A close up of a logo

Description automatically generated

**Module 03**

**IE 5329 – Project Management, Fall Semester 2024**

Dr. Jennifer Cross

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Internet of Things Drones Integration

**Team 3**

Mohammed Noor Alabbasi, Project Lead

Arsalan Habib

Emila Lopez

Victoria Velasquez

Arun Chandana

Dhana Gandham

Loic Wega

# Introduction and Updates:

This third module focuses on adjusting the project's budget, updating the financial projections presented in earlier modules, and confirming the project scope. The IoT-Integrated Drone System, as first described in Module 1, sought to transform businesses by combining modern drone technology with IoT capabilities. Module 2 built on project planning by creating the Work Breakdown Structure (WBS), estimating task durations, and introducing the Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) for successful project timetable management. However, fresh updates, particularly in cost estimates, necessitate adjustments to the overall budget and scope, ensuring that the project remains in line with industry standards and stakeholder expectations.

The most major increase involves raising the drone cost expectation to $1,200 per unit, up from previous estimates. This rise is the result of a thorough examination of current industry price patterns and technological expenses, which provides more precise data for procurement and manufacture. This update has a direct impact on the overall project budget, notably during the Design and Prototyping phase, when 300 drones will be procured from third-party providers. These modifications need budget revisions and financial measure recalculations, including Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period.

In addition, the team has switched from simple cost estimation to three-point estimating, which covers optimistic, pessimistic, and most likely scenarios for cost forecasts. This improved strategy offers a more adaptable and realistic framework for dealing with hardware and software cost uncertainties, integration delays, and resource allocation. It also influences task-level cost estimates, ensuring that possible risks are addressed early in the project.

***Updates from Modules 1 and 2 that affect budget and scope***

Drone Unit Cost Adjustment: The drone cost is now $1,200 per unit, bringing the total cost of 300 drones from $195,000 to $360,000, which has a direct impact on the project budget. The average price of drones worldwide fluctuated between 2018 and 2023. In 2024, a drone cost on average around 520 U.S. dollars. In the coming years, the price is forecast to decrease(Laricchia, 2024.)

Refinement of cost estimation techniques: To effectively manage uncertainty and align the budget with project deliverables, the team used three-point estimating, as well as PERT and CPM.

Work Breakdown Structure (WBS) Refinements: The work breakdown structure (WBS) has been amended to reflect new costs and schedules for tasks such as hardware integration, software development, and prototyping, ensuring that the project remains feasible within the revised budget.

***Vulnerabilities identified with updates***

The enhanced drone cost increases the project's vulnerability to supply chain interruptions. Any delays in obtaining drones, sensors, or other IoT components from third-party providers may cause delays in the prototype and integration phases. This could lead to longer project timeframes and higher costs, particularly during field testing and final deployment.

Integrating cutting-edge IoT modules into drones poses risks for compatibility and performance. The difficulty of integrating sensors, 5G/6G connection, and cloud infrastructure may cause delays or cost increases if substantial troubleshooting is required during the testing process.

Rising drone costs have reduced budget margins. If additional unforeseen costs develop, such as increased labor prices or longer-than-expected testing durations, the project's budget could be exceeded resulting in a budget overrun. As a result, it is necessary to allocate buffer time and contingency funding for high-risk jobs such as system testing and regulatory compliance.

Regulatory barriers, like FAA clearances and IoT security compliance, can create major project delays. Any delays in obtaining the requisite certifications could have an influence on the overall deployment schedule and increase the price of compliance testing.

***Stakeholder alignment***

Before finalizing these revisions, it is critical to validate the updated budget and scope with all stakeholders. This includes:

* Project sponsors and managers: Ensure they are informed of the changed budget and risk considerations.
* Third-party suppliers: Confirming the new drone pricing and confirming that procurement timescales are consistent with the project's updated timetable.
* Development and integration teams will communicate revised cost estimates and job duration modifications to ensure that the new dates are reasonable and feasible.   
  Aligning all stakeholders is critical to ensuring that the project runs successfully within the updated budget and scope. Regular communication and status updates should be implemented to monitor any additional changes and mitigate emerging hazards early in the process.

# Methods for Estimating Project Costs:

There are many methods for estimating the costs of a project, we can consider several methods which have been discussed throughout the course, such as Analogous, Parametric, bottom up, and the three point estimation methods. The method we chose to use was the three-point method as we have an existing PERT analysis from module 2, This made the process a lot easier for us to calculate, however, alongside the three-point estimation method, we complimented that with the analogous and parametric estimation methods to ensure we are getting accurate estimates.

