



UNIVERSIDAD TÉCNICA DEL NORTE

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**CARRERA DE INGENIERÍA EN ELECTRÓNICA Y REDES DE
COMUNICACIÓN**

ARTÍCULO CIENTÍFICO

**ESTUDIO TÉCNICO Y ECONÓMICO DE UNA PLANTA
RECICLADORA DE BASURA ELECTRÓNICA
COMPUTACIONAL PARA LA UNIVERSIDAD TÉCNICA DEL
NORTE**

**PROYECTO PREVIO A LA OBTENCIÓN DEL TÍTULO DE
INGENIERO EN ELECTRÓNICA Y REDES DE COMUNICACIÓN**

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TECHNICAL AND ECONOMIC STUDY OF A RECYCLING PLANT FOR ELECTRONIC WASTE COMPUTATIONAL FOR “UNIVERSIDAD TÉCNICA DEL NORTE”

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Summary— The present work of degree treats about a plant recicladora of computational electronic rubbish for the north Technical University focused in solving the problem of environmental pollution that produces by the waste of the computational teams dice of drop by different institutions of the Province of Imbabura, for which developed a technical study in which it establishes the structure and processes of the plant recicladora and an economic study in which it determines if the project will have economic feasibility.

Electronic Key —words, IRR, NPV

I. INTRODUCTION

The north Technical University as well as other institutions of the Province of Imbabura in the course of the time have gone renewing his technological infrastructure especially the computational, accumulating and refusing of form no adapted the teams given of drop or into disuse generating like this electronic rubbish. At present the north Technical University as well as other institutions of the Province of Imbabura do not have contours or a process that treat of form adapted the electronic rubbish generated by the computers that are into disuse or have been renewed inside the institutions; finding these wastes accumulated in cellars, apilada in corners of some offices and other environments, occupying destined spaces for other activities, generating a negative impact to the environment since this type of rubbish is constituted by several toxic chemical materials.

This project will contribute recycling of the electronic rubbish that generates by the acumulamiento or waste of computers by part of the distinct institutions of the Province of Imbabura, giving him a correct treatment from his recolección and accumulation that will help with the improvement of the environment, going through diverse stages of processing to obtain pieces and teams that will be repotenciados to be

donated and in case of not being functional happened to a process of trituration to obtain recyclable materials that will be sold

The interest that has woken up this technology has promoted a process of review of the rules that regulate the broadcasts irradiate to allow that Band Ultra-Wide can operate legally, can expect that the technology UWB open the doors to the development of infinity of applications and communications of short scope.

II. STUDY OF MARKET

A. Variables of the market

Through the study of market obtained information with regard to the product to offer, the customers, the demand that will have the product as well as the competition defining of this way the following variables.

- Product
- Price
- Square
- Promotion
- Customers
- Competition

With regard to the product obtained two lines of products a sound the teams repotenciados that they will be donados and the second line will be the materials obtained of the processing of recycling of the computers and printers given of drop, offered these materials in saquillos of 100Kg for each one of the materials being these the plastic, glass, copper, aluminium and iron.

The price of market of these materials recycled to commercialise are distinct the one of the another having the following prices:

- Plastic \$1,25Kg
- Glass \$0,90Kg
- Copper \$1,70Kg
- Aluminium \$1,50Kg
- Iron \$3,77Kg

Regarding the square the materials find stored in cellars and the agreements of commercialisation make in an office inside the plant recicladora.

Promotion does not exist advertising neither company some that make the recycling of electronic rubbish in the province of Imbabura.

Customers, these would be the companies INTERCIA, RECYNTER and NOVACERO that commercialise and work with materials recycled.

Competition, in the city of Ibarra as well as in the province of Imbabura do not exist companies or plants recicladoras of electronic rubbish, existing an unsatisfied demand of 100%.

