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Software Engineering 2 Project:

"PowerEnJoy"

Project **P**lan

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Revision History

Revision	Date	Author(s)	Description
1.0	22/01/17	Piazzolla Millimaggi	First document issue

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1 INTRODUCTION

1.1 Purpose and Scope

1.1.1 Purpose

The purpose of this document is to provide an estimation of the cost and the size of the project. This knowledge is needed to organize the resources needed in the development of the system and to properly schedule the activities of the project.
To reach this purpose, two models will be used:

- **Function Point:** This approach is used to estimate the size of the project in LOC.
- **COCOMO:** This model is used to estimate the effort required by the project in PM.

1.1.2 Scope

PowerEnJoy is a digital system for the management of a car-sharing service that only employs electric cars. In particular the aim is to develop a mobile application that allows the user to pick up and use electric cars in the areas reached by the service.

1.2 List of Definitions and Abbreviations

1.2.1 Acronyms

- RASD: Requirement Analysis and Specification Document.
- DD: Design Document.
- DBMS: Database Management System.
- DB: Database.
- GPS: Global Positioning System

1.2.2 Definitions

1.2.3 Abbreviations

- FP: Function Points.
- ILF: Internal logic file
- ELF: External logic file.
- EI: External Input.
- EO: External Output.

- EQ: External Inquiries.
- PH: Person Hours.
- LOC: Lines Of Code.

1.3 List of Reference Documents

- PowerEnJoy RASD.
- PowerEnJoy DD. **NOTE:** The reader must refer to the version 1.1 of the DD.
- COCOMO II Model Definition Manual, http://csse.usc.edu/csse/research/COCOMOII
- "Project Management" slides by prof. Mottola

2 Function Points: size estimation

2.1 Overview

We use the Function Points approach to estimate the size of the project. This approach makes an estimation of the size of the project based on the functionalities of the system. In particular it analyses:

- Data structures. These can be of two types:
  - Internal Logic Files, that are logically related data which are used and managed by the application.
  - External Interface Files, that are logically related data which are used by the application, but are generated, reside and are managed in other applications.
- External Input operations, that are operations that elaborate data coming from external systems.
- External Output operations, that are operations that generate data to send to external systems.
- External Inquiries, that are operations that involve both input and output and allow to retrieve data from Internal Logic Files and External.

To each element of those types a weight is given, based on the complexity of the table.
Multiplying the elements by their weights and summing the results we obtain the overall Function Points:

$$FP = \sum Number\ of\ elements\ of\ a\ type * weight \tag{1}$$

At the end, using the number of FPs, an estimation of the LOC of the project is estimated with the following formula:

$$LOC = AVC * number\ of\ function\ points \tag{2}$$

AVC is a parameter that depends on the programming language used. We have chosen to use the Average value for Java among the values of the table that can be found in [1], because Java is the main language used in the project.

Table 2. FP Counting Weights

For Internal Logical Files and External Interface Files

	Data Elements		
Record Elements	**1 - 19**	**20 - 50**	**51+**
1	Low	Low	Avg.
2 - 5	Low	Avg.	High
6+	Avg.	High	High

For External Output and External Inquiry

	Data Elements		
File Types	**1 - 5**	**6 - 19**	**20+**
0 or 1	Low	Low	Avg.
2 - 3	Low	Avg.	High
4+	Avg.	High	High

For External Input

	Data Elements		
File Types	**1 - 4**	**5 - 15**	**16+**
0 or 1	Low	Low	Avg.
2 - 3	Low	Avg.	High
3+	Avg.	High	High

(a) FP Counting Weights

Table 3. UFP Complexity Weights

Function Type	Complexity-Weight		
	Low	Average	High
Internal Logical Files	7	10	15
External Interfaces Files	5	7	10
External Inputs	3	4	6
External Outputs	4	5	7
External Inquiries	3	4	6

(b) UFP Complexity Weights

Figure 1: FP Analysis

2.2 Internal Logic Files

The PowerEnjoy Service needs to store information about:

- **User:** This data consist in a small set of user information, for this reason its complexity has been considered **Simple**.
- **Car:** This data consist in a small set of car information, for this reason its complexity has been considered **Simple**.
- **Safe Area:** This data consist in a small set of safe area information, for this reason its complexity has been considered **Simple**.
- **Trip:** This data consist in a small set of trip information, for this reason its complexity has been considered **Simple**.

