

逢甲大學學生報告 ePaper

報告題名：

模擬再生衛生紙製造工廠

Simulation of Recycled Toilet Paper Factory

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中文摘要

在現今的生活裡，衛生紙成為不可或缺的生活用品，然而基於衛生紙「用完即棄」的特性，過去有環保團體指出，不應浪費珍貴的木漿來造衛生紙，進而衍發出以廢紙回收，經過較一般再生紙複雜的程序，再生成衛生紙，不但環保也能夠處理廢棄的紙張，減少地球上有限資源的浪費。在製造過程中，將廢紙送入散漿機製成紙漿，經過除污除渣、篩洗及篩選、脫墨淨漿等等，最後經由抄紙機將其作成衛生紙，並在加工後包裝出廠，在此模擬其生產製造所產生的淺在問題，並加以改善。

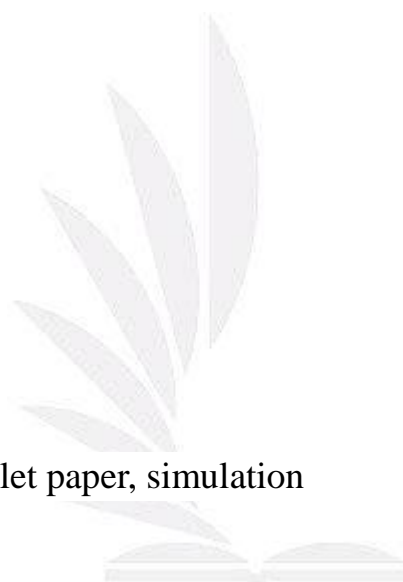
關鍵字：再生衛生紙、模擬



Abstract

In today's life, toilet paper becomes an indispensable daily necessity. However, based on "disposable" characteristics, environmental groups have pointed out that should not waste precious wood-pulp to make toilet paper, and then developed with using wastepaper for recycling. The recycling procedure complex than recycled paper, generate into toilet paper. It's good not only for environmental protection but also capable of processing wastepaper and reduce waste limited resources on Earth. In the manufacturing process, the wastepaper imports to the pulper, through the decontamination cleaner, sieve and filter, deinking flotation etc. Finally, through the paper machine becomes to toilet paper. Simulated the manufacturing to find its potential problems, and make the improvements.

Keyword : recycled toilet paper, simulation



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一、 系統介紹

本課程使用 ProModel 來模擬此再生衛生紙工廠。在一生產再生衛生紙之工廠裡，假設：

1. 到達間隔時間

- 廢紙到達間隔時間為指數分配，平均 60 分鐘，一次 5 噸量
- 包裝用塑膠袋到達間隔時間為指數分配，平均 5 分鐘，一次來 10 組

2. 機器運作時間時間

- 廢紙捆包機：當廢紙量達到 10 噸方可進入廢紙捆包機，在捆包機中運行呈均勻分配，4~12 分鐘
- 廢紙散漿機：運行呈指數分配，平均 10 分鐘
- 去汙機：運行呈指數分配，平均 1 分鐘
- 篩洗與篩選：運行呈均勻分配，10~20 分鐘
- 脫墨浮選機：運行呈指數分配，平均 20 分鐘
- 抄紙機：運行呈指數分配，平均 240 分鐘
- 紙捲繞機：運行呈指數分配，平均 90 分鐘，結合兩捲紙捲為一卷雙層紙捲，並能分成 270 捲細捲
- 自動紙捲切斷機：運行呈均勻分配，8~10 秒，一卷細紙捲能裁切成 16 捲捲筒衛生紙
- 包裝機：運行呈指數分配，平均 1 分鐘，6 捲捲筒衛生紙為一袋
- 檢驗員：操作呈三角分配 4,5,6 分鐘，99.5%之機率為良品(設為 FG)，0.5%之機率為 NG 商品

