UNIVERSITAT POLITÈCNICA DE CATALUNYA

DELIVERABLE 3: BUDGET AND SUSTAINABILITY

Design of an environment for solving pseudo-boolean optimization problems

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Chapter 1

Self-assessment on sustainability

During my studies, there have been different activities related with sustainability. It is a must that ICT[1] students know the effects of the solutions they will develop. ICT are currently releasing the 2% of greenhouse gases[4] which is more than the aerospace industry. Not only this, the electronic waste is difficult to recycle and they end up in poor countries[2] condemning people to an unhealthy life.

This form[2] helped me to realize what are my strengths and weaknesses about sustainability: environment, economic, and social.

As explained before, we have a good education about sustainability and we are aware of ICT problems. I am very conscious with all the environmental problems ICT are causing because all the activities I have done in the past but I do not know how this problems can be solved at global level. I think it is a very hard problem and it has to be solved as soon as possible. On the other hand, I had not been aware about economic and social impact until some months ago. The moment when I understood that was when Uber appeared in Spain[1]. I am not going to discuss who was right but how a mobile application could affect the society and the economy (of the taxi collective in this case).

It is hard to predict which effects will have an ICT solution and I realized doing the form that it has not been my priority in my past projects. Do not misunderstand this, of course I want to improve the world with my projects but side effects are hard to predict.

In conclusion, I would say that I am conscious about the sustainability problems of ICT solutions but not how they can be solved. I am also not aware of the footprint of my past projects.

[1] Information and communications technology

[2] Cuestionario de Estudiantes de Ingeniería Informática

Chapter 2

Analysis of the sustainability of the project

2.1 Economic dimension: Budget

In this section all the costs of the project are exposed.

2.1.1 Direct costs

Direct costs are those that have a direct relation with the manufacture of the product. In this case, the only direct costs are the human resources.

Human resources

The cost of the human resources has been estimated with the following expression: $Cost = \frac{Salary}{Hour} \times ExpectedHours$. The salaries have been extracted from PagePersonnel study[3]. In this study the salaries are expressed per year. In average, there are 1.500 working hours per year. To obtain the price per hour, the salary per year has been divided by the working hours per year.

Taking in consideration the Gantt chart from the previous deliverable, the dedication of each role has been defined as following:

Stage	Project Manager	Software Architect	Developer
GEP	70	0	0
Initial Stage	30	30	30
Iteration 1,2,3	6	147	87
Final Stage	30	0	20

TABLE 2.1: Hours destined to each stage per role

Role	Estimated hours (h)	Price/hour (€)	Total cost (€)
Project Manager	136	27	3.672
Software Architect	177	25	4.425
Developer	137	14	1.918
Total			10.015

TABLE 2.2: Human resources budget

2.1.2 Indirect costs

Indirect costs are those that does not have a direct relation with the manufacture of the product. In this case, the indirect costs are Hardware, Software, and some others.

Hardware

According to *Agencia Tributaria*[1], the maximum number of years to amortize a computer equipment is 8. Therefore the amortization of Hardware resources has been calculated following this expression: $Amortization = \frac{Price}{8 \times 12} \times 5$

Product	Price (€)	Units	Useful life (y)	Amortization (€)
Lenovo IdeaPad U330T	899	1	8	46,83
Total				46,83

TABLE 2.3: Hardware resources budget

Software

For software resources, free tools have been selected and student discounts have been used to minimize the total cost.

Product	Price (€)	Units	Useful life (y)	Amortization (€)
GitHub	6,10/month	5	N/A	30,5
GitHub student pack	-6,10/month	5	N/A	-30,5
Clion	6,90/month	5	N/A	34,5
JetBrains Product Pack for Students	-6,90/month	5	N/A	-34,5
Atom	0,00	1	N/A	0,00
TeXstudio	0,00	1	N/A	0,00
Total				0,00

TABLE 2.4: Software resources budget

Other resources

Internet connexion price has been extracted from Pepephone[2] plan, which is 34,6€ per month.
kWh price has been extracted from Selectra. The average price per kWh is 0,12€. In office supplies paper packs, books, pens, ... are included.

Product	Price(€)	Units	Total (€)
Internet connexion	0,047/h	450 hours	21,15
Power consumption	51Wh	450 hours	2,75
Print	0,05/page	400 pages	20
Office supplies	50	1	50
Total			93,9

TABLE 2.5: Other resources budget

[1] Agencia Tributaria - amortizations
[2] Pepephone fibra

2.1.3 Contingency

The contingency percentage for direct costs has been estimated following my experience on past projects. For indirect costs, the budget is easier to estimate therefore a small percentage has been selected.

