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Design of an Unmanned Aerial Vehicle with a Mass-Actuated Control System

BUDGET

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Introduction

The aim of this annex is to briefly study and analyze the potential markets where the project can be placed in, as well as the determination of the fabrication cost and the final price. Additionally, the possibility of offering some post-sell services will be discussed.

Contents

1	Project Development Cost	1
2	Market Study	1
2.1	Potential Markets and Competitor	1
3	Business Plan	2
3.1	Fabrication Costs	2
3.1.1	Components	2
3.1.2	Materials	3
3.1.3	Manufacturing	4
3.1.4	Total cost	4
3.2	Post-Sell Services	4
3.3	Price	5
	References	6

List of Tables

1	Characteristics and approximate price of competitors	1
2	Components cost: avionics	2
3	Components cost: communication systems	3
4	Components cost: drive	3
5	Components cost: take-off and landing	3
6	Materials cost	4

1 Project Development Cost

The cost of the project development has been calculated considering an average salary of 25€/H, and a total of 715 work hours. The average salary has been determined based on the tasks involved during the development of the project (between 20 €/H and 32 €/H). Therefore, the estimated project development cost is around 17875 €.

2 Market Study

2.1 Potential Markets and Competitor

Small and medium scale fixed wing unmanned aerial vehicles' versatility creates a competitive market for professional and recreational uses. Some of the most demanded uses include search and rescue, mapping, landscape scanning, fire fighting zone scanning, surveillance, cargo transportation in trouble zones, scientific research, etc. Fixed wing drones provide relatively high autonomy and moderate flight speed. This enables to scan larger areas optimally.

On the other hand, multi-rotor, and specially quad-rotor drones are quite popular nowadays. Their application, however, is limited by the relatively small autonomy, although their importance has grown due to their high quality shooting and precision. This market, however, is going to be discarded.

Since the payload enables the possibility to incorporate a thermal sensor or a high definition camera, the main market the project will be targeting will be the one for mapping, landscape scanning and surveillance. According to the brief research done regarding these markets, the next competitors have been selected, and the corresponding information is listed below. The approximate price has been provided by the manufacturer's Sales department:

Characteristics	FeiYu X8	Conyca Geodrone	C-Astral Atlas	Eleron 3SV	Eleron 10SV
Wingspan [m]	2.12	1.55	1.55	1.47	2.2
MTOW [kg]	5.0	2.0	2.0	5.5	15.5
PL [kg]	0.6	0.5	0.3	ND	2.5
Cruise Speed [m/s]	65	72	58	70	75
Endurance [h]	0.6	1.0	1.0-1.2	1.6	2.5
Approximate price [EUR] (without optical sensor)	7,500	20,000	22,500	18,000	28,000

Table 1: Characteristics and approximate price of competitors

3 Business Plan

The Business Plan consists of the study of the fabrication costs and the determination of the final price and post-sell services.

3.1 Fabrication Costs

In this chapter the fabrication cost will be calculated. It is important to note that the goal is to estimate a competitive price to begin with. Therefore, the analysis is done superficially, and the fabrication cost is just an approximation. The process is divided into three groups, where the corresponding costs have been calculated.

3.1.1 Components

The required electronic components and systems, and their corresponding prices are listed in the table below:

Avionics			
Components	Model	Manufacturer	Price [EUR]
Gimbal motors x 3	GB4106	Tiger Motors	90
Gimbal controller	AlexMos	AltiGator	90
Pitot-Static tube	MPXV7002	AltiGator	80
Control system Servo 1	DITEX TD0606M	Hacker GmbH	100
Control system Motor 1	A20-34 S EVO	Hacker GmbH	50
Control system Motor 2	A20-34 S EVO	Hacker GmbH	50
Left light strobe	DS-30A-1 Red	NA Survival Systems	40
Right light strobe	DS-30A-1 Green	NA Survival Systems	40
GNSS	SAM-M8Qd	Matek Systems	30
ArduPilot (flight controller)	ArduPilot Mega 2.8	ArduPilot	30
Systems battery	TopFuel LiPo 10C-ECO-X 3500mAh - 2S	Hacker GmbH	23
Current sensor	AMASS XT60	FullSpeed	8
Power distribution boards	PDB Lantian	Lantian	5

Table 2: Components cost: avionics

Communication systems			
Components	Model	Manufacturer	Price [EUR]
On-board receiver	FS-iA10B Receiver	FlySky	75
On-board transmitter	AMP EST1 Transmitter	Advanced Microwave Products	80
Ground Unit receiver	AMP ESR1 Receiver	Advanced Microwave Products	90
Ground Unit transmitter	FS-i10 Transmitter	FlySky	210

