**ASSIGNMENT 1**

Module 2 - The LP Model

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Question 1

The problem provides the following information:

* Back Savers manufactures backpacks, including two models: Collegiate and Mini.
* They receive a 5000-square-foot weekly shipment of rip-resistant nylon fabric.
* Each Collegiate backpack requires 3 square feet, and each Mini requires 2 square feet of fabric.
* Sales forecasts allow a maximum of 1000 Collegiates and 1200 Minis per week.
* Producing a Collegiate takes 45 minutes of labour, with a profit of $32 per unit.
* A Mini takes 40 minutes of labour, with a profit of $24 per unit.
* Back Savers employs 35 labourers, each working 40 hours per week.
* Management seeks to determine the optimal production quantities for each backpack type

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| --- | --- | --- |
| **ITEM** | **COLLEGIATE BACKPACK** | **MINI BACKPACK** |
| Weekly Fabric Shipment (sa. feet) | 5000 | 5000 |
| Fabric Requirement per Unit (sq. feet) | 3 | 2 |
| Maximum Weekly Sales | 1000 | 1200 |
| Labour Time per Unit (minutes) | 45 | 40 |
| Profit per Unit ($) | $32 | $24 |
| Total Laborers | 35 | 35 |
| Weekly Labour Hours per Labourer | 40 | 40 |

Decision Variables:

Let x be the number of Collegiate backpacks to produce per week.

Let y be the number of Mini backpacks to produce per week.

Objective Function:

The objective is to maximize the total profit, which is the sum of profits from Collegiate and Mini backpacks:

Maximize Z=32x +24y

Both x and y are non-negative logically.  
Hence x ≥ 0 and y ≥ 0

The maximum number of Collegiate bags that can be produced is 1000, and the production quantity of Collegiate bags (represented by x) should be between 0 and 1000:

* 0 ≤ x ≤ 1000

The maximum number of Mini bags that can be produced is 1200, and the production quantity of Mini bags (represented by y) should be between 0 and 1200

* 0 ≤ *y* ≤ 1200

These constraints ensure that the production quantities of Collegiate and Mini

Backpacks are within the specified limits and are non-negative.

The total fabric used, considering the production quantities of Collegiate bags (x) and Mini bags (y), should not exceed the available weekly fabric shipment of 5,000 square feet.

* Collegiate Bag – 3sqft of nylon
* Mini Bag – 2sqft of nylon
* 3x + 2y ≤ 5000.

Each collegiate bag takes 45mins =  hrs =  hrs

Each Mini bag takes 40mins=  hrs=  hrs

* [3/4]x +[2/3]y ≤ 1400 hours

Non-negativity Constraint: The production quantities cannot be negative.

3x +  2y  < 5000

[3/4]x +[2/3]y ≤ 144

* x ≥ 0 x ≥ 0
* y≥ 0 y ≥ 0

Hence the mathematical formulation for this LP problem is in the limits of

0 ≤ x ≤ 1000 and 0 ≤ y ≤ 1200

Question 2

The problem provides the following information:

In this scenario, The Weigelt Corporation has three branch plants with unused production capacity. They are in a favourable position because they have a new product ready for production, and all three plants have the capability to produce it. This new product comes in three different sizes: large, medium, and small, each with its own unit profit of $420, $360, and $300, respectively. Additionally, the three plants have the capacity to produce the new product at the following rates, regardless of the size or combination of sizes involved

|  |  |  |  |
| --- | --- | --- | --- |
| Giving a net profit of | $420 | $360 | $300 |
| Excess capacity to produce | 750 | 900 | 450 |
| In-process storage space plants (sqft) | 13000 | 12000 | 5000 |
| In-process storage space units l,m,s (sqft) | 20 | 15 | 12 |
| Sales forecasted for l,m,s units | 900 | 1200 |  |

1. Decision Variables:

* Let L represent the number of large-sized units produced.
* Let M represent the number of medium-sized units produced.
* Let S represent the number of small-sized units produced.

1. Objective Function:

The objective is to maximise profit, which is the sum of profits from producing each size:

Maximize Z=420(L1+L2+L3) +360(M1+M2+M3) +300(S1+S2+S3)

1. Constraints:

1. Production Capacity Constraints:

* Plant 1's production capacity: L1+ M1 + S1 ≤ 750
* Plant 2's production capacity: L2+ M2+ S2 ≤ 900
* Plant 3's production capacity: L3+ M3 + S3 ≤ 450

2. Storage Space Constraints:

* Plant 1’s storage space: 20L1 + 15M1 + 12S1 ≤ 13,000
* Plant 2’s storage space: 20L2 + 15M2 +12S2 ≤ 12,000
* Plant 3's storage space: 20L3+ 15M3 +12S3 ≤ 5,000

3. Sales Constraints:

* Large-size sales forecast: L ≤ 900
* Medium-size sales forecast: M ≤ 1,200
* Small-size sales forecast: S ≤ 750

Excess Capacity Utilization Constraint:

Each plant should use the same percentage of excess capacity to produce the new product.

Non-negativity Constraints:

* L ≥ 0
* M ≥ 0
* S ≥ 0