

การวิเคราะห์ฟังก์ชันและตำแหน่งจัดวางสินค้า
ที่เหมาะสมสำหรับคลังสินค้า
ที่มีอิทธิพลของตำแหน่งประตูหยิบสินค้า
ต่อประสิทธิภาพการดำเนินงาน



กรณีศึกษา คลังสินค้าอุปกอบริโกคแห่งหนึ่ง

โดย วรรัตน์ สุดโต รหัสนักศึกษา 6310427027

สาขาวิชา การจัดการโลจิสติกส์

คณะสถิติประยุกต์ สถาบันบัณฑิตพัฒนบริหารศาสตร์ (NIDA)



AGENDA

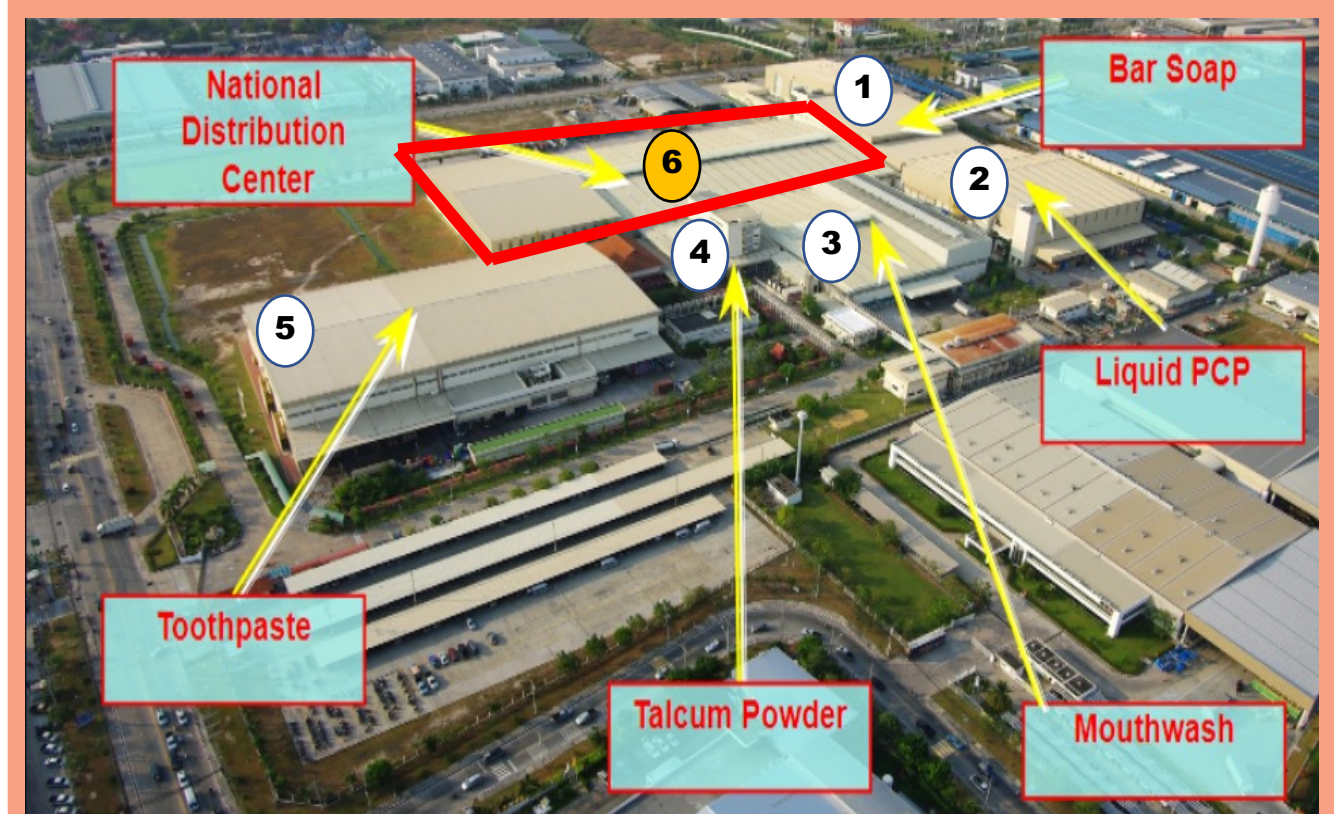
- ลักษณะทั่วไปของธุรกิจ
- ที่มาและความสำคัญของปัญหา
- วัตถุประสงค์และประโยชน์ที่คาดว่าจะได้รับ
- การดำเนินการวิจัย
- ผลการวิจัย และสรุปผล
- ข้อเสนอแนะ