Table 3: Components cost: communication systems

Drive			
Components	Model	Manufacturer	Price [EUR]
Brushless motor	A40-12L V4	Hacker GmbH	140
Propeller	APC Electric 16x10 E	APC-Prop /Hacker GmbH	10
Drive battery 1	TopFuel Power-X 7500 mAh - 5S	Hacker GmbH	150
Drive battery 2	TopFuel Power-X 7500 mAh - 5S	Hacker GmbH	150
Electronic speed controller	ESC X-70 OPTO-Pro	Hacker GmbH	100
Drive current sensor	AMASS XT60	FullSpeed	8
Battery Charger	ABSIMA GPS-1	Hacker GmbH	90

Table 4: Components cost: drive

Take-off and Landing			
Components	Model	Manufacturer	Price [EUR]
Launching catapult	Pneumatic Catapult PL-40	Eli Airborne Solutions	800
Parachute	MARS 58 V2	Mars Parachutes	340

Table 5: Components cost: take-off and landing

The total cost of the previously listed components is **EUR 2,879.00**.

3.1.2 Materials

According to the structural design, the next materials are required:

Materials			
Components	Model	Quantity	Price [EUR]
Motor mounting	Aluminum 2024 - 2.5mm sheet	1 u	5
Stringers	S-glass	40g	5
Spars	CFRP T800S 3mm sheet	1 u	90
Skin	Monokote	1 u	30
Other parts	ABS plastic	740g	5

Table 6: Materials cost

The total cost of the previously listed materials is **EUR 135.00**.

3.1.3 Manufacturing

The main manufacturing processes involved in the structural construction consist in:

- Laser cutting of the spars and motor mounting, and piece machining
- 3D printing of the rest of the components, using ABS plastic filaments

The required machinery and fabrication cost is estimated to be of the 30 % of the total cost.

3.1.4 Total cost

Considering the previous sections, and since there is no certification fees, the total fabrication cost per unit can be estimated as:

$$C_{fab} = C_{components} + C_{materials} + C_{manufacturing} = 2879 + 135 + 0.3 \cdot C_{fab} \quad (1)$$

and

$$C_{fab} \approx 4,306.00 \text{ EUR}$$

An additional 20 % will be considered for the marketing, making a total cost of:

$$C_{total} = C_{fab} + C_{marketing} = 5,167.00 \text{ EUR}$$

3.2 Post-Sell Services

One of the most important goals is to create in the market a technologically advanced and reliable brand. For this reason, it is important to supply high quality products as well as post-sell services. This, additionally, can provide a decent income over the years, and also create a trustworthy customer-brand relationship. The post-sell services can be divided into three groups:

- **Maintenance:** it would include regular inspection and repairing services, as well as some parts substitution, if required and depending on the warranty policy. Depending on the further development of the project, there can be different options of maintenance. One option would be to offer a fixed-price per service, if out of warranty. Another option would be to have a annual plan which covers any kind of maintenance services within a year.
- **Upgrades:** it is important to constantly provide upgrades, both, for the flight control software and on-board hardware, if required. The first one could be done by the customer, and free of cost. The hardware upgrades would be adapted to customers' needs.
- **Optional sensors:** Additionally, it is important to offer a variety of thermal sensors and high definition cameras, and constantly update the compatible components list, in order to match existing and future customers' needs.

3.3 Price

Considering the previous analysis done regarding the potential markets and competitors, and since the fabrication cost has been estimated, it is possible to determine a competitive price to begin with:

- The average cost of similar unmanned systems can be considered to be around **EUR 20,000.00**. The closest competitors on endurance, C-Astral and Conyca, offer their unmanned system at a price of **EUR 22,500.00** and **EUR 20,000.00** respectively. The main goal is to offer a competitive price.
- The estimated total cost is around **EUR 5,167.00** per unit. It is important to note, that normally it is possible to sign an agreement with most of the component suppliers, and get a discount, between 10 and 30 %. Since the components are the most expensive part of the product, and no discounts have been considered, it can be assumed that the estimation is quite conservative, and there is even more profit margin.

- Finally, considering a profit margin of around 50%, a starting price of **EUR 10,000.00** is set, which is an attractive price in comparison to the top two competitors, considering the features and advantages it offers regarding maintenance.

It is important to note, that for the further development of the project it would be necessary to analyze inversion and manufacturing costs in more detail, which would result in a complete Economic Evaluation.

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