***Analogy Estimation***

This method involves using the cost data from previous, similar projects as a basis for estimating costs while simultaneously using characteristics of the top-down method. Since 5g integration in drones is relatively new concept, we had to explore different projects which involved the implementation of 5g, alongside the research we considered that the developments and data available for 5g today is significantly better than the historical data analyzed, which allows us to have been able to develop the 5g integrated drone more efficiently than expected.

***Parametric Estimation***

This technique uses statistical relationships between historical data and other variables to estimate costs. It often involves defining cost per unit, such as cost per hour of development or per sensor used. The drone historical cost data that we collected combined with 5g historical cost information that we found during the research has significantly contributed to the better cost estimation of our 5g integrated drone. This method helps estimate costs by correlating factors like the number of drones, the cost of 5G modules, and labor hours required for integration. For example, if each drone upgrade costs $2,000 and requires 4 labor hours at $50 per hour, the total cost can be calculated by scaling these values according to the number of drones. This approach provides accurate, consistent estimates, allows for easy scalability, and supports scenario planning by adjusting key variables as the project scope evolves.

***Definitive method***

Bottom-Up Estimation involves breaking down the project into smaller, manageable components or tasks and estimating the costs for each one. These individual estimates are then aggregated to form the overall project cost. The detailed nature of this approach can lead to complexities, particularly for developing a new product like our 5g integrated drone, making it challenging to estimate costs accurately. As a team we decided not to move forward with this method as it was very time-consuming to break our tasks down any further as we kept them at a high enough level to be easily manageable. We used the Bottom-up method when creating our work breakdown structure which really benefited the project, however, for a cost analysis perspective this did not fit into our estimation process.

***Three-Point Estimation***

This method includes making three estimates for each task: the optimistic (best-case scenario), pessimistic (worst-case scenario), and most-likely (realistic scenario) costs. The final estimate is often calculated using a weighted average. By using PERT analysis we did on the last module, we can calculate the expected time and costs that allows us to derive a more balanced cost estimate. This method is more benefit for our project because it helps us to increase accuracy by considering different scenarios, teams can better anticipate potential issues and budget, accordingly, allowing us to identify uncertainties better. For example, if installing a 5G module on a drone takes 4 hours in the best case, 6 hours typically, and 10 hours in the worst case, the expected time would be 6.33 hours. This method helps balance estimates by reducing bias and supporting better risk management in complex tasks. This method uses a basic equation which can be applied with the following variables Optimistic (O), Most Likely (M), and Pessimistic (P)