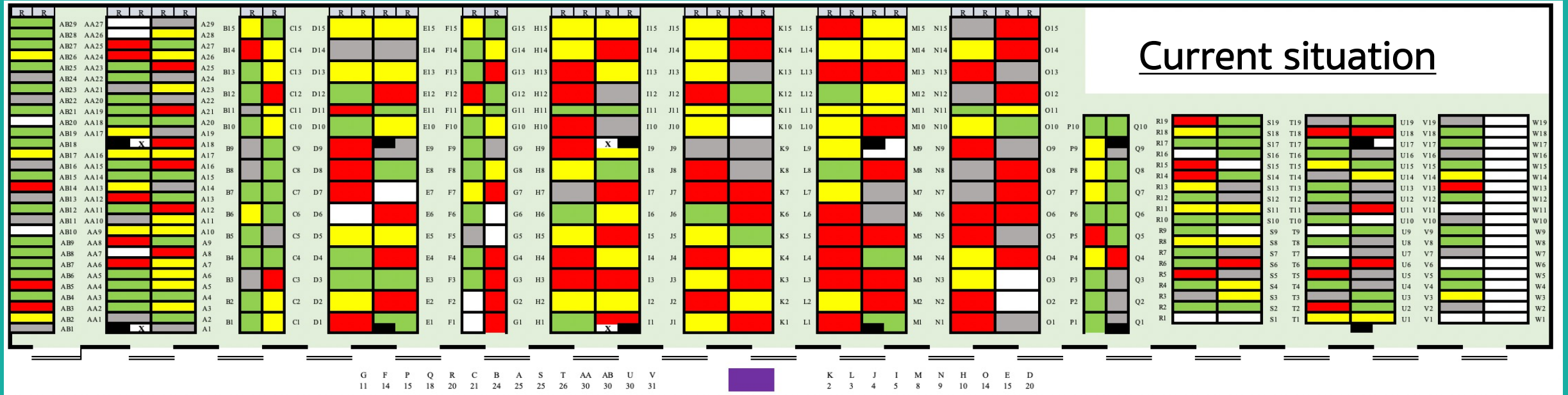
ลักษณะทั่วไปของธุรกิจ

▶ เป็นคลังสินค้าที่มีการจัดเก็บสินค้าสำเร็จรูปที่พร้อมส่งไปยังลูกค้าตามคำสั่งซื้อของลูกค้าทั้งในประเทศและต่างประเทศ

▶ สินค้าที่จัดเก็บ แบ่งออกเป็น 5 กลุ่ม ได้แก่ Bar soap, Liquid PCP, Mouthwash, Talcum Power และ Toothpaste

▶ คลังสินค้ามีการจัดเก็บสินค้า 2 รูปแบบคือ Reserve area (ตำแหน่งที่ 1-5) และ Forward area (ตำแหน่งที่ 6)





ที่มาและความสำคัญของปัญหา

- Storage limitations
- Poor layout and space utilization
- Resource limitations ex. time, labor, equipment, etc.



- High traveling distance
- High labor costs

วัตถุประสงค์

1. เพื่อศึกษาและหาแนวทางในการลดระยะทางในการหยิบสินค้า โดยการกำหนดตำแหน่งของพื้นที่การจัดวางสินค้าภายในคลังสินค้าที่เหมาะสม และสามารถเพิ่มประสิทธิภาพของกิจกรรมที่เกิดขึ้นในคลังสินค้า
2. เพื่อศึกษาและวิเคราะห์หาปัจจัยที่มีผลต่อประสิทธิภาพในการหยิบสินค้าของกรณีศึกษาดังกล่าว

ประโยชน์ที่ได้รับ

1. ได้แนวทางในการลดระยะทางในการหยิบสินค้า และสามารถกำหนดรูปแบบตำแหน่งจัดเก็บสินค้า
2. สามารถเพิ่มประสิทธิภาพของกิจกรรมที่เกิดขึ้นในคลังสินค้า
3. ทราบปัจจัยที่มีผลต่อประสิทธิภาพในการหยิบสินค้าของกรณีศึกษาดังกล่าว



วิธีดำเนินการวิจัย

01

Data characteristic

ศึกษาลักษณะของข้อมูล

02

Pre-processing

เตรียมข้อมูล

03

Analysis

วิเคราะห์ข้อมูล

04

Result &
Discussion

วิเคราะห์ผลลัพธ์และสรุปผล

01

Data characteristic

ศึกษาลักษณะของข้อมูล

PICKING LISTS

- Picking list 3 months = Oct, Nov and Dec'20
- Number of customer order
 - Oct'20 = 3,004 orders
 - Nov'20 = 3,037 orders
 - Dec'20 = 2,867 orders
- Number of SKU = 429 SKUs