Data	Weight Type	Weight
User	Simple	7
Car	Simple	7
Safe Area	Simple	7
Trip	Simple	7
TOT	**28**	

2.3 External Interfaces File

- **GPS positioning:** This data consist on information received by user or by OnBoard device of the car.
  Because the managing involve some algorithms it's considered **Complex**.

Data	Weight Type	Weight
GPS positioning	Complex	10
TOT	**10**	

2.4 External Input

- **Sign-Up:** Create a new user entry in the system Database.
  The complexity has been considered **Simple**
- **Log-In/Log-Out:** Manage the user authentication. Require a module to generate an auth token
  The complexity has been considered **Medium**.
- **Update user information:** Update users information in the system Database.
  The complexity has been considered **Simple**.
- **Request car reservation:** Manage the car reservation in the system. Require many check on the availability.
  The complexity has been considered **Medium**.
- **Unlock car:** Check if the user is nearby the reserved car and send an unlock request to the car. Require algorithm on user position.
  The complexity has been considered **Complex**

Data	Weight Type	Weight
Sign-Up	Simple	3
Log-In/Log-Out	Medium	4
Update user information	Simple	3
Request car reservation	Medium	4
Unlock car	Complex	6
TOT	**20**	

2.5 External Inquiries

A PowerEnJoy user can ask the system for the retrieval of some data:

- **Car list:** User can request the list of cars available in a certain area or address. Involve Geolocalization algorithms.
  The complexity has been considered **Medium**.
- **Special Parking Area request:** User can request the list of available special parking areas. Require to query the status of the nearby special parking area.
  The complexity has been considered **Medium**.
- **Parking Area request:** User can request the list of parking areas. Require to query the status of the nearby special parking area.
  The complexity has been considered **Medium**.
- **Personal Data request:** User can request to see its personal data. Data can be obtained with a simple Database Query.
  The complexity has been considered **Simple**.
- **Trip list:** User can request the list of trips done in a certain period.
  The complexity has been considered **Complex**.

Data	Weight Type	Weight
Car list	Medium	4
Special Parking Area request	Medium	4
Parking Area request	Medium	4
Personal Data request	Simple	3
Trip list	Complex	6
TOT	**21**	

2.6 External Output

Beyond answers to External Inquiries, the system has to send other types of messages to the user:

- **Reservation confirmation:** A notification of the confirmation of a reservation. Require email or push notification system.
  The complexity has been considered **Simple**.
- **End Trip notification:** A notification of the end of a trip. Require the status of the car through the OnBoard device.
  The complexity has been considered **Medium**.
- **Payment notification:** A notification of the confirmation of the payment. Require an integration with the payment system.
  The complexity has been considered **Medium**.

Data	Weight Type	Weight
Reservation confirmation	Simple	4
End Trip notification	Medium	5
Payment notification	Medium	5
TOT	**14**	

2.7 Results

According to the element in each section and their weight in complexity the total of Function Points that provide an indication of the size of the system in functional terms:

$$FP = ILF + EIF + EI + EQ + EO \tag{3}$$

Total Function Points: **93**
Using 46 as AVC the final value of the estimated line of code is:

$$LOC = 46 * 93 = 4278 \tag{4}$$

3 COCOMO analysis

The COCOMO model allows to estimate the time effort required by the project. We use the version of this model called COCOMO II. It is based on a main formula:

$$PM = A * Size^E * \prod_{1<=i<=n} EM_i \tag{5}$$

where:

- **PM** stands for "Person-Months"
- **A**=2.94. It approximates a productivity constant in PM/KSLOC for the case where E = 1.0.
- **Size** is measured in KSLOC and is the result of the Function Points analysis.
- **E** is an aggregation of 5 **scale factors**:
  - **Precedentedness:** It is high if the project is similar to several previous projects
  - **Development Flexibility:** It is high if there are no specific constraints to conform to pre-established requirements and external interface specifications.
  - **Architecture/Risk Resolution:** It is high if the project plan includes a good risk management plan, a clear definition of budget and schedule, with a focus on architectural definition
  - **Team Cohesion:** It is high if all stakeholders are able to work in a team and share the same vision and commitment.
  - **Process Maturity:** Refers to a well known method for assessing the maturity of a software organization, CMMI, that is a process level improvement training and appraisal program.