# Task Level Cost Estimates:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Objective** | **Optimistic Estimate (Hours)** | **Pessimistic estimate**  **(Hours)** | **Most likely estimate (Hours)** | **Laborers** | **Estimated Cost** |
| 1.1 **Define Project Scope** |  |  |  |  |  |
| * 1.1.1 Identify objectives and use cases for IoT in drones | 16 | 40 | 24 | 3 | $4,180 |
| * 1.1.2 Establish project requirements (functional, technical, safety) | 8 | 24 | 16 | 4 | $3,520 |
| * 1.1.3 Conduct feasibility study | 8 | 32 | 24 | 3 | $3,740 |
| * 1.2 **Assemble Project Team** | 8 | 24 | 8 | 3 | $1,760 |
| * 1.2.1 Assign roles and responsibilities | 8 | 16 | 8 | 3 | $1,540 |
| * 1.2.2 Schedule team meetings and set communication protocols | 8 | 24 | 8 | 2 | $1,173 |
| * 1.3 **Risk Assessment and Mitigation Planning** |  |  |  |  |  |
| * 1.3.1 Identify potential risks (technical, financial, regulatory) | 16 | 40 | 24 | 2 | $2,787 |
| * 1.3.2 Develop risk mitigation strategies | 16 | 40 | 24 | 3 | $4,180 |
| **Design and Prototyping** |  |  |  |  |  |
| 2.1 **Drone Hardware Integration** |  |  |  |  |  |
| * 2.1.1 Select suitable drone platform | 32 | 48 | 40 | 5 | $9,600 |
| * 2.1.2 Identify necessary hardware components (sensors, cameras, processors, etc.) | 16 | 40 | 24 | 4 | $4,864 |
| * 2.1.3 Integrate IoT modules (Wi-Fi, LTE, Bluetooth) | 80 | 144 | 96 | 3 | $14,592 |
| * 2.2 **IoT Network Architecture Design** |  |  |  |  |  |
| * 2.2.1 Define communication protocols (MQTT, HTTP, etc.) | 24 | 40 | 32 | 3 | $5,760 |
| * 2.2.2 Set up cloud infrastructure for data transmission | 400 | 600 | 480 | 5 | $146,000 |
| * 2.2.3 Ensure data security and encryption standards | 96 | 160 | 120 | 5 | $36,800 |
| * 2.3 **Software Development and Integration** |  |  |  |  |  |
| * 2.3.1 Implement IoT control software for drones | 96 | 160 | 120 | 4 | $24,533 |
| * 2.3.2 Integrate with existing flight control systems | 56 | 112 | 80 | 3 | $12,200 |
| * 2.3.3 Create mobile/web interface for monitoring and control data uploads | 200 | 360 | 280 | 3 | $42,000 |
| * Stakeholder review…. | 16 | 64 | 40 | 3 | $6,000 |
| * 2.4 **Prototyping and Testing** |  |  |  |  |  |
| * 2.4.1 Build initial prototypes | 160 | 320 | 240 | 4 | $57,600 |
| * 2.4.2 Perform functional tests (sensor integration, communication tests) | 80 | 160 | 112 | 4 | $27,520 |
| * 2.4.3 Conduct performance testing (range, data accuracy) | 112 | 240 | 160 | 2 | $19,840 |
| **IoT-Drone Communication and Data Management** |  |  |  |  |  |
| 3.1 **Configure Data Acquisition System** |  |  |  |  |  |
| * 3.1.1 Set up sensors for real-time data collection (environmental, positional, operational) | 80 | 160 | 112 | 3 | $20,640 |
| * 3.1.2 Configure data collection frequency and formats | 40 | 80 | 64 | 4 | $15,040 |
| * 3.2 **Establish Data Transmission** |  |  |  |  |  |
| * 3.2.1 Implement data transmission from drone to ground station/cloud | 80 | 160 | 112 | 3 | $20,640 |
| * 3.2.2 Optimize data transmission protocols for real-time communication | 80 | 112 | 96 | 3 | $17,280 |
| * 3.3 **Data Processing and Storage** |  |  |  |  |  |
| * 3.3.1 Process raw data into usable formats | 80 | 120 | 104 | 5 | $30,800 |
| * 3.3.2 Store processed data on cloud platforms | 80 | 120 | 104 | 4 | $24,640 |
| * 3.3.3 Set up backup and disaster recovery for data | 40 | 80 | 64 | 3 | $11,280 |
| **System Testing and Deployment** |  |  |  |  |  |
| 4.1 **Unit Testing** |  |  |  |  |  |
| * 4.1.1 Conduct component-level testing (hardware and software) | 64 | 112 | 40 | 3 | $9,240 |
| * 4.1.2 Test IoT connectivity and response times | 40 | 80 | 64 | 2 | $6,893 |
| * 4.2 **Integration Testing** |  |  |  |  |  |
| * 4.2.1 Test full integration of IoT modules with drone systems | 64 | 112 | 80 | 2 | $9,093 |
| * 4.2.2 Ensure data synchronization between drones and cloud | 120 | 200 | 160 | 2 | $17,600 |
| * 4.3 **Field Testing** |  |  |  |  |  |
| * 4.3.1 Perform real-world tests under different conditions | 240 | 320 | 280 | 3 | $46,200 |
| * 4.3.2 Assess drone performance, battery life, and sensor accuracy | 96 | 120 | 112 | 2 | $12,173 |
| * 4.3.3 Collect feedback and make improvements | 240 | 320 | 200 | 2 | $24,933 |
| * 4.4 **Compliance Testing** |  |  |  |  |  |
| * 4.4.1 Ensure adherence to regulatory and industry standards (FAA, IoT security) | 336 | 560 | 448 | 2 | $49,280 |
| * 4.4.2 Perform environmental and safety assessments (dependent on Drone path) | 320 | 80 | 64 | 2 | $12,027 |
| * 4.5 **Final Deployment** |  |  |  |  |  |
| * 4.5.1 Deploy IoT-enabled drones for field operations | 64 | 112 | 80 | 2 | $9,093 |
| * 4.5.2 Monitor performance during early use | 40 | 80 | 64 | 2 | $6,893 |
| * 4.5.3 Provide post-deployment support | 80 | 160 | 112 | 2 | $12,613 |
| 5.1 **Final Documentation** |  |  |  |  |  |
| * 5.1.1 Compile technical documentation (design specs, user manuals) | 224 | 448 | 336 | 3 | $55,440 |
| * 5.1.2 Develop training materials for end users | 56 | 224 | 112 | 2 | $13,347 |
| * 5.2 **Final Review and Sign-off** | 16 | 32 | 24 |  |  |
| * 5.2.1 Conduct final project review with stakeholders | 24 | 56 | 32 | 8 | $18,304 |
| * 5.2.2 Obtain final sign-off on deliverables | 8 | 24 | 16 | 3 | $3,168 |
| * 5.3 **Post-Deployment Maintenance** | 1 | 4 | 24 | 4 | $4,444 |
| * 5.3.1 Set up maintenance and support plan | 14 | 28 | 168 | 3 | $23,562 |
| * 5.3.2 Schedule periodic updates and performance reviews | 5 | 10 | 64 | 3 | $8,943 |