3. 變數

- 設定 FG 為送至倉儲系統之良品，計算其數量。
- 設定 NG 為廢棄之不良品，計算其數量。

備註：廢紙至捆包機需搬運 2 分鐘，捆包後需搬運 5 分鐘至紙捆暫存區，其餘每項製程在搬運至暫存區時需搬運 2 分鐘

二、 模型介紹

將上節之系統介紹一一輸入至 ProModel，如圖一至圖四畫面。點選 Option 設定執行 50 個小時，並使其開始模擬，畫面如圖五。

```
*****
*                               Locations                               *
*****
```

| Name | Cap | Units | Stats | Rules | Cost |
|--------------------------------|----------|-------|-------------|-----------------|------|
| wastepaper_queue | INFINITE | 1 | Time Series | Oldest, FIFO, | |
| automatic_horizontal_baling_pr | 10 | 1 | Time Series | Oldest, , | |
| bundled_paper_queue | INFINITE | 1 | Time Series | Oldest, FIFO, | |
| pulper | 1 | 1 | Time Series | Oldest, , | |
| decontamination | 1 | 1 | Time Series | Oldest, , | |
| sieve_and_filter | 1 | 1 | Time Series | Oldest, , | |
| deinking_flotation_machine | 1 | 1 | Time Series | Oldest, , | |
| paper_machine | 1 | 1 | Time Series | Oldest, , | |
| large_paper_roll_queue | INFINITE | 1 | Time Series | Oldest, FIFO, | |
| winding_machine | 2 | 1 | Time Series | Oldest, , | |
| super_wide_roll_of_toilet_pape | INFINITE | 1 | Time Series | Oldest, FIFO, | |
| automatic_roll_cutting_machine | 1 | 1 | Time Series | Oldest, , | |
| roll_toilet_paper_queue | INFINITE | 1 | Time Series | Oldest, FIFO, | |
| bagging | 600 | 1 | Time Series | Oldest, , First | |
| bags_of_toilet_paper_queue | INFINITE | 1 | Time Series | Oldest, FIFO, | |
| inspector | 4 | 1 | Time Series | Oldest, , | |
| FG_warehouse | inf | 1 | Time Series | Oldest, , | |
| Plastic_bags_queue | INFINITE | 1 | Time Series | Oldest, FIFO, | |

圖一、各設備之運行時間與規則

```
*****
*                               Entities                               *
*****
```

| Name | Speed (fpm) | Stats | Cost |
|--------------------------------|-------------|-------------|------|
| wastepaper | 150 | Time Series | |
| bundled_paper | 150 | Time Series | |
| pulp | 150 | Time Series | |
| large_paper_roll | 150 | Time Series | |
| super_wide_roll_of_toilet_pape | 150 | Time Series | |
| roll_toilet_paper | 150 | Time Series | |
| Plastic_bags | 150 | Time Series | |
| product | 150 | Time Series | |

圖二、各製程會使用到之單位物品

模擬再生衛生紙製造工廠

```
*****
*                               Processing                               *
*****
```