Scale Factors	Very Low	Low	Nominal	High	Very High	Extra High
PREC	thoroughly unprecedented	largely unprecedented	somewhat unprecedented	generally familiar	largely familiar	thoroughly familiar
SF_j:	6.20	4.96	3.72	2.48	1.24	0.00
FLEX	rigorous	occasional relaxation	some relaxation	general conformity	some conformity	general goals
SF_j:	5.07	4.05	3.04	2.03	1.01	0.00
RESL	little (20%)	some (40%)	often (60%)	generally (75%)	mostly (90%)	full (100%)
SF_j:	7.07	5.65	4.24	2.83	1.41	0.00
TEAM	very difficult interactions	some difficult interactions	basically cooperative interactions	largely cooperative	highly cooperative	seamless interactions
SF_j:	5.48	4.38	3.29	2.19	1.10	0.00
PMAT	The estimated Equivalent Process Maturity Level (EPML) or					
	SW-CMM Level 1 Lower	SW-CMM Level 1 Upper	SW-CMM Level 2	SW-CMM Level 3	SW-CMM Level 4	SW-CMM Level 5
SF_j:	7.80	6.24	4.68	3.12	1.56	0.00

Figure 2: Scale Factors

E is calculated with the formula:

$$E = B + 0.01 * \sum_{1<=j<=5} SF_j \tag{6}$$

where B=0.91

3.1 Scale Factors

3.1.1 Precedentedness

For our development team is the first project done in the field of Car Sharing involving electric cars and so the personnel has no previous knowledge about it. For this reason we consider the Precedentedness of our project **Very low**.
PREC=6.20

3.1.2 Development Flexibility

As for pre-established requirements, the development team is provided with a lot of requirements about the application and the service to be considered. On the other hand, there is no constraint on external interfaces to be considered. So, taking the average of the low flexibility for requirements and the high flexibility on external interfaces, the resulting Development Flexibility is **Nominal**.
FLEX=3.04

3.1.3 Architecture/Risk Resolution

Considering that the people in charge of project planning are new to this job, but they are also very motivated and able to learn fast, we can consider that their work on the risk management plan and the definition of budget and schedule has a **Nominal** rate, taking the average of the low experience and the personnel characteristics.
RESL=4.24

3.1.4 Team Cohesion

The group working on the project has newly been assembled, so its cohesion is in general unknown. Nevertheless, the people selected to join the group are all young, motivated, open-minded and suitable for group-works, so we can consider the Team Cohesion **Nominal**, taking the average of high uncertainty and good skills of the personnel.
TEAM=3.29

3.1.5 Process Maturity

The maturity level of the project is **2**, for this reasons:

- The processes of our project will be planned and executed according to specific and clear criteria.
- The people that will work on the project have been selected among a wide list of candidates and only the one that have demonstrated to have the best skills have been chosen.
- We consider the resources provided by the customer and the ones already owned by the development team adequate.
- We have the purpose of involving in the processes all the stakeholders as much as possible, to have frequent feedbacks and suggestions on the works
- Having the purpose of receiving feedbacks, we will use them and other evaluations to check the adherence of the project to requirements.
- The development team is focused only on the PowerEnJoy project, so of course the processes are planned, documented, performed,monitored and controlled at the project level.
- Because the development team has no previous knowledge about the field of car sharing, it will have mainly a reactive behavior, because it cannot predict problems that it doesn't know.