Regarding the sales established a prognosis of sales according to as it indicates it the table 1:

Table 1:

Available prognoses

Product	Year1	Year2	Year3	Year4	Year5
Plastic	17982,8	19350,2	20948,2	22546,2	24144,2
Glass	12225,25	13258,79	14194,79	15130,79	16066,79
Copper	10826,4	11624,1	12623,1	13622,1	14621,1
Aluminium	10607,9	11451,6	12340,6	13229,6	14118,6
Iron	17956,5	19429,5	20869,5	22309,5	23749,5

Source: Study of market (2015).

III. TECHNICAL STUDY

A. Macrolocalización

The plant recicladora of electronic rubbish found situated in the province of Imbabura which finds limited by north the province of the Carchi, south the province of Pichincha, west with the province of Emeralds and to the east with the province of Sucumbíos.



It appears 1. Province of Imbabura.

B. Microlocalización

For the microlocalización obtained 3 alternatives that show in the table 2

Table 2:

Alternatives of microlocalización

Alternative	Place
To	Experimental farm Yuyucocha
B	Farm The Meadow
C	Inland revenue Santa Mónica

Source: technical Study URECYCLA

To each one of the alternatives assign them a weighting for like this by means of a matrix of selection can determine which is the ideal location of the plant recicladora of electronic rubbish. For the weightings established and analysed the following criteria:

- **Area of terrain:** Factor of vital importance since it needs an extensive area for the location of the plant recicladora of electronic rubbish, have to cover the expectations to have a correct operation.

- **Access:** it Is important that the roads of access to the installations or location of the plant recicladora are the ideal and optimum to have a good transport or transfer of prime matters, insumos or products.
- **Prime matters:** The location of the plant recicladora has to have a criterion of connection with the distinct locations or places of which goes to obtain the prime matter.
- **Basic services:** For any type of project to make is indispensable to have basic services like service of electricity, water being east a requerimientor minimum and important to fulfil.
- **Activities to develop:** Inside the dependency in which it goes to find the silver recicladora does not have to have any type of problem that affect or prejudice to other activities that develop in the place or to his time that the activities that already develop in these predios do not cause conflicts with the activities of the plant recicladora
- **Hand of work:** it Is important that inside the sector where go to develop the distinct activities in the plant recicladora have the hand of necessary work for the operation of the same .

The weighting of factors that made shows it the table 3

Table 3
Weighting of factors

Criterion	Puntaje
Area of terrain	10
Access	5
Prime matters	5
Basic service	10
Activities to develop	10
Hand of work	3

Source: technical Study URECYCLA

Each one of the locations are evaluated cuantitativamente multiplying the factor of

weighting by each one of the qualifications of the criteria and finally add the results having a global qualification.

The table 4 sample the results obtained of each one of the locations.

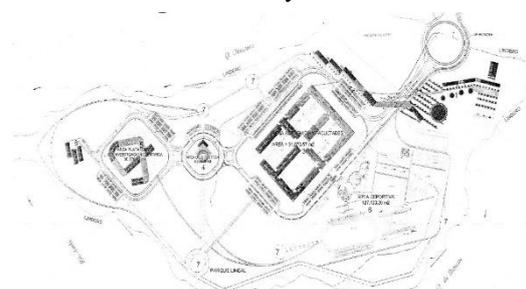
Table 4
Matrix of microlocalización

CRITERION	FACTOR OF PONDERACION	LOCATION - A		LOCATION - B		LOCATION - C	
		CAL. IF.	PO ND.	CAL. IF.	PO ND.	CAL. IF.	PO ND.
Area of terrain	10	7	70	8	80	10	100
Access	5	5	25	5	25	5	25
Prime matters	5	5	25	5	25	5	25
Basic services	10	10	100	10	100	10	100
Activities to develop	10	1	10	1	10	10	100
Hand of work	3	3	9	3	9	3	9
TOTAL			239		249		359

Source: technical Study URECYCLA.

As it can observe it is the location C the aptest for the plant recicladora of electronic rubbish, being this location the Inland revenue Santa Mónica place where will build the new headquarters of the north Technical University. In the figure 3 can see the planes of said construction and where will be situated the plant recicladora.

It appears 2. Plane of the new installations of the north Technical University.