| Entity | Location | Process | | Routing | | | |
|--------------------------------|--------------------------------|--------------------------|------------|--------------------------------|--------------------------------|------------|---------------|
| | | Operation | Blk Output | Destination | Rule | Move Logic | |
| wastepaper | wastepaper_queue | | 1 | wastepaper | automatic_horizontal_baling_pr | FIRST 1 | move for 2min |
| wastepaper | automatic_horizontal_baling_pr | accum 10 | | | | | |
| | | wait u(8,4)min | 1 | bundled_paper | bundled_paper_queue | FIRST 1 | move for 5min |
| bundled_paper | bundled_paper_queue | | 1 | bundled_paper | pulper | FIRST 1 | |
| bundled_paper | pulper | wait e(10)min | 1 | pulp | decontamination | FIRST 1 | |
| pulp | decontamination | wait e(1)min | 1 | pulp | sieve_and_filter | FIRST 1 | |
| pulp | sieve_and_filter | wait u(15,5)min | 1 | pulp | deinking_flotation_machine | FIRST 1 | |
| pulp | deinking_flotation_machine | wait e(20)min | 1 | pulp | paper_machine | FIRST 1 | |
| pulp | paper_machine | wait e(240)min | 1 | large_paper_roll | large_paper_roll_queue | FIRST 1 | move for 2min |
| large_paper_roll | large_paper_roll_queue | | 1 | large_paper_roll | winding_machine | FIRST 1 | |
| large_paper_roll | winding_machine | wait e(90)min | | | | | |
| | | combine 2 | 1 | super_wide_roll_of_toilet_pape | super_wide_roll_of_toilet_pape | FIRST 270 | move for 2min |