| Transfer Order Number | Material | Movement Type (WM) | Source Storage Bin | Source Storage Type | Actual qty | Confirmation time | Time Diff | Confirmation Date | User |
|-----------------------|-----------|--------------------|--------------------|---------------------|------------|-------------------|-----------|-------------------|---------|
| 2132938199 | 1051110 | 850 | P330 | T30 | 174.000 | 00:58:25 | 0:00:00 | 29/10/2020 | THSUP06 |
| 2132934799 | CN05265A | 850 | P299 | T30 | 162.000 | 03:04:35 | 0:00:00 | 25/10/2020 | THANW02 |
| 2132936121 | 61007174 | 850 | P257 | T30 | 148.000 | 15:51:51 | 0:00:00 | 26/10/2020 | THKIP03 |
| 2132919671 | 183902086 | 850 | P264 | T30 | 147.000 | 17:41:34 | 0:06:04 | 12/10/2020 | THTHB01 |
| 2132931590 | 1525428 | 850 | P197 | T30 | 140.000 | 04:58:41 | 0:04:34 | 22/10/2020 | THSAI02 |
| 2132914505 | 1525428 | 850 | P197 | T30 | 138.000 | 00:52:50 | | 8/10/2020 | THSOL03 |
| 2132933683 | 61003160 | 850 | P003 | T30 | 126.000 | 10:01:09 | 0:08:19 | 24/10/2020 | THSOL03 |
| 2132936890 | 1525428 | 850 | P197 | T30 | 114.000 | 13:39:42 | 0:06:44 | 28/10/2020 | THNOT02 |
| 2132919644 | 61001524 | 850 | P072 | T30 | 110.000 | 09:49:58 | 0:00:15 | 12/10/2020 | THBAK01 |
| 2132924734 | 61001524 | 850 | P072 | T30 | 110.000 | 17:36:22 | 0:16:14 | 16/10/2020 | THANW02 |
| 2132937798 | 61001524 | 850 | P072 | T30 | 110.000 | 20:10:35 | 0:00:43 | 29/10/2020 | THROC00 |
| 2132928921 | 61002937 | 850 | P033 | T30 | 109.000 | 23:54:56 | | 21/10/2020 | THJRR02 |
| 2132919670 | CN07562A | 850 | P091 | T30 | 108.000 | 17:46:48 | 0:06:50 | 12/10/2020 | THSUP06 |
| 2132936056 | 61001524 | 850 | P072 | T30 | 107.000 | 13:13:55 | 0:08:38 | 28/10/2020 | THANK02 |
| 2132936378 | 61001512 | 850 | P214 | T30 | 106.000 | 03:45:09 | 0:05:55 | 29/10/2020 | THSUP06 |
| 2132929745 | 61001538 | 850 | P324 | T30 | 104.000 | 10:54:15 | | 20/10/2020 | THBAK01 |
| 2132936890 | 61001513 | 850 | P049 | T30 | 103.000 | 12:54:34 | 0:09:11 | 28/10/2020 | THNOT02 |
| 2132928921 | 61001512 | 850 | P214 | T30 | 101.000 | 00:44:07 | 0:03:46 | 21/10/2020 | THJRR02 |
| 2132907191 | 61001504 | 850 | P235 | T30 | 100.000 | 05:11:43 | | 1/10/2020 | THWAJ06 |
| 2132914490 | 61001524 | 850 | P072 | T30 | 100.000 | 20:48:52 | 0:07:53 | 8/10/2020 | THCHH00 |
| 2132916386 | CN05930A | 850 | P060 | T30 | 100.000 | 21:38:43 | 0:12:21 | 8/10/2020 | THANW02 |
| 2132918435 | 61007738 | 850 | P051 | T30 | 100.000 | 08:59:54 | 0:07:17 | 10/10/2020 | THJUL00 |
| 2132924794 | TH03266A | 850 | P136 | T30 | 100.000 | 05:15:52 | 0:04:29 | 17/10/2020 | THKIP03 |
| 2132926635 | 61005936 | 850 | P144 | T30 | 100.000 | 02:04:35 | | 17/10/2020 | THWIA00 |
| 2132927410 | 61001513 | 850 | P049 | T30 | 100.000 | 23:21:51 | | 17/10/2020 | THKIP03 |
| 2132931330 | 61001523 | 850 | P032 | T30 | 100.000 | 04:45:44 | 0:01:48 | 23/10/2020 | THANW02 |
| 2132931330 | 61001506 | 850 | P077 | T30 | 100.000 | 05:07:31 | 0:17:54 | 23/10/2020 | THANW02 |
| 2132931334 | 61001512 | 850 | P214 | T30 | 100.000 | 04:00:27 | 0:04:12 | 23/10/2020 | THKIP03 |
| 2132932609 | 61001514 | 850 | P238 | T30 | 100.000 | 11:10:19 | 0:04:37 | 24/10/2020 | THSOL03 |
| 2132934799 | 1524555 | 850 | P044 | T30 | 100.000 | 02:29:41 | 0:10:34 | 25/10/2020 | THANW02 |
| 2132935177 | TH02262A | 850 | P103 | T30 | 100.000 | 12:52:20 | 0:00:36 | 26/10/2020 | THANK02 |
| 2132935339 | 61007738 | 850 | P051 | T30 | 100.000 | 21:22:18 | 0:06:50 | 26/10/2020 | THSUP06 |
| 2132935339 | 61007102 | 850 | P228 | T30 | 100.000 | 21:40:38 | 0:06:40 | 26/10/2020 | THSUP06 |
| 2132935339 | 61007108 | 850 | P229 | T30 | 100.000 | 21:47:18 | 0:05:49 | 26/10/2020 | THSUP06 |

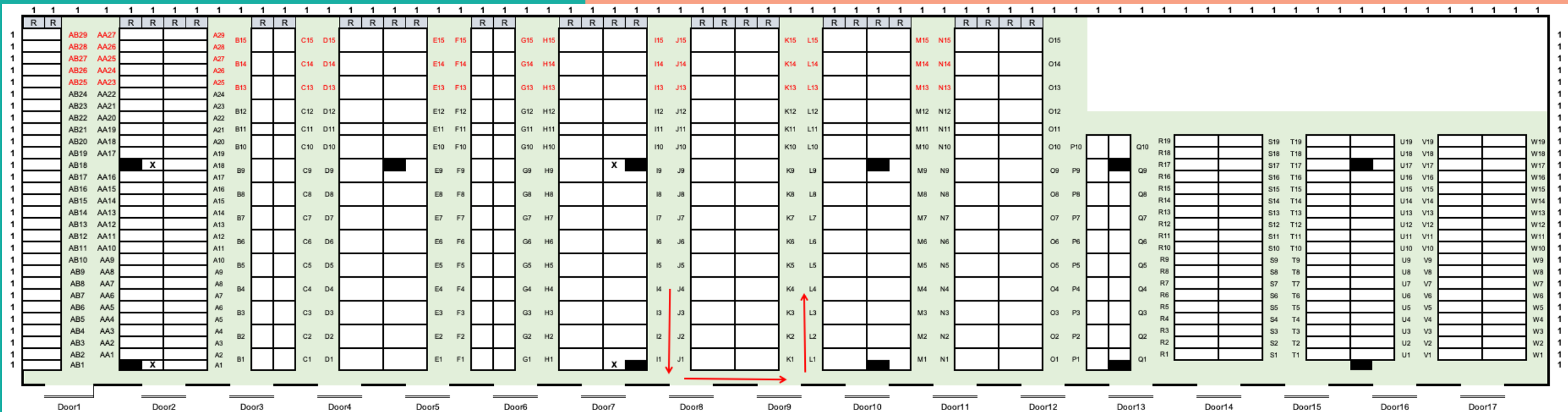


Data characteristic

ศึกษาลักษณะของข้อมูล

WAREHOUSE LAYOUT

- Storage location in forward area = 429 locations
- Door position = 17 doors





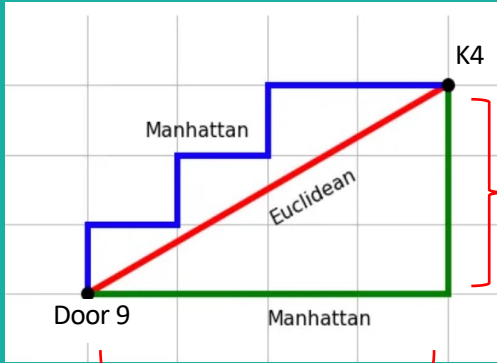
03

Pre-processing

เตรียมข้อมูล

DISTANCE MATRIX

Manhattan distance



X = 4 m.

Y = 3 m.