C. ProvAndedores

Like providers of prime matters in this case the computers and printers that go to process has to distinct institutions of the province of Imbabura that have a big computational infrastructure, being these the Autonomous Governments Decentralised of all the province, public companies like EMAPA, EMELNORTE, the zonal coordination 1 of the region north, and also educational institutions like the north Technical University and the

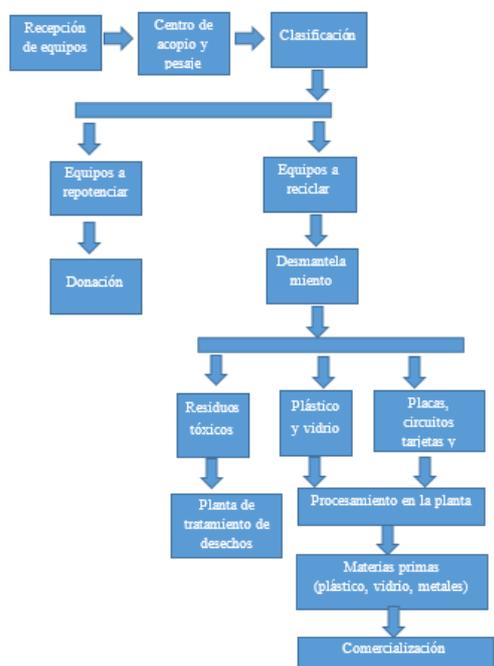
Catholic University headquarters Ibarra. They made calculations in base to the information recolectada of all these institutions having the following figures showed in the table 5 that indicate us the projections of teams to process in 5 years.

Table 5:
Projections of teams to process

Source: Technical Study URECYCLA

D. Operative proposal

Prime matter		Annual projections				
Comp uters (25Kg)	Prin ters (12 Kg)	Year 1	Year 2	Year 3	Year 4	Year 5



In the operative proposal have all the macro and micro-processes that will have the plant recicladora of electronic rubbish having the following macroprocesos like sample the figure 3.

It appears 3. Diagram of macroprocesos

Reception of teams: it proceeds to receive and disembark the teams from the providers.

Centre of gather and pesaje: The teams received are heavy and stored until happening to the following process.

Classification: The teams and his distinct elements that conform it are put to proofs of operations to classify those that they will be able to be reportenciados and those that became recycled.

Teams to reportenciar: they Are the teams that can have a second useful life him them reportencia for his operation.

Donation: The teams already reportenciados become donados like social contribution.

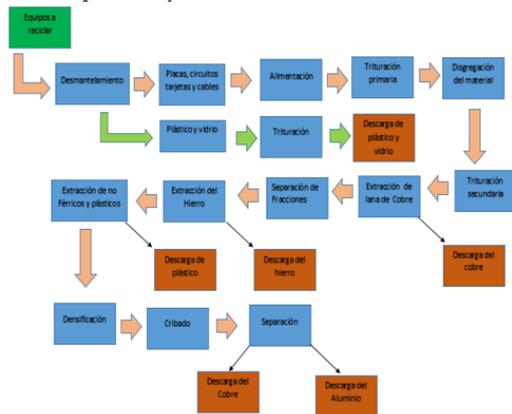
Teams to recycle: they Are teams no functional by which can not have a second useful life.

Dismantlement: In this stage to the no functional teams dismantles them to him to separate the toxic components, extract the plastic, glass, plates of circuits and wires to process.

Processing of the plant: it Is the group of microprocesos that will have the teams to recycle to obtain like result the glass, plastic and metals like prime matter.

Commercialisation: Stage in which the plastic prime matters, glass, and metals obtained of the process of the recycling will sell to the distinct buyers that wish to purchase them.

To continuation shows in the figure 4 which indicates all the microprocesos that carry out through the machinery inside the plant recicladora of electronic rubbish.



It appears 4. Diagram of microprocesos

Trituración Primary: The electronic rubbish goes in to a crusher with rotary shears to obtain lower fragments to the 150mm.

Disgregación Of the material: The fragments go through a vibrant table to have a better separation or desunión after the trituración.