PAMT=4.68

3.2 Effort Multiplier

EM stands for Effort Multiplier. Effort multipliers are derived from **Cost drivers**. The selection of these cost drivers depends on wh1ether the project regards a **Post-Architecture** system or a **Early Design** system. We are in the Early Design case, because we are extending an existing product and our system will be developed from scratch. So the cost drivers are:

3.2.1 Personnel Capability

Personnel Capability (PERS) is a combination of Analyst Capability(ACAP), Programmer Capability(PCAP) and Personnel Continuity cost driver of Post-Architecture.
In our case we have little experience in the software analysis but this is balanced by good programming skills. The combination of ACAP and PCAP can be considered as **"Nominal" PERS=1.0**

Rating Levels	Extra Low	Very Low	Low	Nominal	High	Very High	Extra High
Effort Multipliers	2.12	1.62	1.26	1.00	0.83	0.63	0.50

Figure 3: EMs of PERS

3.2.2 Product Reliability and Complexity

Product Reliability and Complexity(RCPX) is a combination of Required Software Reliability(RELY), Data Base Size(DATA), Product Complexity(CPLX) and Documentation Match to Life-Cycle Need(DOCU) cost drivers of Post-Architecture.
The software reliability is very important because a failure of the system can potentially cause a huge financial loss.
The DATA cost driver attempts to capture the effect large test data requirements have on product development. For this particular driver we don't have enough information to do a reliable estimation so the value can be considered **"Nominal"**.
We decided to assign the complexity of the system a value **"High"**
RCPX=1.33

Rating Levels	Extra Low	Very Low	Low	Nominal	High	Very High	Extra High
Effort Multipliers	0.49	0.60	0.83	1.00	1.33	1.91	2.72

Figure 4: EM of RCPX

3.2.3 Developed for Reusability

There are no requirement on Reusability so the value is considered **"Nominal"**
RUSE=1.0

RUSE Descriptors:		none	across project	across program	across product line	across multiple product lines
Rating Levels	Very Low	Low	Nominal	High	Very High	Extra High
Effort Multipliers	n/a	0.95	1.00	1.07	1.15	1.24

Figure 5: EMs of RUSE

3.2.4 Platform Difficulty

Platform Difficulty (PDIF) is a combination of Execution Time Constraint(TIME), Main Storage Constraint(STOR) and Platform Volatility(PVOL) cost drivers of Post-Architecture.
The OnBoard device is real-time embedded product so the execution time is important, but on the rest of the system there are no particular constraint about the execution time. Same as before there are no requirements on Storage so both can be considered ad **"Nominal"**. Platform Volatility can be considered **"Very high"** because the system is composed of different part on different system (OnBoard Device, Application Logic on server, Client on smartphone or browser).
PDIF=1.29

Rating Levels	Low	Nominal	High	Very High	Extra High
Effort Multipliers	0.87	1.00	1.29	1.81	2.61

Figure 6: EMs of PDIF

3.2.5 Personnel Experience

Personnel Experience (PREX) is a combination of Application Experience(APEX), Platform Experience(PLEX), Language and Tool Experience(LTEX) cost drivers of Post-Architecture.
Because of the team inexperience the overall value is considered **"Low"**
PREX=1.22

Rating Levels	Extra Low	Very Low	Low	Nominal	High	Very High	Extra High
Effort Multipliers	1.59	1.33	1.22	1.00	0.87	0.74	0.62

Figure 7: EMs of PREX

3.2.6 Facilities

Facilities (FCIL) is a combination of Use of Software Tools(TOOL) and Multi-site Development(SITE) cost drivers of Post-Architecture.
Because of the entity and the life-cycle of the product development there are different system and tools that need to be integrated to develop the whole product so TOOL is considered **"Low"**. With all the new collaboration tools (Slack,

github, Skype) the Multi-Site development driver is considered **"Nominal"**
FCIL=1.10

Rating Levels	Extra Low	Very Low	Low	Nominal	High	Very High	Extra High
Effort Multipliers	1.43	1.30	1.10	1.0	0.87	0.73	0.62