Total distance from Door 9 to L4 is $3+4 = 7$ m.



| Code | AB1 | AB2 | AB3 | AB4 | AB5 | AB6 | AB7 | AB8 | AB9 | AB10 | AB11 | AB12 | AB13 | AB14 | AB15 | AB16 | AB17 | AB18 | AB19 | AB20 | AB21 | AB22 | AB23 | AB24 | AB25 | AB26 | AB27 | AB28 | AB29 | AA1 | AA2 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----|-----|
| AB1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 2 | 3 |
| AB2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 1 | 2 |
| AB3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 2 | 1 |
| AB4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 3 | 2 |
| AB5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 4 | 3 |
| AB6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 5 | 4 |
| AB7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 6 | 5 |
| AB8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 7 | 6 |
| AB9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 8 | 7 |
| AB10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 9 | 8 |
| AB11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 10 | 9 |
| AB12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 11 | 10 |
| AB13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 12 | 11 |
| AB14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 13 | 12 |
| AB15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 14 | 13 |
| AB16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 15 | 14 |
| AB17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 16 | 15 |
| AB18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 17 | 16 |
| AB19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 18 | 17 |
| AB20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 19 | 18 |
| AB21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 20 | 19 |
| AB22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 21 | 20 |
| AB23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 22 | 21 |
| AB24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 23 | 22 |
| AB25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 24 | 23 |
| AB26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 25 | 24 |
| AB27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 26 | 25 |
| AB28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 27 | 26 |
| AB29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 28 | 27 |
| AA1 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 0 | 1 |
| AA2 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 1 | 0 |
| AA3 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 2 | 1 |



03

Analysis

วิเคราะห์ข้อมูล

PART I
Relocation

- Original : Single picking list

Calculate total traveling distance :

$$\sum_{i=1}^n (frequency * Distance)$$

Total traveling distance (m.)

| 1. Original | Oct | Nov | Dec |
|---------------------------|------------|------------|------------|
| 1.1 Single picking | | | |
| One by one | 11,602,772 | 12,761,421 | 11,974,926 |

Oct = 3,004 orders

Nov = 3,037 orders

Dec = 2,867 orders

| Distance | Oct | 11,602,772.40 |
|---------------|----------|---------------|
| Location code | Distance | Actual qty |
| AB14 | 42.5 | 56.000 |
| AB25 | 53.5 | 35.000 |
| AB25 | 53.5 | 34.000 |
| AB18 | 46.5 | 36.000 |
| AA9 | 37.5 | 9.000 |
| C13 | 43 | 12.000 |
| E13 | 37 | 41.000 |
| E13 | 37 | 15.000 |
| H13 | 32 | 56.000 |
| L15 | 36 | 49.000 |
| L15 | 36 | 7.000 |
| N13 | 38 | 54.000 |
| N13 | 38 | 2.000 |
| S12 | 41.5 | 18.000 |
| V13 | 49.5 | 6.000 |
| M10 | 32 | 20.000 |
| V3 | 39.5 | 50.000 |
| V3 | 39.5 | 19.000 |
| AB14 | 42.5 | 39.000 |
| AB3 | 31.5 | 18.000 |
| AB5 | 33.5 | 1.000 |
| AB6 | 34.5 | 7.000 |
| AB18 | 46.5 | 5.000 |
| AA8 | 36.5 | 50.000 |
| A12 | 34.5 | 5.000 |
| A20 | 42.5 | 2.000 |
| A28 | 50.5 | 5.000 |
| A28 | 50.5 | 4.000 |
| B12 | 44 | 1.000 |
| B6 | 33 | 5.000 |
| A16 | 38.5 | 24.000 |
| C3 | 24 | 10.000 |
| AA25 | 54.5 | 37.000 |
| A8 | 30.5 | 37.000 |
| C12 | 41 | 13.000 |
| D15 | 46 | 11.000 |
| D13 | 42 | 4.000 |
| D11 | 38.5 | 1.000 |
| D5 | 27 | 14.000 |
| D5 | 27 | 4.000 |
| D10 | 37 | 19.000 |
| D10 | 37 | 11.000 |

| Distance | Nov | 12,761,420.50 |
|---------------|----------|---------------|
| Location code | Distance | Actual qty |
| D14 | 44 | 34.000 |
| D1 | 19 | 11.000 |
| J8 | 14 | 61.000 |
| J4 | 6 | 5.000 |
| J2 | 2 | 4.000 |
| J3 | 4 | 16.000 |
| E6 | 24 | 19.000 |
| J14 | 25 | 17.000 |
| J6 | 10 | 22.000 |
| K2 | 10 | 2.000 |
| N3 | 19 | 8.000 |
| L15 | 36 | 4.000 |
| L12 | 30 | 4.000 |
| O15 | 47 | 52.000 |
| AA8 | 36.5 | 63.000 |
| AB14 | 42.5 | 7.000 |
| B14 | 48 | 15.000 |
| A18 | 40.5 | 80.000 |
| D11 | 38.5 | 42.000 |
| G2 | 12 | 30.000 |
| G2 | 12 | 10.000 |
| D11 | 38.5 | 28.000 |
| D2 | 21 | 15.000 |
| E5 | 22 | 30.000 |
| G14 | 35 | 9.000 |
| G14 | 35 | 1.000 |
| E6 | 24 | 60.000 |
| I5 | 9 | 5.000 |
| H9 | 25 | 4.000 |
| H9 | 25 | 16.000 |
| I14 | 26 | 15.000 |
| J10 | 18 | 25.000 |
| J3 | 4 | 57.000 |
| J3 | 4 | 8.000 |
| L5 | 17 | 34.000 |
| L5 | 17 | 6.000 |
| P8 | 35 | 5.000 |
| R2 | 26.5 | 5.000 |
| R2 | 26.5 | 4.000 |
| T13 | 43.5 | 1.000 |
| D10 | 37 | 19.000 |
| N4 | 21 | 15.000 |
| T1 | 31.5 | 4.000 |