Trituración Secondary: Through an ascending strip the fragments direct to the triturador secondary which goes to triturar these fragments obtaining ones of lower lower size to 25 and 30mm.

Extraction of wools of copper: The fragments are transported to a selection of vibrant bars where separates the wool of copper of the fragments and becomes loaded in the containers.

Separation of fractions: The fragments are transported to a separate automatic zig-zag which makes a separation of heavy and light fractions separating the dust of the fragments, which is stored in costales to refuse like rubbish.

Extraction of the iron: Through a band transport the fragments until arriving a separate magnetic overband which extracts the iron of the fragments and afterwards east becomes downloaded in a container.

Extraction of no ferric and plastic: The remaining fragments without iron arrive through a band transportadora to a separador inductivo

which withdraws the no ferric metals the remaining material is plastic that happens to download in containers.

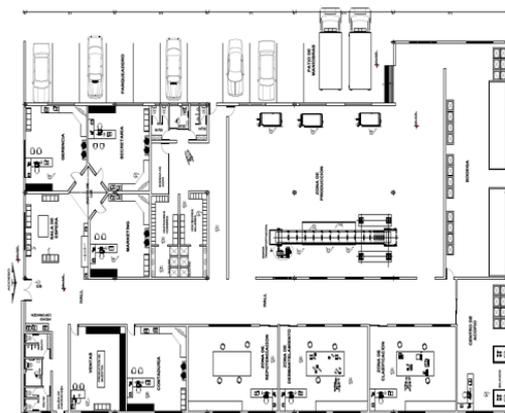
Densificación: The no ferric metals obtained by the separador inductivo happen to a mill of hammers so that these metals take a greater density.

Sifted: The no ferric metals arrive to the process of sifted where separates the fragments according to the size of cut, in this case courts between 4 and 8mm.

Separation: The already sifted metals arrive to the tables densimétricas of aluminium and of heavy metals where produces the separation of these that afterwards become loaded in the containers of aluminium and copper.

E. Infrastructure and equipment

Regarding the infrastructure the figure 5 shows us the distribution of the plant and all his dependencies.



It appears 5: Plane of the company URECYCLA

The table 6 that shows to continuation details us the distinct dependencies of the plane as well as his measures.

Table 6:
Detail of areas and metres of the plane
URECYCLA

#	Areas / Detail	Area in m2
1.- Area of attention:		100
1	Hall Of access	50
2	Room of wait	20
3	Office of sales	30
2.- Area of Production		800
4	Centre of gather	70
5	Zone of classification	70
6	Zone of dismantlement	70
7	Zone of repotenciación	70
8	Zone of production	300
9	Cellar	200
10	Camerinos Of employees	20
3.- Offices and services		300
11	Management	30
12	Secretary	30
13	Contaduría	30
14	Marketing	30
15	Hygienic services	30
16	Parqueaderos	150
TOTAL		1200

To continuation detail all scheme them necessary for the operation of the plant of recycling of electronic rubbish.

- Modular elevator
- Crusher with rotary shears
- Table vibradora
- Band transportadora
- Crusher
- Selection vibradora
- Separador Of Zig.Zag
- Separador Magnetic
- Separador inductivo
- Mill of hammers
- Selection with court

- Mensa densimetrica For aluminium
- Table densimetrica for copper
- Crusher of glass

Regarding the equipment for offices or the plough administrative and vehicles have the following:

- Computer
- Telephone
- Desk
- Chair
- Montacargas

F. Proposed partner-business

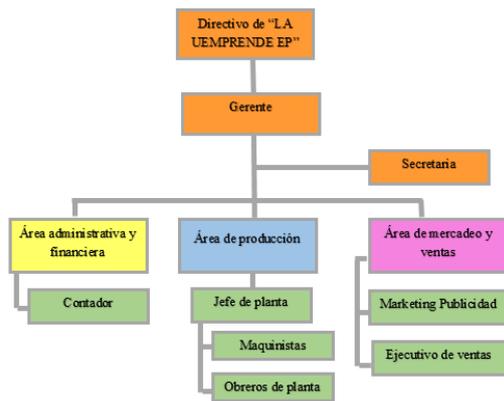
The name of the company will be URECYCLA- And.P., it determined this name based in that the project belongs or gives off of the north Technical University by which employ the letter Or to identify to the place to the that belongs the project and the word RECYCLA that does reference to the recycling of the electronic devices and the acronyms And.P Pertaining to his legal structuring like public company.

