoline. That is, a loss for the country of 521.21 million dollars per year. (Diario el Comercio, 2013)

Illegal merchants in restaurants can not justify, for example, why they use several cylinders of liquefied gas in a very short time, with the RFID application it will be

possible to detect irregularities since there will be cylinders assigned to each user, through unique codes.

During an operation in the Quevedo canton, Los Rios, the director of Hydrocarbons, Juan Carlos Chimbo, seized 865 cylinders for domestic use that were being used in commercial

activities, which is legally prohibited. These businesses must consume the 40 kilos cylinder that has a higher price. This detour, according to Chimbo, causes millionaire losses as the domestic cylinder is subsidized and must be used exclusively in cooking food. (Ecuador Inmediato, 2018).

Beginning with the statement of Mr. Jesús Alfonso Parada Cruz, general manager of the Empresa Distribuidora de gas de Colombia, who claims that 26,000 gas cylinders a month are smuggled into their country, experts estimate that 53% of the production consumed in the southern municipalities of Nariño, are supplied with Ecuadorian gas; the informal commerce, adds the information, "involves dozens of people that starts in Tulcán with the purchase of the ticket with which the fuel that transports it to Colombia is purchased, generally using carriers through the alternate routes". (Diario Expreso, 2011).

The same information assures that at least 500 families of Ipiales are engaged in the sale of Ecuadorian fuel; the CAE identified 37 alternative routes used for illegal trade; that by only one of these routes, 300 cylinders of gas per day escape; that the municipalities of the province consume Ecuadorian gas, harming Colombian distributors; and that more than 345,000 gas tanks were sold last year, of the 26,000 families that live in Ipiales, 18,000 are supplied with Ecuadorian gas. In these circumstances, all efforts to stop this illegal trade have failed. (Diario Expreso, 2011).

Discussion of results

With the implementation of RFID tags and their readers, a very powerful and versatile network and computing tool will be available through which all the liquefied petroleum gas cylinders could be tracked and monitored. At a national level in Ecuador, a massive and individual monitoring of all cylinders of liquefied petroleum gas would be obtained, which would allow to establish regulations that will regulate the commercialization and use.

Inspection has been made to several restaurants in the cities of Ibarra and Tulcán in 2012 that confirms the illegal use of liquefied petroleum gas cylinders in food restaurants, the savings by not acquiring industrial cylinders is remarkable compared to the price of industrial cylinders, situation that is not part of the contraband, but of an inadequate use of the gas cylinders in exchange for the cylinders of industrial use.

As previously noted, Ecuador loses 146.65 million dollars a year as a cause of the smuggling of liquefied petroleum gas, but it does not calculate what is lost in the

country, but it gives them profits in people who illegally smuggle, The figures are millionaire, which increase in certain cases and places up to 1000% of the real value. These data make it difficult to control the smuggling of liquefied petroleum gas, and in recent years the seizure figures have increased and contraband continues.

Informal trade with the indicated numbers becomes a threat as they are gaining more and more power by minimizing the actions of the contraband and order control forces in the border cities of Ecuador.

Internal rate of return and implementation costs

This analysis determines the viability for the investment in this project by the Ecuadorian State, based on a percentage obtained from the actual prices to date. It is estimated in the



future a return to the Ecuadorian State of the investment in a maximum time of 1 year, a situation that is valued due to the cost of implementation of RFID active tags, infrastructure and human talent and the modification of cylinders for their adaptation of the devices in its structure.

Taking into account the above data, the following formula is applied:

$$NAV = -initial\ investment + \frac{cash\ flows\ in\ each\ period}{(1 + bank\ interest\ rate)^{number\ of\ periods}}$$

$$NAV = -10000000 + \frac{146000000}{(1 + 0.18)^1}$$

$$NAV = 113728813,56$$

As can be seen, the net added value is higher than the initial value of the investment; for which the implementation time of the project of 1 years would be estimated, after this time the Net Added Value would be calculated, in this case the VAN indicates that it could safely invest in the infrastructure and the devices with RFID technology.

Due to storage characteristics, durability and resistance, the error rate in technologies based on magnetic tapes, bar codes, and biometric equipment is not comparable to the reliability in an RFID solution. Using RFID technology would increase quality control, increase productivity and efficiency, increase profitability, allow better management and handling of liquefied petroleum gas cylinders and facilitate the availability of information for both users and products.