| super_wide_roll_of_toilet_pape | super_wide_roll_of_toilet_pape | | 1 | super_wide_roll_of_toilet_pape | automatic_roll_cutting_machine | FIRST 1 | |
| super_wide_roll_of_toilet_pape | automatic_roll_cutting_machine | wait u(9,1)sec | 1 | roll_toilet_paper | roll_toilet_paper_queue | FIRST 16 | move for 2min |
| roll_toilet_paper | roll_toilet_paper_queue | | 1 | roll_toilet_paper | bagging | JOIN 1 | |
| Plastic_bags | Plastic_bags_queue | | 1 | Plastic_bags | bagging | FIRST 1 | |
| Plastic_bags | bagging | join 6 roll_toilet_paper | | | | | |
| | | wait e(1)min | 1 | product | bags_of_toilet_paper_queue | FIRST 1 | move for 2min |
| product | bags_of_toilet_paper_queue | | 1 | product | inspector | FIRST 1 | |
| product | inspector | wait t(4,5,6)min | 1 | product | FG_warehouse | 0.995000 1 | |
| | | | | product | EXIT | 0.005000 | NG=NG+1 |
| product | FG_warehouse | FG=FG+1 | 1 | product | EXIT | FIRST 1 | |

圖三、製造的流程與規則

```
*****
*                               Arrivals                               *
*****
```

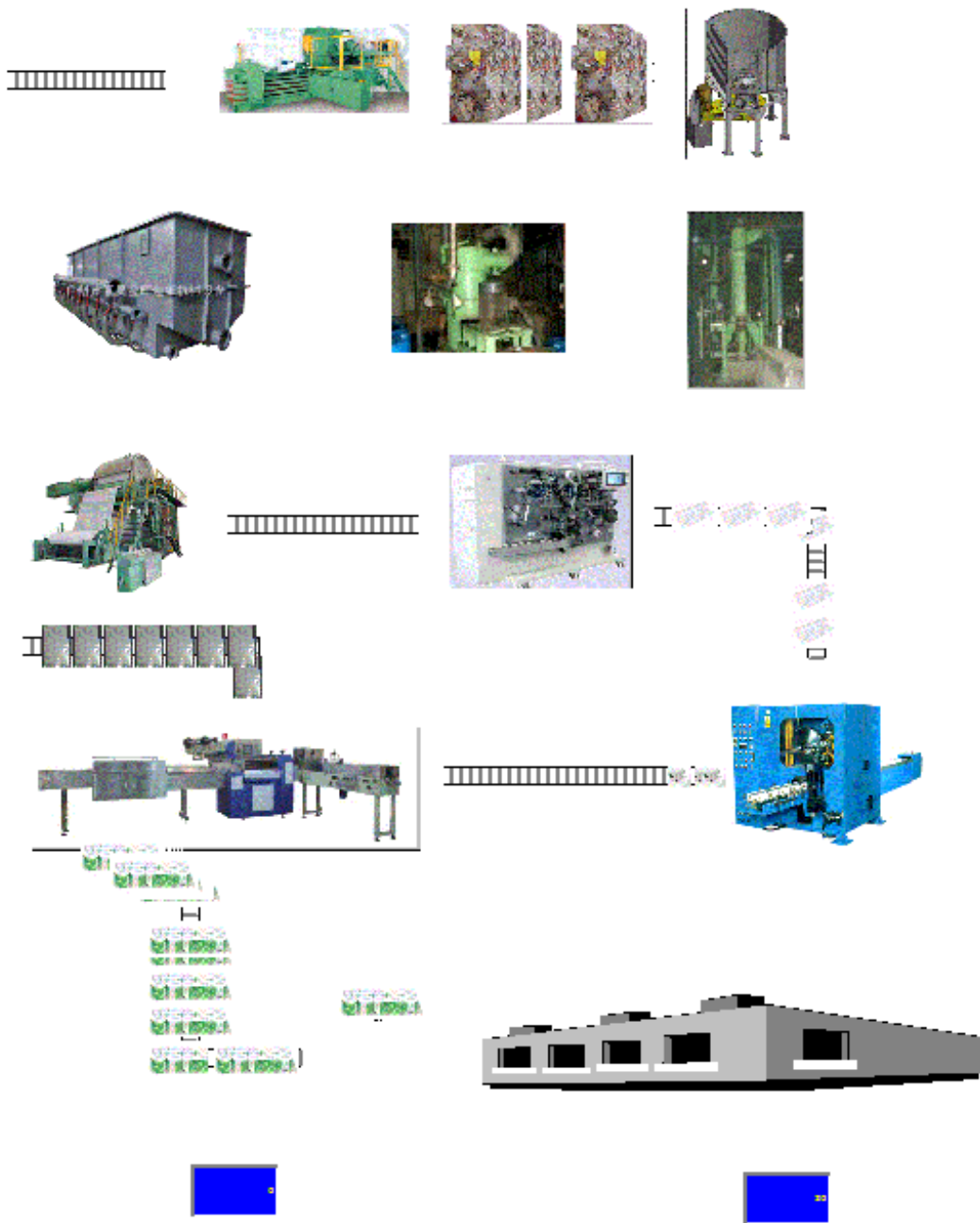
| Entity | Location | Qty Each | First Time Occurrences | Frequency | Logic |
|--------------|--------------------|----------|------------------------|-----------|---------|
| wastepaper | wastepaper_queue | 5 | inf | e(60)min | |
| Plastic_bags | Plastic_bags_queue | 10 | 0 | INF | e(5)min |

```
*****
*                               Variables (global)                       *
*****
```