In the proposed partner-business established the mission and vision of the company that are the following:

Mission: Recolectar and process technological wastes of responsible form and with the commitment to take care the environment, with the end to contribute to the social development and offer to the national market as well as to the international prime matters of high quality obtained of the process of recycling.

Vision: For the year 2020 be an innovative company and leader in the processes and recycling of the electronic rubbish in the Ecuador.

It established the structural organisation chart of the company as it shows it the figure 6, and to his time structure a manual of functions that establishes all the activities and profile that have to have the workers.



It appears 6. Structural organisation chart

G. Proposal of corporate image

Like proposal of image made the following logo, that can observe in the figure 7.



It

appears 7. Logo URECYCLA

The logo consists in a plate of electronic circuit which is of green colour since this colour represents to the projects of ecological order as it is the case of the project that goes to contribute to the care and mejoramiento of the ecosystem since it goes to recycle electronic rubbish which is constituted by a lot of electronic circuits.

Like slogan of identification established the sentence **Your electronic teams can have another life Recycles!**, since like social contribution of the project many of the computational teams will be repotenciados giving them a second useful life, being donados and given a social contribution.

H. Legal proposal

So that the project URECYCLA constitute like public company of the north Technical University has to base in the Resolution of creation of the PUBLIC COMPANY “THE UEMPRENDE EP”, in which the **article 2 Object** protects the creation of the project URECYCLA.

I. Analysis FODA

F (Fortresses)

F1. The north Technical University has the physical spaces or necessary dependencies so that the location and operation of the plant recicladora of electronic rubbish.

F2. It exists the availability of resources by part of the north Technical University as well as of the Government to undertake projects that contribute to the environment.

Or (Opportunities)

Or1. They do not exist other plants recicladoras of electronic rubbish inside the province of Imbabura.

Or2. It exists a big opening in the market for the commercialisation of materials recycled.

D (Weaknesses)

D1. They do not exist constitutional contours, in organic codes or university politics with regard to the handle of the electronic rubbish.

D2. Little personal with experience in the handle of wastes or electronic waste.

To (Threats)

To1. A national economic crisis would limit or would restrict the resources that allocate for project that contribute to the care of the environment.

To2. Development of a project of electronic recycling by part of another institution or public or private organism.

IV. ECONOMIC STUDY

To determine the economic feasibility of the project URECYCLA, used distinct tools and financial variables that to continuation detailed and showed.

They established costs of production to be able to determine the price of each one of our materials and can determine if these are competitive inside the market having the following prices:

- Glass \$0,85 each kilo
- Plastic \$1,24 each kilo
- Copper \$1,42 each kilo
- Aluminium \$1,45 each kilo
- Iron \$0,85 each kilo

With regard to the necessary investment to undertake the project URECYCLA had a mount total of \$217.167,90, being this investment totally with an own bottom since these resources would put the University and does not exist private investment by part of another institución financial like a bank.

In the table 7 can observe the personnel with which goes to explain the plant recicladora of electronic rubbish and the respective wages to assigned to each one of the charges.

Table 7:
Personnel

Personnel			
PERSONNEL	NUMBER	MONTHLY WAGE	TOTAL YEAR
Manager	1	750,00	9.000,00
Secretary	1	366,00	4.392,00
Boss of plant	1	550,00	6.600,00
Engine driver	2	450,00	5.400,00
Worker	6	2.196,00	26.352,00
TOTAL		4.312,00	51.744,00

The capital of work that needs consists of some rubros, in the table 8 can them to him observe.