Figure 8: EMs of FCIL

3.2.7 Required Development Schedule

Required Development Schedule (SCED):
Non accelerated Waterfall Developement Schedule so it's considered **"Nominal"**.
SCED=1.0

Rating Level	Very Low	Low	Nominal	High	Very High	Extra High
Effort Multiplier	1.43	1.14	1.00	1.00	1.00	n/a

Figure 9: EMs of SCED

Driver	PERS	RCPX	RUSE	PDIF	PREX	FCIL	SCED	Product
Value	1.0	1.33	1.0	1.29	1.22	1.10	1.0	2.3024694

Table 2: EM Result Table

3.3 Results

According to the Scale Factors and the Effort Multiplier

$$Effort = A * KLOC^{E} * EAF$$

$$A = 2.94$$

$$EAF = \prod_{1<=i<=n} EM_i \approx 2.3$$

$$E = 0.91 + 0.01 * 21.45$$

Total effort result in persons months:

$$PM = 34.70$$

$$Duration = 3.67 * (PM)^{(0.28+0.2*(E-0.91))} = 11.4924 \quad (7)$$

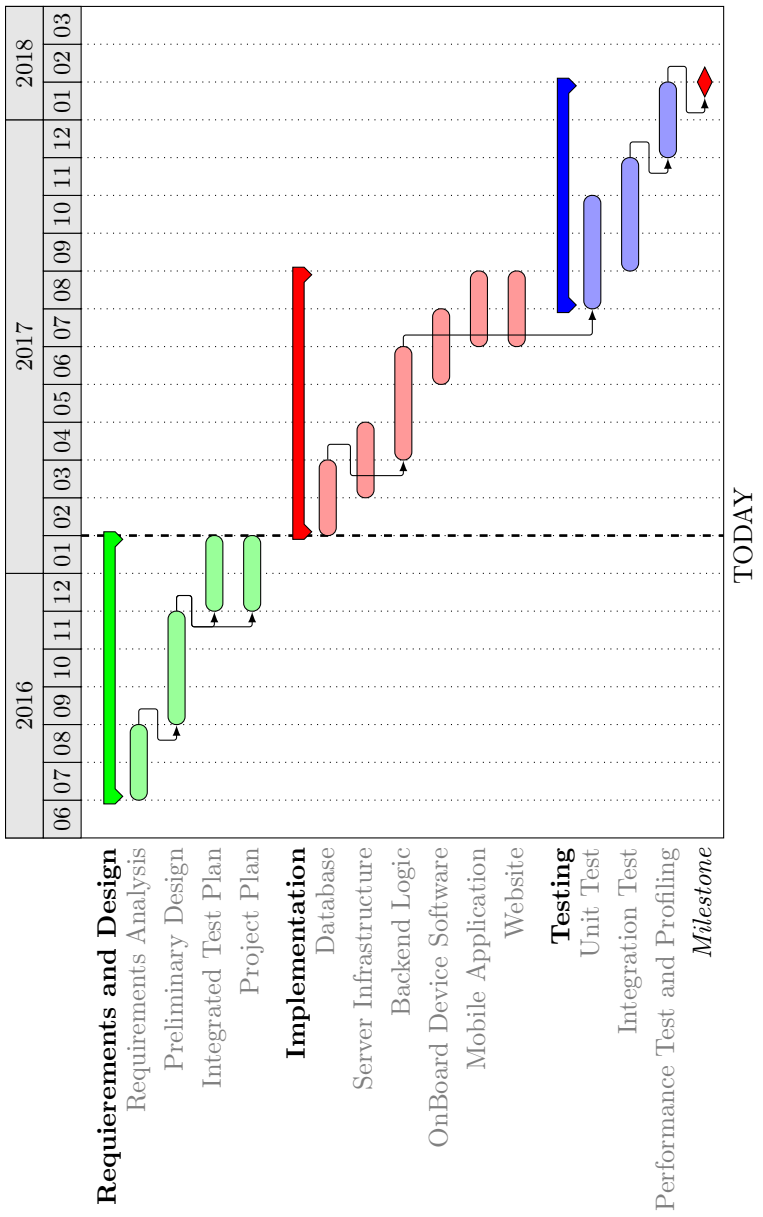
This equation brings us to a estimated duration of approximately 11.5 months.

$$Numberofdevelopers = \frac{Effort}{Duration} \approx 3 \tag{8}$$

This brings to an estimation of 3 developers to allocate to this project.