| Distance | Dec | 11,974,925.50 |
|---------------|----------|---------------|
| Location code | Distance | Actual qty |
| AA12 | 40.5 | 20.000 |
| AB2 | 30.5 | 10.000 |
| A10 | 32.5 | 5.000 |
| A18 | 40.5 | 20.000 |
| C4 | 26 | 5.000 |
| C3 | 24 | 20.000 |
| D11 | 38.5 | 20.000 |
| G11 | 29.5 | 5.000 |
| A28 | 50.5 | 20.000 |
| L6 | 19 | 5.000 |
| L6 | 19 | 15.000 |
| G15 | 37 | 5.000 |
| J4 | 6 | 5.000 |
| G10 | 28 | 40.000 |
| K14 | 33 | 5.000 |
| M1 | 14 | 22.000 |
| M1 | 14 | 28.000 |
| T2 | 32.5 | 30.000 |
| P9 | 37 | 7.000 |
| P9 | 37 | 3.000 |
| S3 | 32.5 | 15.000 |
| T8 | 38.5 | 47.000 |
| T8 | 38.5 | 3.000 |
| S19 | 48.5 | 8.000 |
| S19 | 48.5 | 22.000 |
| S10 | 39.5 | 3.000 |
| U11 | 46.5 | 7.000 |
| U11 | 46.5 | 3.000 |
| V9 | 45.5 | 3.000 |
| V8 | 44.5 | 8.000 |
| V8 | 44.5 | 12.000 |
| AB14 | 42.5 | 32.000 |
| AB2 | 30.5 | 7.000 |
| AB15 | 43.5 | 9.000 |
| AB17 | 45.5 | 8.000 |
| AB18 | 46.5 | 12.000 |
| A3 | 25.5 | 4.000 |
| AB3 | 31.5 | 34.000 |
| AA19 | 48.5 | 5.000 |
| AA17 | 46.5 | 12.000 |
| AA12 | 40.5 | 18.000 |
| AA8 | 36.5 | 28.000 |



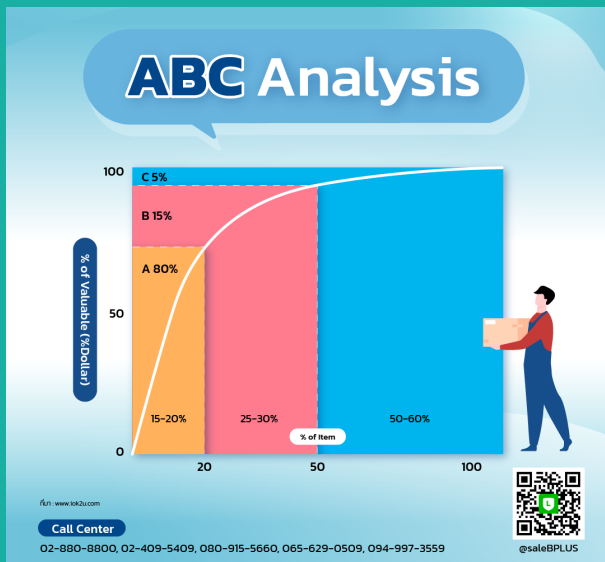
03

Analysis

วิเคราะห์ข้อมูล

PART I
Relocation

- Class base and Association analysis



| Class | No. of SKU |
|-------|------------|
| A | 16 |
| B | 70 |
| C | 343 |
| Total | 429 |

| Material | Actual qty | Percent | Acc | Class | No. |
|----------|------------|---------|--------|-------|-----|
| 61001513 | 23901 | 2.0% | 1.98% | A | 1 |
| 61001512 | 22044 | 1.8% | 3.80% | A | 2 |
| 61001523 | 18114 | 1.5% | 5.30% | A | 3 |
| VN00604A | 16782 | 1.4% | 6.69% | A | 4 |
| TH03266A | 15930 | 1.3% | 8.00% | A | 5 |
| 1525287 | 14881 | 1.2% | 9.23% | A | 6 |
| 61001514 | 14228 | 1.2% | 10.41% | A | 7 |
| 61001504 | 14059 | 1.2% | 11.57% | A | 8 |
| 61007290 | 12494 | 1.0% | 12.61% | A | 9 |
| 61001473 | 12482 | 1.0% | 13.64% | A | 10 |
| 61001524 | 12386 | 1.0% | 14.66% | A | 11 |
| 1525308 | 11915 | 1.0% | 15.65% | A | 12 |
| TH03157A | 11886 | 1.0% | 16.63% | A | 13 |
| VN00605A | 11696 | 1.0% | 17.60% | A | 14 |
| VN01119A | 11641 | 1.0% | 18.56% | A | 15 |
| 61003160 | 11451 | 0.9% | 19.51% | A | 16 |
| 61008221 | 11238 | 0.9% | 20.44% | B | 17 |
| TH03149A | 10485 | 0.9% | 21.30% | B | 18 |
| 61001479 | 10313 | 0.9% | 22.16% | B | 19 |
| 61001506 | 10258 | 0.8% | 23.00% | B | 20 |



03

Analysis

วิเคราะห์ข้อมูล

PART I
Relocation

Class base and Association analysis

Support value : ค่าความน่าจะเป็นที่เกิดเหตุการณ์ X ร่วมกับ Y
Minimum support value = 0.02

```
freq_items = apriori(ohc_df, min_support=0.02, use_colnames=True)
#freq_items.head(50)
freq_items
```

Confidence value : ค่าความน่าจะเป็นที่เกิดเหตุการณ์ X แล้วเกิดเหตุการณ์ Y
Minimum confidence value = 0.8

```
rules = association_rules(freq_items, metric="confidence", min_threshold=0.8)
rules.sort_values('confidence', ascending=False)
```