| ID | Type | Initial value | Stats |
|----|---------|---------------|-------------|
| NG | Integer | 0 | Time Series |
| FG | Integer | 0 | Time Series |

圖四、到達的間隔時間以及定義所需計數之貨物

模擬再生衛生紙製造工廠



圖五、ProModel 模擬畫面

三、 模擬結果及分析

在模擬結束之後，輸出數值取得以下之模擬結果，如圖六至九。由 Locations 欄位裡我們可以得知其模擬的總時成為 3000 分鐘(50 小時)，單位物品在每一設備裡平均所停留的時間，一次平均、最大和最小容納量，以及我們這次要探討的稼動率，或稱設備使用率(Utilization)。

| Report for toilet paper 最終初始版 | | | | | | | | | | |
|---------------------------------------|----------------------|-----------------------|-----------------------------|--------------------------|-----------------|------------------|------------------|-----------------|---------------|-----------|
| General | Locations | Location States Multi | Location States Single/Tank | Resources | Resource States | Node Entries | Failed Arrivals | Entity Activity | Entity States | Variables |
| Locations for toilet paper 最終初始版 | | | | | | | | | | |
| Name | Scheduled Time (MIN) | Capacity | Total Entries | Avg Time Per Entry (MIN) | Avg Contents | Maximum Contents | Current Contents | % Utilization | | |
| wastepaper queue | 3000.00 | 999999... | 325.00 | 0.31 | 0.03 | 10.00 | 0.00 | 0.00 | | |
| automatic horizontal baling press | 3000.00 | 10.00 | 325.00 | 31.35 | 3.40 | 10.00 | 5.00 | 33.96 | | |
| bundled paper queue | 3000.00 | 999999... | 320.00 | 1456.44 | 155.35 | 303.00 | 303.00 | 0.02 | | |
| pulper | 3000.00 | 1.00 | 17.00 | 171.30 | 0.97 | 1.00 | 1.00 | 97.07 | | |
| decontamination | 3000.00 | 1.00 | 16.00 | 181.46 | 0.97 | 1.00 | 1.00 | 96.78 | | |
| sieve and filter | 3000.00 | 1.00 | 15.00 | 193.53 | 0.97 | 1.00 | 1.00 | 96.76 | | |
| deinking flotation machine | 3000.00 | 1.00 | 14.00 | 206.03 | 0.96 | 1.00 | 1.00 | 96.15 | | |
| paper machine | 3000.00 | 1.00 | 13.00 | 216.73 | 0.94 | 1.00 | 1.00 | 93.92 | | |
| large paper roll queue | 3000.00 | 999999... | 12.00 | 28.09 | 0.11 | 2.00 | 0.00 | 0.00 | | |
| winding machine | 3000.00 | 2.00 | 12.00 | 173.96 | 0.70 | 2.00 | 0.00 | 34.79 | | |
| super wide roll of toilet paper queue | 3000.00 | 999999... | 1620.00 | 20.51 | 11.08 | 270.00 | 0.00 | 0.00 | | |
| automatic roll cutting machine | 3000.00 | 1.00 | 1620.00 | 0.15 | 0.08 | 1.00 | 0.00 | 8.12 | | |
| roll toilet paper queue | 3000.00 | 999999... | 25920.00 | 0.25 | 2.13 | 32.00 | 0.00 | 0.00 | | |
| bagging | 3000.00 | 600.00 | 4920.00 | 350.52 | 574.86 | 600.00 | 600.00 | 95.81 | | |
| bags of toilet paper queue | 3000.00 | 999999... | 4320.00 | 506.85 | 729.87 | 2751.00 | 2666.00 | 0.07 | | |
| inspector | 3000.00 | 4.00 | 1654.00 | 4.99 | 2.75 | 4.00 | 4.00 | 68.78 | | |
| FG warehouse | 3000.00 | 999999... | 1641.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | | |
| Plastic bags queue | 3000.00 | 999999... | 6010.00 | 592.80 | 1187.58 | 2340.00 | 1090.00 | 0.12 | | |

圖六、Locations 模擬結果

| Report for toilet paper 最終初始版 | | | | | | | | | | |
|----------------------------------------|-------------|-----------------------|-----------------------------|------------------------------|-----------------------------|-----------------------------|------------------------|-----------------|---------------|-----------|
| General | Locations | Location States Multi | Location States Single/Tank | Resources | Resource States | Node Entries | Failed Arrivals | Entity Activity | Entity States | Variables |
| Entity Activity for toilet paper 最終初始版 | | | | | | | | | | |
| Name | Total Exits | Current Qty In System | Avg Time In System (MIN) | Avg Time In Move Logic (MIN) | Avg Time Wait For Res (MIN) | Avg Time In Operation (MIN) | Avg Time Blocked (MIN) | | | |
| wastepaper | 0.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | |
| bundled paper | 0.00 | 304.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | |
| pulp | 0.00 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | |
| large paper roll | 12.00 | 0.00 | 1983.09 | 9.00 | 718.78 | 353.82 | 901.49 | | | |
| super wide roll of toilet paper | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | |
| roll toilet paper | 25920.00 | 0.00 | 24.91 | 4.00 | 20.07 | 0.70 | 0.15 | | | |
| Plastic bags | 0.00 | 1690.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | |
| product | 1650.00 | 2670.00 | 1589.42 | 2.00 | 1578.72 | 6.51 | 2.19 | | | |

圖七、Entity Activity 模擬結果

| Report for toilet paper 最終初始版 | | | | | | |
|----------------------------------|---------------|---------------------------|-----------------------------|---------------|-----------------|-----------|
| General | Locations | Location States Multi | Location States Single/Tank | Resources | Resource States | Nodes |
| Variables for toilet paper 最終初始版 | | | | | | |
| Name | Total Changes | Avg Time Per Change (MIN) | Minimum Value | Maximum Value | Current Value | Avg Value |
| NG | 9.00 | 329.56 | 0.00 | 9.00 | 9.00 | 2.94 |
| FG | 1641.00 | 1.83 | 0.00 | 1641.00 | 1641.00 | 564.17 |