For the Task-Level Cost Estimates above, a salary average of the corresponding role was used to estimate the average pay per hour for the lead in each primary/parent task. The industry average salary of each role was estimated using Chat GPT. There were tasks that could be performed by various roles, in such cases, the average of the roles’ salaries was found before and then was used to find the hourly average. There were also occasions where a phase would need various roles to do different tasks in the phase, so those tasks done by one role were lumped together to have the same hourly salary rate.

Once the hourly average was calculated, a conservative approach was taken to provide leeway in case it becomes necessary in the future process of the project. For example, if the hourly average was calculated to be $54.49, it would be rounded to be $55.

In the Define Project Scope phase, the individuals that would work on this would be project managers and line managers. The average hourly rate of these roles combined was $55.

During the Design and Prototyping phase, the employees required for this work are product/industrial designers, design engineers, systems engineers, project managers, UX/UI designers, and software designers. The average hourly rate of design engineers and product/industrial designers is $48. The average hourly rate of IoT network engineers is $60. The average hourly rate of software engineers is $50. The average hourly rate of systems engineers is $60.

In the IoT Drone Communication and Data Management phase, the employees required to complete these tasks are IoT architects, network engineers, cloud engineers, cybersecurity engineers, data engineers, IoT software developers, and system integration engineers. The average hourly rate of these roles combined is $60.

During the System Testing and Deployment phase, the professionals required to complete these tasks are quality assurance engineers, systems engineers, test engineers, project managers, and field engineers. The average hourly rate of these roles combined is $55.

During the Final Documentation phase of the project, the professionals usually required to complete these tasks are project managers, compliance managers, field engineers, systems engineers, and operations managers. The average hourly rate of these roles combined is $66.

Using these calculated rates, we found the cost of each task. This was done by first calculating the “Optimistic” cost by multiplying the “Optimistic” days by 8 hours, then by the number of laborers needed to complete the task, and then by the average hourly rate for the necessary laborer roles. This process was repeated for the “Most Likely” days it would take to complete a task and for the “Pessimistic” days it would take to complete a task. Finally, the Optimistic, Most Likely, and Pessimistic costs were used to calculate the PERT of each task.

# Whole Project Cost Estimates:

|  |  |
| --- | --- |
| **Cost of the tasks** | **Budget allocated in ($)** |
| Project Scope Definition | $22,380 |
| Design and Prototyping | $40,7309 |
| IoT Drone Communication and Data Management | $140,320 |
| System Testing and Deployment | $216,038 |
| Final Documentation | $127,208 |
| Office Leasing | $80,000 |
| Office Maintenance | $9,600 |
| Drone Acquisition | $195,000 |
| Salaries and Wages | $400,000 |
| Material Costs | $60,000 |
| Insurance | $40,000 |
| Other Expenses (licenses, advertisement, etc.) | $38,000 |
| Total investment | $1,735,855 |

We get the final budget estimation of $1,735,855. By taking the 10% rule into account the total estimated budget will be = ~1.86 million. The initial budget planned was around 5 million. The Discrepancies in the project are:

**Initial Budget:** $5,000,000

**Variance:** $5,000,000 - $1860000= $3.3millon (+ variance is observed)

**Cost variance index of the project** = 5000000/1860000 =2.68 (+ is observed indicates that project was under the budget)

***To check the estimation at completion:***

EAC= BAC \* (1/CPI) = 5000000\* (1\2.68) = $1,865,671

Based on the analysis, we are significantly under the initial budget estimation for the whole project. The discrepancy indicates that the project has been executed with a high degree of efficiency.

