# FIT3158 Business Decision Modelling
# Semester 2 2022
# Assignment – Case I

**Case I: AAD Supply Operations**

The Australian Antarctic Division (AAD) manages and delivers Australia's Antarctic Program. Three year-round research stations, Casey, Davis, and Mawson are maintained in Antarctica to run scientific and logistical operations together with a station at the sub-Antarctic Macquarie Island. Each year the AAD charters ships and vessels for resupply and transport operations to these station bases.

https://www.antarctica.gov.au/about-us/

In the current season Southern Lights Logistics (SLL) operates an ice strengthened cargo ship the "Noyina" for resupply operations and critical cargo delivery for the AAD.

Dave Ellis is managing cargo operations of the Noyina in its current resupply voyage at the Port of Hobart in Tasmania. The AAD wants to transport four cargo types (C1 – C4) in relation to the four classified categories "General Cargo", "Dangerous Goods", "Scientific Support" and "Personal Effects" respectively aboard the vessel as follows.

| Cargo Type | Amount Available (tons) | Volume per ton (cubic feet) | |
|---|---|---|---|
| C1 | 4800 | 50 | General Cargo |
| C2 | 2500 | 35 | Dangerous Goods |
| C3 | 1200 | 70 | Scientific Support |
| C4 | 1700 | 65 | Personal Effects |

If the vessel departs the port of Hobart on time as scheduled, Southern Lights Logistics (SLL) can achieve the following profit margins over the four cargo types. However, any delay will affect these values on the order of <u>10%</u> reduction in profit per day that the vessel is delayed due to associated costs. Dave is confident that the ship can depart with one day delay due to an ongoing maintenance issue.

| Cargo Type | Profit per ton ($) |
|---|---|
| C1 | 75 |
| C2 | 55 |
| C3 | 65 |
| C4 | 85 |

Dave is preparing the loading plan and can decide to load any amount or all the available cargo for AAD. However, the Noyina has the following capacity restrictions in relation to its four cargo holds.

| Cargo Hold | Weight Capacity (tons) | Volume Capacity (cubic feet) |
| --- | --- | --- |
| Forward Hold | 3000 | 170,000 |
| Center (Port) Hold | 3000 | 100,000 |
| Center (Starboard)Hold | 3000 | 105,000 |
| Rear Hold | 4000 | 180,000 |

More than one AAD cargo type can be transported in the same hold. However, balance considerations have enforced the following conditions to be applied.

Forward cargo hold weight must be within 15% of the rear cargo hold weight. The center cargo holds must cumulatively hold between 45% to 55% of the total weight that is freighted on board the vessel.

## Section A

Considering the above, mathematically formulate the freight loading plan for the Noyina as an LP model. Implement the formulation in Excel following the goals and guidelines for good spreadsheet design and solve using solver. Generate the answer and sensitivity reports. Then answer the following questions in Section B assuming each question as independent of the other questions unless explicitly referred to.

## Section B

1) What are the optimal amounts of cargo types transported in each hold of the Noyina and the optimal value for total profit for Southern Light Logistics (SLL)?
2) Are there alternate optimal solutions to the freight loading plan? Explain your answer.
3) Is the solution degenerate? Explain your answer.
4) Can Southern Light Logistics (SLL) transport all of the cargo amounts as required by the AAD? What are the marginal values of each loaded cargo type?
5) If the profit per ton of "Scientific Support" cargo goes up by $5 would the optimal solution change? Explain your answer.
6) If the ship is delayed by two days due to the current maintenance issue requiring additional time, comment on any changes to the optimal solution.
7) An urgent request to AAD from Mawson Station with regard to an ongoing scientific experiment has added a further 100 tons of "Scientific Support" cargo. Comment on possibilities for this to be accommodated by SLL and the impact over total profit.
8) If certain reconfigurations can be made on board using hired labour to increase the weight capacity of the two center holds by 100 tons each, should SLL go ahead with that process?
9) The maintenance engineers have advised SLL that 250 tons of extra equipment need to be carried onboard the Noyina on this voyage with regard to the ship's ongoing maintenance issue. It is decided that the Center Port hold would be the most convenient place to store the equipment. Comment on any effects this has to the solution (Amounts freighted for the AAD) and the total achievable profit.
10) A new crane is added to the forward deck of the Noyina altering balance considerations. The new requirement is that the Forward cargo hold weight be within 10% of the rear cargo hold weight. Discuss on any impacts to the solution.

**Delivery structure and submission instructions for Case I.**

Your delivery should include an Excel file comprising the following work sheets.

- Case I Title Page
- Case I Model
- Case I Sensitivity/Answer Reports
- Case I Report

1) The "**Case I Title Page**" should include the following information.

- The Title and brief description of the case.

- Each group members contribution (tasks performed and contribution percentages in a table).

2) The "**Case I Model**" sheet should include the following.

- The mathematical (algebraic) formulation of the linear programming model.

- The spreadsheet implementation of the model following goals and guidelines for good spreadsheet design.

- The model should consistently produce accurate and reliable results.

- Every member in the group must know the model well and be able to demonstrate/explain the model when asked.

3) The "**Case I Sensitivity/Answer Report**" sheets.

- The reports generated by Excel Solver based on your spreadsheet model.

4) The "**Case I Report**" sheet should include the following.

- Correct responses for each of the 10 questions in Section B.

- Good analysis and discussion accompanying the responses as required showing accurate understanding of problem context and model/report use.

The Excel file should be named as <Group_No.>_Assignment_Case1.xlsx (or.xlsm) where the <Group_No> is the number assigned to your group by the tutor.

The file should be uploaded on the FIT3158 Moodle site under the submission link together with Case 2 and Case 3 files by the due date.

**Marking Criteria**

| Criteria | Content | Marks Allocation |
|---|---|---|
| Title Page/Sheet | Title and brief description of case. | 3 |
| | Each group member's contribution (tasks performed and contribution percentages). | 2 |
| Case I Model Sheet | Mathematical formulation of the problem. | 10 |
| | Correct implementation of spreadsheet model. | 10 |
| | Good consideration of goals and guidelines for good spreadsheet design. The model should be robust and produce accurate and reliable output consistently. | 10 |
| Case I Sensitivity and Answer Reports | Reports generated from Excel Solver are representative, meaningful, and actionable. | 5 |
| Case I Report | Correct responses for the ten questions in Section B. (Having accurate calculations accompanied with good analysis and discussion making use of the generated sensitivity report and model outputs as relevant.) | 20 |