圖八、Variables 模擬結果

| Report for toilet paper 最終初始版 | | | | | | |
|--------------------------------------|-----------------|-----------------------|-----------------------------|-----------|-----------------|-------|
| General | Locations | Location States Multi | Location States Single/Tank | Resources | Resource States | Nodes |
| Entity States for toilet paper 最終初始版 | | | | | | |
| Name | % In Move Logic | % Wait For Res | % In Operation | % Blocked | | |
| wastepaper | 0.00 | 0.00 | 0.00 | 0.00 | | |
| bundled paper | 0.00 | 0.00 | 0.00 | 0.00 | | |
| pulp | 0.00 | 0.00 | 0.00 | 0.00 | | |
| large paper roll | 0.45 | 36.25 | 17.84 | 45.46 | | |
| super wide roll of toilet paper | 0.00 | 0.00 | 0.00 | 0.00 | | |
| roll toilet paper | 16.06 | 80.55 | 2.80 | 0.60 | | |
| Plastic bags | 0.00 | 0.00 | 0.00 | 0.00 | | |
| product | 0.13 | 99.33 | 0.41 | 0.14 | | |

圖九、Entity States 模擬結果

四、改善方案

利用率(Utilization)可以反映出人員或設備之使用的頻率，設備最佳之利用率最好維持在 90%左右，以保留設備故障而停產的缺失；對於人員的利用率則大約維持在 70%到 80%是最佳的，以免過於勞累。在此只針對於利用率上的改善，來模擬其改善後的結果。

將設備利用率超過 95%的設備各增加一台時，發現部分的設備利用率並沒有顯著的改善效果，但使包裝機的利用率減少許多，產量也從 1641 增加到 2130，如圖十、十一。

| Report for toilet paper 最終初始版 | | | | | | | | | | |
|---------------------------------------|----------------------|-----------------------|-----------------------------|--------------------------|-----------------|------------------|------------------|-----------------|---------------|-----------|
| General | Locations | Location States Multi | Location States Single/Tank | Resources | Resource States | Node Entries | Failed Arrivals | Entity Activity | Entity States | Variables |
| Locations for toilet paper 最終初始版 | | | | | | | | | | |
| Name | Scheduled Time (MIN) | Capacity | Total Entries | Avg Time Per Entry (MIN) | Avg Contents | Maximum Contents | Current Contents | % Utilization | | |
| wastepaper queue | 3000.00 | 999999... | 215.00 | 0.66 | 0.05 | 10.00 | 0.00 | 0.00 | | |
| automatic horizontal baling press | 3000.00 | 10.00 | 215.00 | 32.23 | 2.31 | 10.00 | 5.00 | 23.10 | | |
| bundled paper queue | 3000.00 | 999999... | 210.00 | 1340.64 | 93.85 | 182.00 | 182.00 | 0.01 | | |
| pulper.1 | 3000.00 | 1.00 | 17.00 | 171.30 | 0.97 | 1.00 | 1.00 | 97.07 | | |
| pulper.2 | 3000.00 | 1.00 | 11.00 | 264.73 | 0.97 | 1.00 | 1.00 | 97.07 | | |