Concept	Price (€)	Percentage (%)	Total (€)
Direct costs	10.015	30	3.004,5
Indirect costs	140,73	15	21,11
Total			3.025,61

TABLE 2.6: Contingency budget

2.1.4 Unforeseen

The first unforeseen is that the computer breaks. In this case a new one will be bought. The other unforeseen events are that the stages of the project being extended. For each stage a 50% delay has been estimated.

Unforeseen	Cost (€)	Probability (%)	Total (€)
Broken computer	1.300	5	65
Delay GEP stage	945	15	141,75
Delay initial stage	990	15	148,5
Delay iteration 1	842,5	15	126,38
Delay iteration 2	842,5	15	126,38
Delay iteration 3	842,5	15	126,38
Delay final stage	545	15	81,75
Total			816,14

TABLE 2.7: Unforeseen budget

2.1.5 Total budget

In conclusion, the total budget of the project is:

	Cost (€)
Direct costs	10.015
Indirect costs	140,73
Contingency	3.025,61
Unforeseen	816,14
Total	13.997,48

TABLE 2.8: Total budget

2.1.6 Control management

The control management mechanisms will be used to study and compare deviations.

For Human Resources, a follow-up of the hours will be done to see if the planning is accurate or not. With this information, some adjustments could be done. For

example add or remove functionalities to achieve the dead line. An other method to solve the possible deviations could be reorganize the Gantt chart. Finally, if the deviations could not be avoided, the contingency budget would be used to compensate them.

At the end of the project, the original estimated budget will be compared with the real one. Finally where deviations appeared, why, and how much will be studied.

The indicators used for that are: Variance in cost by rate, efficiency variance, variance in totals, ...

2.2 Economic dimension: Reflection

2.2.1 PPP

The estimated budget of the project can be found in table 2.8. The estimated budget ascends to 13.997,48€. This number has been estimated taking into account the working hours of each role, the hardware and software used, indirect costs, contingency, and unforeseen events.

2.2.2 Shelf life

Nowadays, the no optimization of Pseudo-Boolean encodings implies that the problems are bigger and harder which causes a long execution and more consumption of resources. With the optimizations that this project will study, the final execution time could be reduced therefore the power needed to solve the problem which translates in a more reduced cost.

2.2.3 Risks

As exposed previously, some risks are problems with the planning, problems with the tools used,...
The main risk is that the optimizations proposed are not useful in a practical environment.

2.3 Environmental dimension

2.3.1 PPP

The estimated electric usage for this project can be found in this table 2.5. The estimation has been done with this expression: $E = \frac{W}{h} \times T$. In this project $E = \frac{51W}{1h} \times 450h = 22,950kW$

It is hard to minimize more the impact of this project. Some strategies are turning off the computer when not using it, minimizing the amount of paper used, ...
Some resources are reused, for example, instead of writing all the functionalities, some C++ libraries will be used.

2.3.2 Shelf life

It is hard to measure the footprint of this project along all its useful life. It will depend on the success of the project and how many people will use it.

Currently SAT problems are executed in SAT-Solvers using some optimizations. This project purposes more optimizations to reduce the execution time. This will have a positive impact in the environment because it will reduce the total CO^2 emissions released by the computers used to solve them.

2.3.3 Risks

The footprint of this project could be worst than expected if the development of it is extended.

2.4 Social dimension

2.4.1 PPP

This first stage of the project, GEP, will improve my management and planning skills, my English abilities, how to document and budget projects.
The other stages, will expand my knowledge about informatics and the opportunity to put in practice a lot of skill developed during this degree.
Finally, my ability to present in front of people and defend the work done during these months.

2.4.2 Shelf life

This project will improve a lot of fields because SAT-Solvers are widely used. For example, Planners, Artificial Intelligence, ... which can have an unpredictable impact in the life of people.

Currently this problem is solved using other techniques. The solution that this project purposes is an addition to them (it is not exclusive). There is a real need for this type of projects because as said previously, SAT is an NP-Complete problem therefore any improvement on this field will reduce the hardness of the problem with all the consequences this implies.

2.4.3 Risks

The only negative impact that this project can have is not being useful. In this case it will not be used and the society will remain the unchanged.

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