In addition, this difference between technologies depends greatly on: the specific application, the requirements of the end user and the sector of the industry in which the technology is used.

A general computer system would allow managing the information obtained from the RFID devices installed in each participant (cylinders, tanks, vehicles, dispensers,

distributors, users, etc.) when it is distributed of fuel, therefore, it would obtain results such as:

- The information obtained from all the protagonists would be managed in real time.
- Reports would be presented of the actual amounts of losses caused by fuel smuggling.

Conclusions

- A complete inventory of the liquefied petroleum gas cylinders delivered to each citizen who would be responsible for them would be available.
- The number of full cylinders dispensed by each distributor would be known, which would allow the return of the same number of empty cylinders.

- The security before the plagiarism of the TAGS installed in each cylinder would be determined by encryption codes between the identification of the citizen and the unique code of the TAG.
- The statistical reports presented by the general system would allow to minimize the illegal use of the cylinders since these would have a unique label that would store complete information and that would be related to each consumer citizen.

References

Urueña, A. Ferrari, A. Valdecasa, E. (2010). La Tecnología RFID: Usos y Oportunidades. ©red.es. España. EDITA.

Gidekel, A. (2006). Introducción a la Identificación por Radio Frecuencia. TELETRÓNICA Codificación S.A. Argentina. Teletrónica Codificación S.A.

Instituto de Tecnologías de la Comunicación, (2010) Guía sobre seguridad y privacidad de la tecnología RFID. ITENCO, España, ITENCO

Escobar, Pablo, Diseño e implementación de un prototipo para un sistema de control de venta de gas licuado de petróleo utilizando tarjetas inteligentes y terminales de aplicaciones bancarias, 2009, Proyecto previo a la obtención del título de ingeniería en electrónica y telecomunicaciones, EPN. Recuperado de: <http://bibdigital.epn.edu.ec/bitstream/15000/1591/1/CD-2267.pdf>.

RFID POINT. (2011). La comunidad RFID en Latinoamérica. Recuperado de: <http://www.rfidpoint.com/lanzamientos/intermec-introduce-nuevas-etiquetas-rfid-duraderas-para-envases-retornables-y-seguimiento-de-activos/>

JENCE - RFID Tags. (2015). Some of the special features of RFID systems. Recuperado de: <http://jence.com/new/index.php/products/rfid/rfid-tags>

Barrueto, L. (2009). Aplicaciones de la Tecnología RFID. Recuperado de: <http://www.maestrosdelweb.com/editorial/aplicaciones-de-la-tecnologia-rfid-la-educacion/>

Llamazares, J. (2011). Tarjetas identificadoras sin contacto o sistemas RFID. Recuperado de: <http://www.ecojoven.com/dos/03/RFID.html>

RFID by MOVILTRACK. (2010). Transponedor TAGS Activos 2.4 GHz. Recuperado de: <http://www.moviltrack.com/tienda/index.php/etiquetas-y-lectores-rfid-activos/tags-activos.html>

OSSES RFID. (2013). Tecnología RFID OSSES Products. Recuperado de: <http://www.ossesrfid.es/content2.php?id=11/>

Explored. (2011). El estado pierde 4.5 millones anuales por contrabando de gas a Colombia. Recuperado de: <http://www.explored.com.ec/noticias-ecuador/el-estado-pierde-4-5-millones-anuales-por-contrabando-de-gas-a-colombia-494704.html>

Mantilla, S. (2013). Contrabando de combustibles. Recuperado de: <http://www.elcomercio.com/opinion/contrabando-combustibles.html>



El Universo. (2004). Contrabando de combustibles a Perú deja millonarias pérdidas a Ecuador. Recuperado de: <http://www.eluniverso.com/2004/09/08/0001/9/CF6A475C771744B2AD5416398B968EFB.html>

OLADE. (2014). OLADE trabajará en conjunto con Organizaciones Latinoamericanas en Proyectos de Biogás. Recuperado de: <http://www.olade.org/es/noticias/olade-trabajar%C3%A1-en-conjunto-con-organizaciones-latinoamericanas-en-proyectos-de-biog%C3%A1s>

ECUADOR INMEDIATO (2015), Ecuador pierde hasta \$100 000 diarios por contrabando de combustible a Perú. Recuperado de: http://ecuadorinmediato.com/index.php?module=Noticias&func=news_user_view&id=161708&umt=ecuador_pierde_hasta_100_000_diarios_por_contrabando_combustible_a_peru