31 SKUs from 429 SKUs

| | | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| 61002937 | 61001523 | 61001513 | VN00896A | TH03197A | 61001524 | CN05701A | 61001473 | 61001506 |
| 61001512 | 61001514 | 61001504 | TH03159A | | | | | |
| 61003160 | TH02945A | | | | | | | |
| TH03501A | TH03883A | TH03163A | | | | | | |
| TH03162A | TH03156A | TH03157A | 1523260 | | | | | |
| TH02262A | TH03112A | TH03266A | 61007291 | | | | | |
| 1536378 | 1523071 | | | | | | | |
| VN00604A | 61008220 | 61008221 | | | | | | |

| Code | I/O | Association | Class | Frequency | | |
|------|-----|-------------|-------|-----------|--------|-------|
| | | | | Oct | Nov | Dec |
| J0 | 0 | 61002937 | B | 2,084 | 1,669 | 1,908 |
| I1 | 1.5 | 61001523 | A | 5,340 | 7,771 | 5,003 |
| J2 | 2 | 61001513 | A | 6,616 | 10,181 | 7,104 |
| I2 | 3 | VN00896A | B | 1,859 | 1,893 | 1,840 |
| J3 | 4 | TH03197A | B | 2,088 | 1,850 | 1,571 |
| I3 | 5 | 61001524 | A | 3,522 | 5,682 | 3,182 |
| J4 | 6 | CN05701A | C | 1,430 | 1,482 | 1,530 |
| I4 | 7 | 61001473 | A | 2,772 | 5,157 | 4,553 |
| J5 | 8 | 61001506 | B | 2,559 | 4,868 | 2,831 |
| K1 | 8 | 61001512 | A | 7,011 | 9,528 | 5,505 |
| H1 | 9 | 61001514 | A | 3,572 | 6,818 | 3,838 |
| I5 | 9 | 61001504 | A | 4,088 | 6,737 | 3,234 |
| L1 | 9 | TH03159A | B | 2,326 | 5,106 | 1,269 |
| G1 | 10 | 61003160 | A | 3,323 | 3,775 | 4,353 |
| J6 | 10 | TH02945A | C | 870 | 958 | 900 |
| K2 | 10 | TH03501A | C | 356 | 353 | 324 |
| H2 | 11 | TH03883A | C | 290 | 369 | 346 |
| I6 | 11 | TH03163A | C | 1,475 | 1,275 | 1,027 |
| L2 | 11 | TH03162A | B | 1,519 | 3,766 | 992 |
| G2 | 12 | TH03156A | B | 2,679 | 5,219 | 1,559 |
| J7 | 12 | TH03157A | A | 3,239 | 5,573 | 3,074 |
| K3 | 12 | 1523260 | B | 1,613 | 3,368 | 1,920 |
| F1 | 13 | TH02262A | B | 2,216 | 2,933 | 2,559 |
| H3 | 13 | TH03112A | C | 555 | 658 | 405 |
| I7 | 13 | TH03266A | A | 8,174 | 3,411 | 4,345 |
| L3 | 13 | 61007291 | B | 2,751 | 1,820 | 4,042 |
| E1 | 14 | 1536378 | C | 1,093 | 1,370 | 1,258 |
| G3 | 14 | 1523071 | B | 3,994 | 2,273 | 2,963 |
| J8 | 14 | VN00604A | A | 4,949 | 5,417 | 6,416 |
| K4 | 14 | 61008220 | B | 4,270 | 1,376 | 3,423 |
| M1 | 14 | 61008221 | B | 5,394 | 1,965 | 3,879 |
| F2 | 15 | 1525287 | A | 2,928 | 6,956 | 4,997 |
| H4 | 15 | 61007290 | A | 2,664 | 2,904 | 6,926 |
| I8 | 15 | 1525308 | A | 4,197 | 3,494 | 4,224 |
| L4 | 15 | VN00605A | A | 4,021 | 3,703 | 3,972 |

Total traveling distance (m.)

| 2. Relocation | Oct | Nov | Dec |
|------------------------------|-----------|-----------|-----------|
| 2.1 Class base + Association | | | |
| Total | 8,787,580 | 8,780,195 | 8,579,005 |
| | -24% | -31% | -28% |

03

Analysis

วิเคราะห์ข้อมูล

PART I
Relocation

- Storage Assignment Location problem

Objective function

$$\text{Min } Z = \sum_{i=1}^{429} \sum_{j=1}^{429} f_i D_{ij} X_{ij}$$

Define variable :

f_i = Picking frequency
 D_{ij} = Distance from start to location j
 i = SKU i $i = \{1,2,3,\dots,429\}$
 j = Location j $j = \{1,2,3,\dots,429\}$

Decision variable :

$$X_{ij} = \begin{cases} 1 & \text{if sku } i \text{ is assigned to location } j \\ 0 & \text{; otherwise} \end{cases}$$

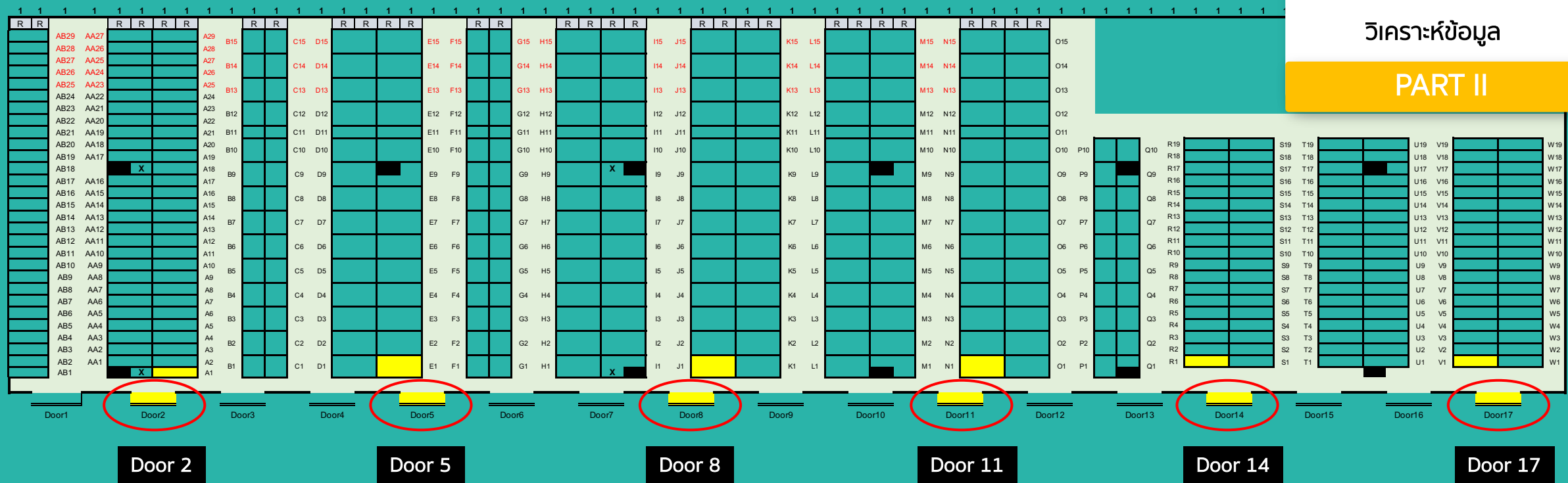
Subject to :