| pulper | 6000.00 | 2.00 | 28.00 | 280.00 | 0.97 | 2.00 | 2.00 | 97.07 | | |
| decontamination.1 | 3000.00 | 1.00 | 15.00 | 191.99 | 0.96 | 1.00 | 1.00 | 96.00 | | |
| decontamination.2 | 3000.00 | 1.00 | 11.00 | 261.84 | 0.96 | 1.00 | 1.00 | 96.01 | | |
| decontamination | 6000.00 | 2.00 | 26.00 | 221.54 | 0.96 | 2.00 | 2.00 | 96.00 | | |
| sieve and filter.1 | 3000.00 | 1.00 | 13.00 | 223.30 | 0.97 | 1.00 | 1.00 | 96.76 | | |
| sieve and filter.2 | 3000.00 | 1.00 | 11.00 | 263.80 | 0.97 | 1.00 | 1.00 | 96.73 | | |
| sieve and filter | 6000.00 | 2.00 | 24.00 | 241.86 | 0.97 | 2.00 | 2.00 | 96.75 | | |
| deinking flotation machine.1 | 3000.00 | 1.00 | 11.00 | 262.86 | 0.96 | 1.00 | 1.00 | 96.38 | | |
| deinking flotation machine.2 | 3000.00 | 1.00 | 11.00 | 261.06 | 0.96 | 1.00 | 1.00 | 95.72 | | |
| deinking flotation machine | 6000.00 | 2.00 | 22.00 | 261.96 | 0.96 | 2.00 | 2.00 | 96.05 | | |
| paper machine.1 | 3000.00 | 1.00 | 13.00 | 221.89 | 0.96 | 1.00 | 1.00 | 96.15 | | |
| paper machine.2 | 3000.00 | 1.00 | 7.00 | 411.66 | 0.96 | 1.00 | 1.00 | 96.05 | | |
| paper machine | 6000.00 | 2.00 | 20.00 | 288.31 | 0.96 | 2.00 | 2.00 | 96.10 | | |
| large paper roll queue | 3000.00 | 999999... | 18.00 | 35.33 | 0.21 | 2.00 | 0.00 | 0.00 | | |
| winding machine | 3000.00 | 2.00 | 18.00 | 226.11 | 1.36 | 2.00 | 0.00 | 67.83 | | |
| super wide roll of toilet paper queue | 3000.00 | 999999... | 2430.00 | 20.46 | 16.57 | 270.00 | 2.00 | 0.00 | | |
| automatic roll cutting machine | 3000.00 | 1.00 | 2428.00 | 0.15 | 0.12 | 1.00 | 1.00 | 12.14 | | |
| roll toilet paper queue | 3000.00 | 999999... | 38624.00 | 37.40 | 481.56 | 4740.00 | 4064.00 | 0.05 | | |
| bagging.1 | 3000.00 | 600.00 | 5330.00 | 115.04 | 204.38 | 600.00 | 2.00 | 34.06 | | |
| bagging.2 | 3000.00 | 600.00 | 430.00 | 158.49 | 22.72 | 290.00 | 0.00 | 3.79 | | |
| bagging | 6000.00 | 1200.00 | 5760.00 | 118.28 | 113.55 | 34576.00 | 2.00 | 18.92 | | |
| bags of toilet paper queue | 3000.00 | 999999... | 5744.00 | 869.45 | 1664.71 | 3600.00 | 3600.00 | 0.17 | | |
| inspector | 3000.00 | 4.00 | 2144.00 | 5.01 | 3.58 | 4.00 | 4.00 | 89.42 | | |
| FG warehouse | 3000.00 | 999999... | 2130.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | | |
| Plastic bags queue | 3000.00 | 999999... | 5760.00 | 0.27 | 0.52 | 30.00 | 0.00 | 0.00 | | |