4 Resources Allocation

Through a Gantt chart, all activities are represented for blocks over time in order to highlight how resources are allocate to the various tasks. The beginning and the end of the block correspond to the beginning and at the end of the activity. Start of some activities are linked to the end of other.



5 Risk management

In this section we mention the risks that could affect our project. We provide a brief description of the risk, its probability to actualize, the impact of such actualization on the project and possible solutions to take into account in order to avoid or limit the damages. The possible values for the probability are *Low, Medium* or *High*, while the possible values for the impact are *Marginal, Serious* or *Catastrophic*.

5.1 Project Risks

Project Risks are those risks which threaten the project plan and whose actualization can result in a slipping of the schedule

Risk	Description	Probability	Impact	Possible Solutions
Personnel Shortfall	Due to a wrong estimation of the size of the project, there could be not enough people to complete the project deliveries in time	Medium	Serious	Prepare the personnel to the possibility of extra-work due to the lack of people. Plan a possible new recruitment.
Skill Lack	It could be the case that the team hasn't the skill required to face some types of issues, because it was not supposed to deal with them.	Low	Serious	Recruit people with more skills than the strictly required ones. Consider the organization of update courses.
Size of the Project	The project size could be underestimated, because of the lack of knowledge about the field of the project of the staff in charge of planning	Medium	Marginal	Prepare more resources than the strictly needed ones. Consider a possible extension of the time of the project
Competitors	Other companies can begin similar projects	Low	Serious	Plan an additional period in the schedule devoted to the development of new features and the improvement of the quality, in order to discourage the development of other similar projects
Personnel Illness	People of the staff can be ill in critical phases of the project	High	Marginal	Make some tasks of the staff overlap with each other. In this way there will be always possible substitutes to ill people.
Data Loss	Data loss during the development	Low	Critical	Backup strategy and software versioning.

5.2 Technical Risks

Technical Risks are those risks which threaten the quality and the functioning of the product and whose actualization makes the implementation more difficult.

Risk	Description	Probability	Impact	Possible Solution
Obsolete Design	Some new technology, that provides so as many better features to force the team to change the design of the system, could born in the course of the project	Low	Serious	Design the system in a way that allows to change components easily.
Inadequate Infrastructure	The resources, the facilities and the machines provided by the company or owned by the team are discovered to be inadequate for the project	Low	Catastrophic	While defining the budget with the customer, ask him the creation of a fund for possible substitutions of inadequate equipment.
New Requirements	New requirements are defined after the design phase	Low	Serious	The Waterfall development approach require frozen requirements. Change the to Scrum or Agile approach.

5.3 Business Risks

Business Risks are those risks which threaten the feasibility of a complete product and the chances of selling it. Their actualization can cause bad results on sales and evaluation of consumers.

Risk	Description	Probability	Impact	Possible Solution
Budget Lack	At some point it can be discovered that there has been an underestimation of the costs of project and that the budget is insufficient	Medium	Serious	Prepare a document to deliver to the customer, in which are explained the good results obtained till that moment, the reason for the budget increase, the disadvantages of non-concluding the project and the advantages of improving it with more functionalities.
Market Risk	The team has developed a good product, but this does not match the real requirements, expectations and needs of consumers, resulting in poor sales	Medium	Catastrophic	Consider interviews to stakeholder and random consumers during all the phases of project in order to have feedbacks on the partial work done till a certain moment.

6 Appendix

6.1 Used software

1. **TeXstudio:** `http://www.texstudio.org/` to redact this document in LaTeX format.

6.2 Time effort

The estimated time spent by us to redact this document:

Andrea Millimaggi	15h
Matteo Michele Piazzolla	15h

References

[1] http://www.qsm.com/resources/function-point-languages-table