$$\sum_{i=1}^{429} X_{ij} \leq 1 \quad \text{for all location } j$$

$$\sum_{j=1}^{429} X_{ij} = 1 \quad \text{for all SKU } i$$

$$X_{ij} \geq 0 \text{ and } \{0,1\}$$

Part II : Effects of door location on traveling distance



Select 6 doors from 17 possible entrance door



Analysis

วิเคราะห์ข้อมูล

PART II

Part II : Effects of door location on traveling distance

Python

```
[ ] num_skus = len(distance)
num_locations = len(distance[0])

[ ] solver = pywraplp.Solver.CreateSolver('SCIP')

x = {}
for i in range(num_skus):
    for j in range(num_locations):
        x[i, j] = solver.IntVar(0, 1, '')

[ ] # Each sku is assigned to exactly 1 location.
for i in range(num_skus):
    solver.Add(solver.Sum([x[i, j] for j in range(num_locations)]) == 1)

# Each location is assigned to not at most sku.
for j in range(num_locations):
    solver.Add(solver.Sum([x[i, j] for i in range(num_skus)]) <= 1)

▶ objective_terms = []
for i in range(num_skus):
    for j in range(num_locations):
        objective_terms.append(distance[i][j] * x[i, j])
solver.Minimize(solver.Sum(objective_terms))

[ ] status = solver.Solve()

[ ] if status == pywraplp.Solver.OPTIMAL or status == pywraplp.Solver.FEASIBLE:
    print(f'Total distance = {solver.Objective().Value()}\n')
    for i in range(num_skus):
        for j in range(num_locations):
            # Test if x[i,j] is 1 (with tolerance for floating point arithmetic).
            if x[i, j].solution_value() > 0.5:
                print(f'SKU {i} assigned to location {j}.' +
                    f'distance: {distance[i][j]}')
    else:
        print('No solution found.')

Total distance = 7413153.0
```

| | Based | | | | | | |
|---|------------|------------|------------|------------|------------|------------|------------|
| | J1 | A1 | E1 | N1 | R1 | V1 | |
| | Door 8 | Door 2 | Door 5 | Door 11 | Door 14 | Door 17 | Min |
| Oct | | | | | | | |
| 1.1 Single picking | 11,602,772 | 14,521,188 | 12,508,505 | 12,858,104 | 15,571,376 | 19,658,161 | 11,602,772 |
| 2.1 Association->Class base + association | 8,787,580 | 8,627,673 | 8,576,391 | 8,699,429 | 8,381,652 | 9,610,036 | 8,381,652 |
| 2.2 SLAP | 7,822,845 | 7,436,973 | 7,552,924 | 7,694,997 | 7,215,624 | 8,190,529 | 7,215,624 |
| 2.3 Fix Association and SLAP | 9,818,187 | 10,374,178 | 10,430,104 | 10,617,443 | 10,079,738 | 11,489,909 | 9,818,187 |
| Nov | | | | | | | |
| 1.1 Single picking | 12,761,421 | 15,367,709 | 13,649,112 | 14,104,914 | 16,952,789 | 21,262,736 | 12,761,421 |
| 2.1 Association->Class base + association | 8,780,195 | 8,468,912 | 8,517,512 | 8,655,837 | 8,223,212 | 9,383,648 | 8,223,212 |
| 2.2 SLAP | 8,044,682 | 7,641,714 | 7,771,795 | 7,917,906 | 7,413,153 | 8,407,096 | 7,413,153 |
| 2.3 Fix Association and SLAP | 10,213,880 | 10,835,810 | 10,945,217 | 11,149,544 | 10,534,063 | 11,960,050 | 10,213,880 |
| Dec | | | | | | | |
| 1.1 Single picking | 11,974,926 | 14,590,144 | 12,840,569 | 12,977,776 | 15,207,058 | 19,190,643 | 11,974,926 |
| 2.1 Association->Class base + association | 8,579,005 | 8,410,150 | 8,361,951 | 8,479,584 | 8,170,553 | 9,397,098 | 8,170,553 |
| 2.2 SLAP | 7,663,171 | 7,290,065 | 7,399,588 | 7,536,296 | 7,071,914 | 8,041,565 | 7,071,914 |
| 2.3 Fix Association and SLAP | 8,173,617 | 10,101,951 | 10,141,156 | 10,316,153 | 9,814,741 | 11,213,584 | 8,173,617 |

The lowest traveling distance obtained by SLAP method is the best method 17

04

Result & Discussion

วิเคราะห์ผลลัพธ์และสรุปผล

PART I

| 1. Original : Door 8 | Oct | Nov | Dec |
|---------------------------|------------|------------|------------|
| 1.1 Single picking | | | |
| One by one | 11,602,772 | 12,761,421 | 11,974,926 |

