UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Escola Superior d'Enginyeries Industrial,
Aeroespacial i Audiovisual de Terrassa

BACHELOR FINAL THESIS

Design of an autonomous drone for agricultural control

Document:

Budget

Author:

Alexandru Turcoman

Director /Co-director:

Luis Manuel Pérez Llera

Degree:

Bachelor in aerospace vehicle engineering

Examination session:

Spring, 2023

1 Economic study

In this final part of the project, a complete economic study of the project will be carried out to analyse its profitability. The chosen business model will be a **services company** meaning that:

- The drone will not be sold or rented, but will be used by the company itself to provide the service.
- The company will consist of a single employee in charge of flying the drone and post-processing the images.
- The selected employee will be required to have the necessary drone pilot licence and a course in multispectral and thermographic image interpretation for the agricultural sector.

As the sector of aerial inspection with drones in the agricultural industry is relatively new, the calculations presented below represent indicative results that try to resemble reality as far as possible.

1.1 Cost estimation

In this section the total cost estimation will be done, distinguishing between budget estimation and operating costs.

1.1.1 Budget estimation

The budget represents all costs related to the creation of the company and the drone to put it into operation:

Resource	Amount	Units	Cost/unit (€)	Direct cost (€)	Indirect cost (€)	Total cost (€)
Motor	4	u	27.20	108.80	0.00	108.80
ESC	4	u	16.90	67.60	0.00	67.60
Battery	1	u	79.50	79.50	0.00	79.50
FC	1	u	87.50	87.50	0.00	87.50
PDB	1	u	8.60	8.60	0.00	8.60
RX	1	u	16.20	16.20	0.00	16.20
TX	1	u	206.80	206.80	0.00	206.80
GNSS	1	u	41.10	41.10	0.00	41.10
LED	2	u	6.50	13.00	0.00	13.00
Camera and solar sensor with bracket	1	u	18300.00	18300.00	0.00	18300.00
Gimbal	1	u	619.80	619.80	0.00	619.80
M3x9 screw	4	u	0.13	0.52	12.30	12.82
M3x7 screw	4	u	0.13	0.52	12.30	12.82
M3x10 screw	4	u	0.16	0.64	7.35	7.99
M2x4 screw	4	u	0.12	0.48	11.84	12.32
M3x8 screw	8	u	0.07	0.56	6.58	7.14
M3x4 screw	8	u	0.06	0.48	5.62	6.10
3.6x100 plastic tie	9	u	0.02	0.18	16.41	16.59
8x4x2 rubber washer	12	u	0.84	10.08	6.55	16.63
Wiring harness	1	u	16.00	16.00	0.00	16.00
PC-ABS	298.6	Kg	41.50	12.39	29.11	41.50
PEI	32	Kg	150.00	9.60	140.40	150.00
Carbon fiber	56	Kg	54.30	6.08	48.22	54.30
3D Printer	28	h	2.50	0.00	70	70.00
Project engineer	40	person/h	30.00	0.00	1200.00	1200.00
Systems engineer	30	person/h	20.00	0.00	600.00	600.00
Software engineer	30	person/h	20.00	0.00	600.00	600.00
Purchasing engineer	30	person/h	20.00	0.00	600.00	600.00
Creation of the company	1	u	600	0.00	600.00	600
Budget estimation						**23573.11**

Table 1: Budget estimation. *Own elaboration.*

The data provided in the table is clarified below:

- All purchase components have a direct purchase cost.
- Some secondary purchase components such as screws and washers have an associated indirect cost as they are purchased in packs of many units.
- The price of the self-designed parts is divided into the price of the material and the price of the 3D printing, which will be done by renting a printer.
- The price of the creation of the company includes all the formalities and the lawyer necessary to carry it out.
- The final buget estimation is around **23600€.**

1.1.2 Operating costs

Operating costs are the expenses that are related to the operation of the business and the functioning of the drone. They are the cost of resources used by an organisation just to maintain its existence.

These costs can be fixed or variable over time:

	Fixed costs (€)
UgCS license	790
PC	1500
Total	**2290**

Table 2: Fixed operating costs. *Own elaboration.*

The fixed costs include the one-off licence fee for the flight planning software and the price of a powerful computer to work with.

