Barrios Technology & Angelo State University

Computer Science Department, Spring 2024

International Space Station (ISS) Consumables Analysis Project Summary

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| Company Description | Barrios Technology is an award-winning, woman-owned and operated small aerospace business. We provide high-quality engineering, software, and technology integration solutions to government and commercial space flight programs, in the USA and the rest of the world.  We are driven by innovation and propelled by possibility. Barrios has been purposefully advancing humanity, on and off the planet, for over 40 years.  Your mission is our passion. Together we can go further. *Barrios.io* is a branch of Barrios Technology that brings modern data solutions to your industry, wherever you are. *Input data, output value*. We offer our expertise to reduce data sprawl and make your data processes valuable and profitable. Our data specialists seek to empower teams with database design, creation, and management, procedural data updates, and business intelligence standards, such as dynamic and responsive visualizations, interactive reporting, Key Performance Indicators (KPIs), alerts and monitoring, parameters inputs, data forecasting and trending, and more.  *Barrios.io* is seeking to work with talented students across the areas of Data Engineering, Computer Science, Data Analytics, Project Management, and Business Management on a diverse and flexible selection of real-world problems that benefit university students at multiple levels while bringing value to Barrios.io and our government and commercial space exploration industry. |
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| Project Description | **Project Mission Statement:**  Evaluate and provide insights and predictions into consumable usage rates, resupply logistics constraints, and previous projection accuracy based on ISS vehicle traffic schedule, crew complement, minimum supply thresholds, and historicalsupply actuals.  **Objective Summary:**  The objective of this project is to assess historical data regarding the above ISS parameters and consumables supply to derive historical insights and prescribe predictive outcomes to minimize risks to mission success, refine usage rate assumptions, assess novel data visualization techniques for the effective communication of data-driven answers, and identify upcoming logistics challenges in the strategic planning timeline. |
| Data Package | **Data Sets:**   1. ISS Inventory Management System (IMS) historical data for the last two years as relates to Consumables items. Cleared for public release. 2. ISS Flight Plan historical data for the last two years and the next two years. Cleared for public release. 3. Historical Actuals derived from Mission Control Center (MCC) Gateway Environmental Controls and Life Support Systems (ECLSS) Tracker. To be cleared for public release.   **Assumptions:**   1. Historical data used for analysis should be limited to Jan. 1st, 2022 and onward. 2. Barrios will provide organized, structured data sets with accompanying data dictionaries and major relationship mappings 3. Barrios will meet with class (either virtually or in-person) at the beginning of the semester/term to provide an overview on the ISS and the relevant data sets, questions, predictive modeling challenges, and deliverables 4. Barrios will provide at least two Subject Matter Expert (SME) lectures during the semester, to provide students with real-world demonstration of ongoing ISS analysis and expert-level insight into analysis processes and constraints 5. In addition to data analysis insights and predictive model outcomes, ASU students will document data manipulation processes, software implementation details, and solution architecture to provide robust deliverable reports that satisfy the key components listed in Final Deliverables section below |
| Requirements and Recommendations | **Requirements:**   1. Solutions must incorporate loading the provided CSV data sets into a relational SQL database 2. **Solutions must focus on addressing the questions, predictive modeling prompts, and deliverables specified below**, with additional features, insights, functionality, and findings (such as those in the “Recommendations” section) considered secondary in priority   **Recommendations:**   1. From a Barrios perspective, any technology stack is acceptable for delivering the specified analyses (e.g. Python and libraries, C# .NET, Power BI, Tableau, R, etc.). **Please confer with your professor on approved and recommended technologies/software** 2. Best results are often obtained from visualizations that clearly express answers to questions; well-designed UI is a plus, but if the UI looks great and the visualizations don’t communicate the data well, the end product will be less effective 3. Consumables analysis results have traditionally been communicated using a line chart showing quantity, resupplies, usage, and limits versus time. Representation of data using inspired alternative visualization techniques is highly encouraged 4. Features that support “what-if” analyses are highly desirable. The most versatile and successful solutions will likely be those which expose adjustable parameters to the users. Starting from the base data set, fields such as “usage rate”, “launch date”, “dock date”, “undock date”, “crew count”, “item quantity”, and “resupply quantity” should be considered for inclusion as adjustable analysis parameters 5. Features that support “collaboration” and “presentation” of the data are highly desirable. Example features include: user-created custom labels for data points, comments/notes overlay for visualizations, etc. |
| Analysis Goals | **Data Analysis Questions:**   1. **[Assumption Validation Analysis]** - What is the percent difference between historical consumable usage rate assumptions and actual calculated usage rates in mission time frames between resupply? 2. **[Optimization Analysis]** - What are the minimum required resupply quantities for each consumable category, considering planned resupply vehicle traffic from the ISS Flight Plan, planned On-Orbit Crew counts, and historical usage rates to sustain minimum supply thresholds through the next two years? 3. **[‘What-if’ / Parameterized Analysis]** - What is the answer to Question #2 if all usage rates were increased by 25%?   **Predictive Analysis / Forecasting Questions:**   1. **[Predictive Analysis, Deterministic Modeling]** - What month in the next two years of the Flight Plan timeline will require the greatest quantity of resupply for each consumables category to sustain minimum supply thresholds over the course of the analysis period? 2. **[Predictive Analysis, Probabilistic Modeling]** -What is the min/max forecasted quantity of each consumables category, using a 90% confidence interval, at a date 60 days beyond the latest “actual” data point?   **Bonus Question:**   1. **[Statistical Significance]** - In the observed (i.e. calculated using historical data, not forecasts/predictions) usage rates, identify any statistically significant changes in usage rate over time.    1. Example: On 6/15/23 the calculated rate of XYZ-item was 1.25 units/crew/day, but on 6/16/23 the calculated rate of XYZ-item was 7.77 units/crew/day. Is this change statistically significant? That is, can this change be attributed to chance/randomness, or is it caused by a non-random variation in the system? |
| Final Deliverable(s) | In a team of 3-5 students, each group will deliver a final report and presentation including documentation of the following key components:   * Data-driven insights and responses to the above questions * Predictive modeling results from the above prompts * Analysis methodology * Technology stack * Predictive modeling / forecasting algorithm(s) * Data architecture recommendations * Unanswered questions * Summary presentation (approx. 15-20 min. in length) * Brief demonstration video (approx. 2-5 min. in length) |