***Allocation of the Remaining Investment***

1. **User Experience Enhancement:**
   1. **Software Development:** Invest in the creation of intuitive and user-friendly software interfaces.
   2. **Regular Updates:** Implement a system for frequent software updates, incorporating user feedback to enhance functionality and satisfaction.
   3. **Budget Allocation:** ~ $800k
2. **Data Storage Solutions:**
   1. **Scalability:** Develop scalable data storage solutions to accommodate the increasing volume of data over time.
   2. **Security:** Ensure robust and secure data management practices to protect sensitive information.
   3. **Budget Allocation:** ~$ 1.3 million
3. **Partnership with drone company:**
   1. **Collaborations:**  to access their drones for the (Testing and Validation, Research and Development (R&D), Market Development, Training and Support, Sustainability Initiatives, Integration with IoT Solutions & Sustainability Initiatives).
   2. **Budget allocation: ~** 1 million

# Economic Evaluation Using Time Value of Money:

***Time Frame Selection***

For this economic evaluation, we will use a 5-year time frame. This choice is based on the following rationale:

1. "DJI currently dominates more than 70% of the global drone market. According to a report by Drone Industry Insights, the market is expected to grow from $30.6 billion in 2022 to $55.8 billion by 2030" (Anwar N, 2023.)
2. The project involves significant technological development, which typically has a lifecycle of 3-5 years before major upgrades are needed.
3. It allows sufficient time for the project to overcome initial implementation challenges and start generating substantial returns.
4. A 5-year period provides a balanced view between short-term costs and long-term benefits.
5. Discount rate: 10%

***Key Financial Metrics Calculation***

To calculate NPV and IRR, we need the following information:

* Initial investment: $5,000,000 (sum of all estimated costs from the task list)
* **Projected annual cash flows for 5 years (assumptions):** 
  + Year 1: $600,000
  + Year 2: $900,000
  + Year 3: $2,500,000
  + Year 4: $3,000,000
  + Year 5: $4,000,000

***Net Present Value (NPV) Calculation***

**NPV = Σ (Cash Flow / (1 + r) ^t) - Initial Investment**

NPV = - $5,000,000 + (600,000 / (1 + 0.10) ^1) + (900,000 / (1 + 0.10) ^2) + (2,500,000 / (1 + 0.10) ^3) + (3,000,000 / (1 + 0.10) ^4) + (4,000,000 / (1 + 0.10) ^5)

***Detailed calculation:***

1. **Year 0:** -$5,000,000.00
2. **Year 1:** 600,000 (1+0.10) 1 = 545,454.55 \ {600,000} {(1 + 0.10) ^1} = 545,454.55 (1+0.10) 1600,000 = 545,454.55
3. **Year 2:** 900,000 (1+0.10) 2 = 743,801.65 \ {00,000} {(1 + 0.10) ^2} = 743,801.65 (1 + 0.10) 2900,000 = 743,801.65
4. **Year 3:** 2,500,000 (1 + 0.10) 3 = 1,878,287.80 \ {2,500,000} {(1 + 0.10) ^3} =1,878,287.80 (1 + 0.10) 32,500,000 = 1,878,287.80
5. **Year 4:** 3,000,000 (1 + 0.10) 4 = 2,048,698.56 \ {3,000,000} {(1 + 0.10) ^4} = 2,048,698.56 (1 + 0.10) 43,000,000 = 2,048,698.56
6. **Year 5:** 4,000,000 (1 + 0.10) 5 = 2,483,399.15 \ {4,000,000} {(1 + 0.10) ^5} =2,483,399.15 (1 + 0.10) 54,000,000 = 2,483,399.15

***NPV Calculation:***

NPV=−5,000,000 + 545,454.55 + 743,801.65 + 1,878,287.80 + 2,048,698.56 + 2,483,399.15

NPV=−5,000,000 + 7,699,641.71 = **2,699,641.71**

**NPV = $2,699,641.71**

***Internal Rate of Return (IRR) Calculation***

The IRR is the discount rate that makes the NPV equal to zero. We solve this equation:

Detailed IRR Calculation:

Year 0: $-5,000,000.00 / (1 + 0.2952) ^0 = $-5,000,000.00

Year 1: $600,000.00 / (1 + 0.2952) ^1 = $463,246.08

Year 2: $900,000.00 / (1 + 0.2952) ^2 = $536,055.81

Year 3: $2,500,000.00 / (1 + 0.2952) ^3 = $1,149,201.08

Year 4: $3,000,000.00 / (1 + 0.2952) ^4 = $1,063,761.67

Year 5: $4,000,000.00 / (1 + 0.2952) ^5 = $1,092,735.37

Sum of Present Values: **$0.00≈ 29.5188%**

This equation cannot be solved algebraically, so we use an iterative process or a financial calculator. Using an IRR calculator, we get:

**IRR ≈** 29.5188%

To verify this result, we can calculate the NPV using **29.5188%** as the discount rate:

NPV at **29.5188%** = - $5,000,000 + (200,000 / 1.447^1) + (400,000 / 1.447^2) + (600,000 / 1.447^3) + (800,000 / 1.447^4) + (1,000,000 / 1.447^5) = -831,027 + 138,217.69 + 190,983.96 + 197,482.59 + 181,755.40 + 122,587.36 ≈ 0

This confirms that **29.5188%** is indeed the IRR (rounded to the nearest tenth of a percent).

***Discussion of Financial Metrics***

The calculated NPV of **$ $2,699,641.71** is positive, which indicates that the project is expected to be profitable over the 5-year period. This suggests that the IoT Drones Integration project is financially viable and should create value for the organization.For the Internal Rate of Return (IRR)The IRR of **29.5188%** is significantly higher than the assumed discount rate of 10%. This high IRR suggests that the project has the potential to generate substantial returns relative to its costs. It indicates that the project is highly profitable and exceeds the minimum acceptable rate of return.

***Payback Period Calculation***

The payback period is the time required to recover the initial investment. It's calculated by tracking the cumulative cash flow until it turns positive.

Initial Investment: $5,000,000

Cumulative cash flows:

* Year 1: -$4,400,000 ($600,000 - $5,000,000)
* Year 2: -$3,500,000 ($900,000 - $4,400,000)
* Year 3: -$1,000,000 ($2,500,000 - $3,500,000)

Year 4: $2,000,000 ($3,000,000 - $1,000,000)

We can see that the investment recovered during Year 3. To calculate the exact payback period:

Fraction of Year 4 needed: $1,000,000 / $3,000,000 = **0.3333**

Payback Period = 3 + 0.3333 = **3.33 years**

This indicates that the initial investment will be recovered in approximately 3 years and 4 months.

Interpretation: The payback period of **3.33 years** is relatively short for a project of this scale and technological complexity. This quick recovery of the initial investment suggests that the project starts generating net positive cash flows early, which can be advantageous in terms of risk management and liquidity.

# Assessment of Economic Vulnerability:

***Cybersecurity Threats***

Akin to our cellphones and personal laptops, “IoT drones are vulnerable to interception, intrusion, unauthorized access, data breaches, and physical manipulation without an appropriate cybersecurity framework, which can have serious repercussions like compromised privacy, data loss, operational interruption, and even safety issues.” (Ashraf et al., 2023). To add, industrial espionage in sectors like agriculture or logistics, sensitive data (e.g., crop yield information or delivery routes) can be stolen, resulting in competitive disadvantages.

***Dependence on Drone Technology***

In the logistics and delivery service industries, they rely on IoT drones, if a failure or disruption in the drone networks were to occur (due to technical or cyber-attacks) can have serious economic consequences such as: supply chain disruptions leading to delays, increased costs, and loss of customer trust. In addition, economic losses from downtime in industries like construction, mining, and agriculture that depend on drones for mapping, surveying, or monitoring could lose productivity and incur financial losses if drones are unavailable.

***Cost of Compliance and Regulatory Burden***

Regulation and legal challenges are a given as governments introduce regulations to ensure the safe and ethical use of drones: there are high compliance costs in industries utilizing drones may need to invest in new technologies or processes to meet regulatory requirements, increasing operational costs. Insurance and liability for IoT drones if they were to cause accidents or damage, businesses could face very high legal costs or need to invest in drone-specific insurance, raising their financial risk.