	Variable costs (€)				
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Maintenance	0	59	139	59	139
Insurance	200	200	250	250	250
Car renting	350	350	350	350	350
Drone operator	12780	15975	20235	25560	25560
Car fuel	600	800	1000	1200	1200
Total	**13930.00**	**17384.30**	**21973.80**	**27419.30**	**27498.80**

Table 3: Fixed operating costs. *Own elaboration.*

- Maintenance costs are zero during the first year as the only components that need to be replaced are the battery (every 1 or 2 years) and the propellers in case of impact. As the material for the propellers was bought in excess this does not cost extra, but the 3D printing time does.
- The drone will be covered by full insurance.
- The worker shall be paid in proportion to the number of hours worked. This will depend on the number of clients.
- The worker will be provided with a car and the necessary petrol to reach the client.
- An increase in customers is assumed in the first years until stabilisation in the fifth year.

1.2 Economic feasibility

In order to study the risk of investing in a new company, the following set of parameters will be estimated:

1.2.1 Payback time

Payback time expresses how long it would take to recover the initial investment. To calculate it, the value of the initial investment and the cash flow (CF) are needed. In this case the Updated CF (UFC) has also been taken into account, which represents a 5% discount for currency depreciation and other variable factors.

Year	Investment (€)	CF (€/year)	Updated CF (5%)	Cumulative UFC (€/year)
0	26000	26000	26000	-26000
1		26846	25504	-496
2		64168	60959	60463
3		107150	101793	162256
4		135685	128900	291156
5		135605	128825	419981
Average annual cash flow (€/year)		93891	89196	186672
Payback period		0.28	0.29	0.14
		3 months	**3 months**	**2 months**

Table 4: Payback time. *Own elaboration.*

The following considerations have been taken into account:

- Initial investment covers budget estimation and fixed operational costs.

- The worker's hourly rate will be 15€.

- Price of an average service (depending of the size of the field) will be **3400€.**
  - Average flight plan preparation time = between 5 and 15h ≈ 220€
  - Average price of fuel for the car needed = between 20 and 40€
  - Pilot's time on flight day = between 1 and 2h ≈ 22€
  - Image post-processing time = between 30 and 40h ≈ 525€
  - Amortisation of the drone over 5 years = 83€
  - Price of the service = between 1500 and 2500€

- The estimated number of servicies per year is as follows:
  - Year 1: 12 servicies.
  - Year 2: 24 servicies.
  - Year 3: 38 servicies.
  - Year 4: 48 servicies.
  - Year 5: 48 servicies.

- The average duration from the start of a service to the end with a satisfied customer is 36 hours. Therefore, in the years of maximum work (48 services) the worker will work a maximum of 142 hours per month, so it will not be necessary to hire more employees.

Finally, taking into account these data, we will be able to recover the total investment in **two months**.

1.2.2 Net present value

Net present value (NPV) answers the question of how much money will be earned over a period of time from the investment.

The following expression is used:

$$NPV = -C_0 + \sum_{t=1}^{n} \frac{C_t}{(1+k_t)^t} \tag{1}$$

Where:

- C_0 : initial investment.
- C_t : cash flow for year t.
- n : project duration in years.
- k_t : applicable discount rate for year t (minimum attractive rate of return).

For a duration of 5 years and a discount rate of 20 %, it is obtained:

$$NPV = 210428.25€ \tag{2}$$

In other words, it will be possible to obtain a net economic income of about 3500 €/month.

1.2.3 Internal rate of return

The internal rate of return (IRR) is the discount rate that makes NPV=0:

$$0 = -C_0 + \sum_{t=1}^{n} \frac{C_t}{(1+IRR)^t} \tag{3}$$

The higher the IRR, the better the return of an investment. The following result is obtained:

$$IRR = 129\ \% \tag{4}$$

The result obtained is very positive and is justified by the high profit per service in relation to the costs.

1.2.4 Break even point

The break even point is the exact moment at which total costs equal total revenues.

It is normally calculated for units of product sold. As in our case we are dealing with the sale of a service, it can be calculated intuitively as follows:

$$Break\ even\ point = \frac{Total\ cost\ estimation}{Price\ per\ service} = 40\ services \tag{5}$$

Therefore, from 40 services onwards, the company will start to make a profit.