Table 8: Capital of work

CAPITAL OF WORK	
	MONTH
Wages	4.312,00
Cost Luz, Water	80
I spend Telephone and Internet	21
Promotion and Advertising	25
Supplies Office	25
TOTAL	4.463,00

The projections of sales and therefore of our income made to 5 years having the following results for every year:

- Year 1 \$136.393,10
- Year2 \$147.275,76
- Year 3 \$158.656,16
- Year 4 \$170.036,56
- Year5 \$181.416,96

The depreciations are rubros important which were calculated and will be useful to the moment to make our flows of box. In the table 9 can observe the depreciations through the time.

Table 9:
Depreciations

DEPRECIATIONS		
PERIOD	ANNUAL VALUE	MONTHLY VALUE
1	6.246,45	520,5375
2	6.246,45	520,5375
3	6.246,45	520,5375
4	5.436,45	453,0375
5	5.436,45	453,0375
6	3.996,45	333,0375
7	3.996,45	333,0375
8	3.996,45	333,0375
9	3.996,45	333,0375
10	3.996,45	333,0375

To continuation determines our state of results which indicates us if they exist losses or utilities having the following values projected in the table 10.

Table 10:
State of results

RUBROS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
INCOME	136.393,10	147.275,76	158.656,16	170.036,56	181.416,96
SALES	136.393,10	147.275,76	158.656,16	170.036,56	181.416,96
COSTS OF PRODUCTION	104.825,24	104.825,24	104.825,24	104.825,24	104.825,24
GROSS UTILITY	31.567,86	42.450,52	53.830,92	65.211,32	76.591,72
COSTS OF OPERATION	14.661,96	16.128,16	17.740,97	19.515,07	21.466,58
OPERATIVE UTILITY	16.905,90	26.322,36	36.089,94	45.696,25	55.125,14
NET UTILITY	16.905,90	26.322,36	36.089,94	45.696,25	55.125,14

To continuation proceeds to project our flows of box in base to which used the financial variables TIR (Internal Tax of Return), and GO

(Net Current Value), the flows of box obtained are the following:

- Year 0 \$-134.905,00
- Year 1 \$ 21.304,96
- Year 2 \$ 36.522,67
- Year 3 \$ 41.564,63
- Year 4 \$ 46.162,22
- Year 5 \$ 50.278,58

Already with the flows of box obtained proceed to calculate the economic variables IRR and NPV and also the relation cost benefit. The table 11 shows us the figures obtained.

Table 11
IRR And NPV

TAX OF DISCOUNT	0,12
CURRENT VALUE INCOME	\$ 575.895,99
CURRENT VALUE EGRESOS	\$ 562.433,20
NET CURRENT VALUE	\$ 13.462,79
INTERNAL TAX OF RETURN	15%
RELACION BENEFIT COST	\$ 1,02

The tax of discount established is of 12% value porcentual with which the SENPLADES works the projects of public order, the Net Current Value is of **\$ 13.462,79** which indicates that there are not losses, the Internal Cup of Return is of 15% which when being greater to the tax of discount of 12% determines us that it exists economic feasibility and the relation cost benefit is of **\$1,02** which when being greater to 1 establishes that there is gain or is viable the project.

To his time made the caculos to determine the monetary break-even point which is of **\$64.205**, figure or rubro that indicates us that they have to make sales by this value not to lose neither win.

V. CONCLUSIONS AND RECOMMENDATIONS

Conclusions:

- Like providers of prime matter estimated to the distinct institutions of the province of Imbabura obtaining for the first year 69598,85Kg to process and with which obtained the prices or costs of production of the products to obtain being these competitive in comparison to which offers the current market.
- It determined the economic feasibility of the plant recicladora of electronic

rubbish with through the economic variables IRR of 15% and a NPV of 13.462,79 taking in account an annual increase of 5800Kg in prime matters and of sales projected to 5 years.

Recommendations

- Obtain a greater quantity of teams given of drop by part of people, or other institutions to obtain a greater quantity of income and like this obtain a better price to offer to the market.
- Fulfil with the quantity of kilos from the teams established to process to obtain economic feasibility inside the project, established of annual way and projected to 5 years.

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