***Supply Chain Vulnerabilities***

Firstly, component shortages for IoT drones depend on various components (e.g., sensors, cameras, GPS modules), a great number of them are sourced from global supply chains and any disruption in the supply for these components (in consequence of geopolitical tensions, trade restrictions, or natural disasters) can affect the production and operation of drones, leading to economic losses for industries dependent on them. Secondly, energy costs are imperative because the drones require energy to function, and their widespread use could lead to increased energy consumption, driving up operational costs, especially if energy prices rise.

***Environmental and Infrastructure Costs***

Environmental degradation is a given when there is an increased production and deployment of IoT drones could strain resources and generate e-waste if not managed properly, leading to long-term environmental and economic costs and infrastructure costs to support IoT drone networks, businesses and governments may need to invest heavily in infrastructure such as 5G networks (already in progress within our project), drone ports, and air traffic management systems. These investments could be a significant economic burden, especially for developing economies.

***Proposed mitigation for our project economic vulnerabilities***

* Strengthening cybersecurity by investing in better encryption services and have regular security updates as well as to have monitoring systems in place that can reduce the risk of cyberattacks.
* Diversifying supply chains to reduce dependance on single sources of drone components can help mitigate risks related to supply chain disruption.
* Public-Private partnerships could be an asset to have collaboration between governments and private companies to help create fair and affordable access to IoT drone technologies while reducing regulatory burdens.
* Sustainable practices by implementing green energy solutions and recycling programs for drone technology can help mitigate environmental costs and long-term economic impacts.

Addressing these vulnerabilities will be crucial for our project to fully realize the potential of our project while minimizing potential risks and losses.

# Conclusion and Next Steps:

During this phase, considerable changes were made to the project's budget and estimation methodologies. The most important update was raising the drone's price to $1 per unit, which better aligned it with industry standards. Furthermore, the use of three-point estimating, paired with PERT and CPM approaches, enables the project team to better manage uncertainties and plan for numerous situations. These changes were implemented into the Work Breakdown Structure (WBS), ensuring that the scope and budget are still achievable and practical. Communication with stakeholders has been prioritized, ensuring that all parties agree with the project's updated financials and timeframes. With these adjustments, the project is still financially viable and structurally solid, preparing it for successful implementation.

***Next Steps***

Module 4 of the upcoming phase will focus on Risk and Quality Management. The team will begin by conducting a thorough risk assessment to identify potential concerns, such as technology challenges, supply chain disruptions, and financial limits. Following that, risk mitigation techniques will be devised, such as allocating time buffers for important tasks and establishing contingency plans with suppliers. Furthermore, a complete quality management plan will be developed to guarantee that the project satisfies all performance, safety, and regulatory requirements. These efforts will help to maintain the project's momentum and ensure the delivery of a high-quality product.

References:

Ashraf, S. N., Manickam, S., Zia, S. S., Abro, A. A., Obaidat, M., Uddin, M., Abdelhaq, M., & Alsaqour, R. (2023). IoT empowered smart cybersecurity framework for intrusion detection in internet drones. *Scientific Reports*,*13*(1),18422. <https://doi.org/10.1038/s41598-023-45065-8>

Anwar, N. (2023, February 8). *World’s largest drone maker is unfazed - even if it’s blacklisted by the U.S.* CNBC. <https://www.cnbc.com/2023/02/08/worlds-largest-drone-maker-dji-is-unfazed-by-challenges-like-us-blacklist.html#:~:text=DJI%20currently%20dominates%20more%20than,by%20its%20founder%20Frank%20Wang>.

iBwave. (n.d.). *Integrating and operating 5G use cases: A guide*. Retrieved from <https://info.ibwave.com/ebook-integrating-operating-5g-use-cases/>

Laricchia, F. (2024, September 3). *Drone average price worldwide 2029*. Statista. https://www.statista.com/forecasts/1399086/drone-average-price-worldwide

***Disclosure:***

In this research, ChatGPT an AI language model by OpenAI was used to gather initial information and insights on IOT and Drone capabilities. ChatGPT helped in understanding the general concepts of IOT through 5G and brainstorming ideas. The use of ChatGPT was intended to make the research of the IOT implementation more efficient, while helping us understand how our implementation ideas could be improved. All critical information was confirmed through reliable academic resources.