圖十、改善後之 Locations

| Report for toilet paper 最終初始版 | | | | | | | |
|----------------------------------|---------------|---------------------------|-----------------------------|---------------|-----------------|-----------|-----------|
| General | Locations | Location States Multi | Location States Single/Tank | Resources | Resource States | Node | Variables |
| Variables for toilet paper 最終初始版 | | | | | | | |
| Name | Total Changes | Avg Time Per Change (MIN) | Minimum Value | Maximum Value | Current Value | Avg Value | |
| NG | 10.00 | 294.92 | 0.00 | 10.00 | 10.00 | 4.27 | |
| FG | 2130.00 | 1.41 | 0.00 | 2130.00 | 2130.00 | 948.93 | |

圖十一、改善後之 Variables

經第一次改善後，發現兩台機器並沒有分擔到原本一台機器的運行，設備利用力依舊居高不下，因此將利用率仍為 95% 以上之設備再各增添一台，並模擬其結果得圖十二，由此可明顯看出設備利用率均已達 90% 以下，因此此系統應將散漿機、去污機、篩洗篩選機、脫墨浮選機以及抄紙機增為三台才能更有效的生產產品。

| | | | | | | | | |
|------------------------------|---------|-----------|--------|---------|-------|-------|-------|-------|
| bundled paper queue | 1219.90 | 999999... | 120.00 | 337.85 | 33.23 | 90.00 | 89.00 | 0.00 |
| pulper.1 | 1219.90 | 1.00 | 9.00 | 110.20 | 0.81 | 1.00 | 1.00 | 81.30 |
| pulper.2 | 1219.90 | 1.00 | 7.00 | 142.42 | 0.82 | 1.00 | 1.00 | 81.73 |
| pulper.3 | 1219.90 | 1.00 | 15.00 | 65.94 | 0.81 | 1.00 | 1.00 | 81.08 |
| pulper | 3659.69 | 3.00 | 31.00 | 96.06 | 0.81 | 3.00 | 3.00 | 81.37 |
| decontamination.1 | 1219.90 | 1.00 | 12.00 | 81.14 | 0.80 | 1.00 | 1.00 | 79.82 |
| decontamination.2 | 1219.90 | 1.00 | 10.00 | 101.23 | 0.83 | 1.00 | 1.00 | 82.98 |
| decontamination.3 | 1219.90 | 1.00 | 6.00 | 158.87 | 0.78 | 1.00 | 1.00 | 78.14 |
| decontamination | 3659.69 | 3.00 | 28.00 | 104.97 | 0.80 | 3.00 | 3.00 | 80.31 |
| sieve and filter.1 | 1219.90 | 1.00 | 9.00 | 123.07 | 0.91 | 1.00 | 1.00 | 90.80 |
| sieve and filter.2 | 1219.90 | 1.00 | 8.00 | 135.26 | 0.89 | 1.00 | 1.00 | 88.70 |
| sieve and filter.3 | 1219.90 | 1.00 | 8.00 | 135.59 | 0.89 | 1.00 | 1.00 | 88.92 |
| sieve and filter | 3659.69 | 3.00 | 25.00 | 130.98 | 0.89 | 3.00 | 3.00 | 89.47 |
| deinking flotation machine.1 | 1219.90 | 1.00 | 7.00 | 157.76 | 0.91 | 1.00 | 1.00 | 90.52 |
| deinking flotation machine.2 | 1219.90 | 1.00 | 8.00 | 137.30 | 0.90 | 1.00 | 1.00 | 90.04 |
| deinking flotation machine.3 | 1219.90 | 1.00 | 7.00 | 155.98 | 0.90 | 1.00 | 1.00 | 89.50 |
| deinking flotation machine | 3659.69 | 3.00 | 22.00 | 149.75 | 0.90 | 3.00 | 3.00 | 90.02 |
| paper machine.1 | 1219.90 | 1.00 | 8.00 | 138.40 | 0.91 | 1.00 | 1.00 | 90.76 |
| paper machine.2 | 1219.90 | 1.00 | 1.00 | 1103.74 | 0.90 | 1.00 | 1.00 | 90.48 |
| paper machine.3 | 1219.90 | 1.00 | 10.00 | 107.44 | 0.88 | 1.00 | 1.00 | 88.07 |
| paper machine | 3659.69 | 3.00 | 19.00 | 172.91 | 0.90 | 3.00 | 3.00 | 89.77 |
| large paper roll queue | 1219.90 | 999999... | 16.00 | 64.85 | 0.85 | 4.00 | 2.00 | 0.00 |

圖十二、二次改善之結果

五、 結果及討論

當利用率過高時，不但會加速機器的折舊率及壽命的耗損，還會因此影響到生產的效率，所以本報告針對利用率來做改善。一開始之工廠設計為各個設備均配一台，模擬之後透過數據我們得知其利用率已經達到負荷，不但容易損壞，也會因故障而使整條生產線停擺，因此由改善分析裡我們得知當設備各增為 3 台時能夠更有效的利用。

一個工廠若有問題卻又擔心成本考量不敢隨意改善時，我們就可以運用像這樣簡易的模擬系統來檢視需要改善的設備，不僅能看出其生產量、系統所花費的時間以及整個系統的瓶頸為何，還能探討其利用率之高低，然後再以時間、空間和成本之考量來做後續的延伸探討。

六、 參考文獻

- (1.) How Its Made: Toilet Paper
<https://youtu.be/Z74OfpUbeac>
- (2.) 【製造科技】廁紙 製造流程（再生紙回收）
<https://youtu.be/gGqnxG5IvPo>
- (3.) 資源回收網
<http://recycle.epa.gov.tw/recycle/epa/ShowPage2.aspx?sno=11&subsno=17#4>