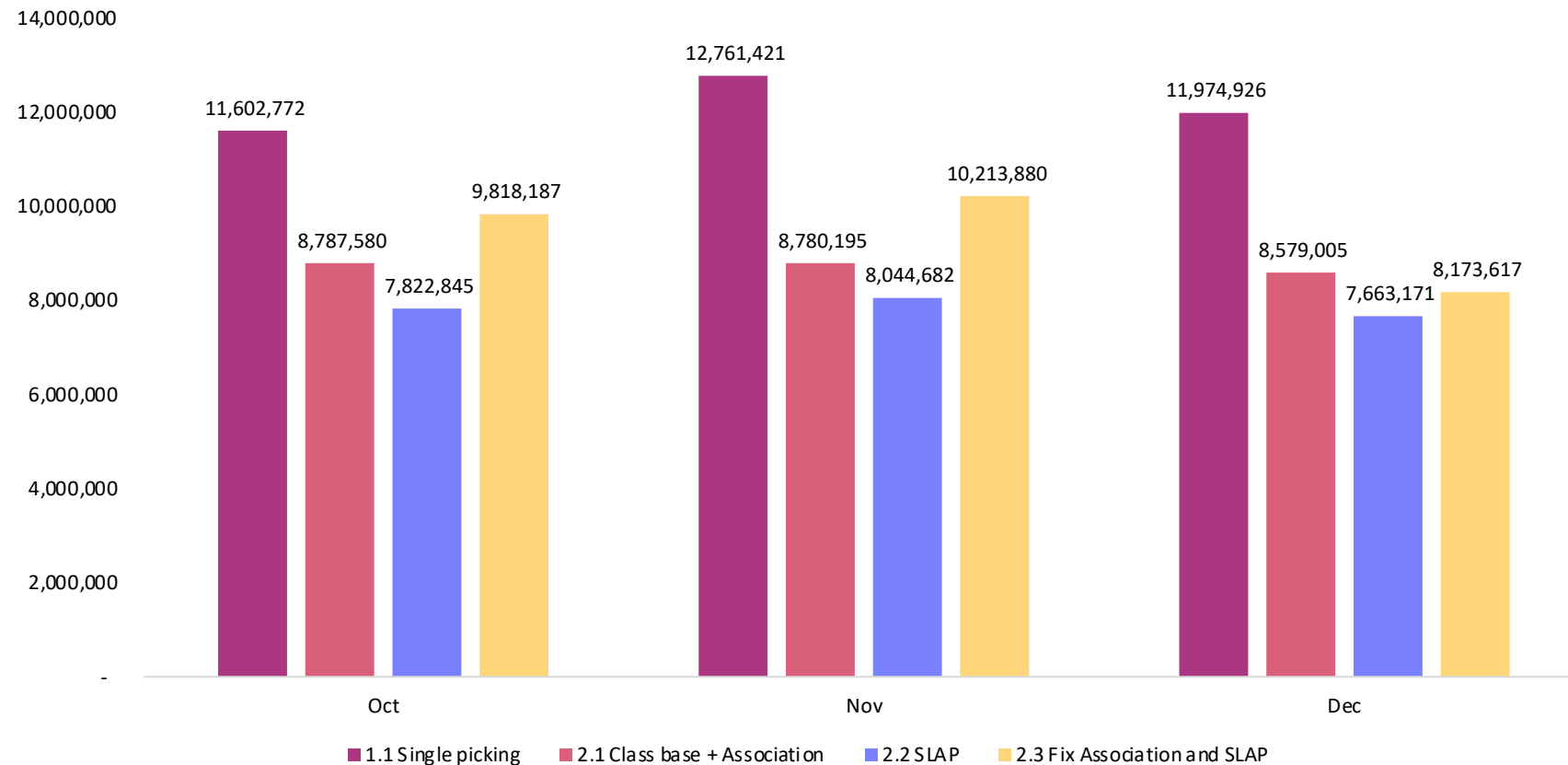
| 2. Relocation | Oct | Nov | Dec |
|-------------------------------------|-----------|-----------|-----------|
| 2.1 Class base + Association | | | |
| Total | 8,787,580 | 8,780,195 | 8,579,005 |
| | -24% | -31% | -28% |

| 2.2 SLAP | Oct | Nov | Dec |
|----------|-----------|-----------|-----------|
| Total | 7,822,845 | 8,044,682 | 7,663,171 |
| | -33% | -37% | -36% |

| 2.3 Fix Association and SLAP | | | |
|-------------------------------------|-----------|------------|-----------|
| Fix | 873,033 | 970,206 | 791,365 |
| SLAP | 8,945,154 | 9,243,674 | 7,382,252 |
| Total | 9,818,187 | 10,213,880 | 8,173,617 |
| | -15% | -20% | -32% |

- Original
- Class base and association
- SLAP
- Fix Association and SLAP

Original is Door no. 8



The lowest traveling distance obtained by SLAP method is the best method

Results & Discussion

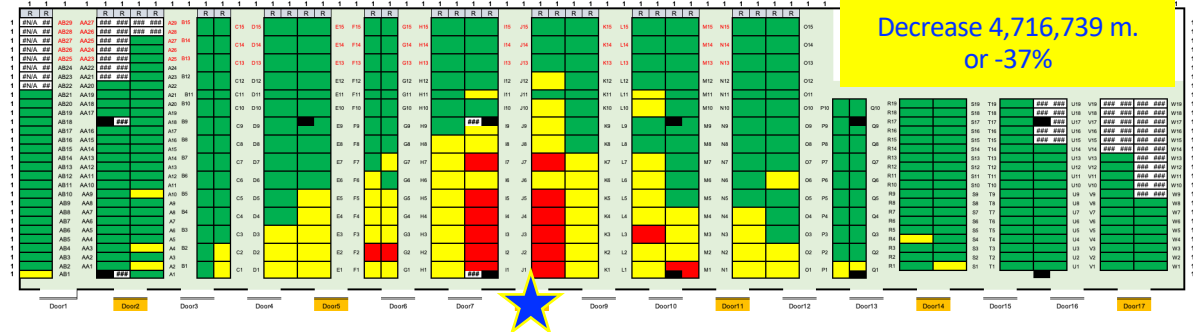
Part I : Relocation

Total traveling distance in November 2022

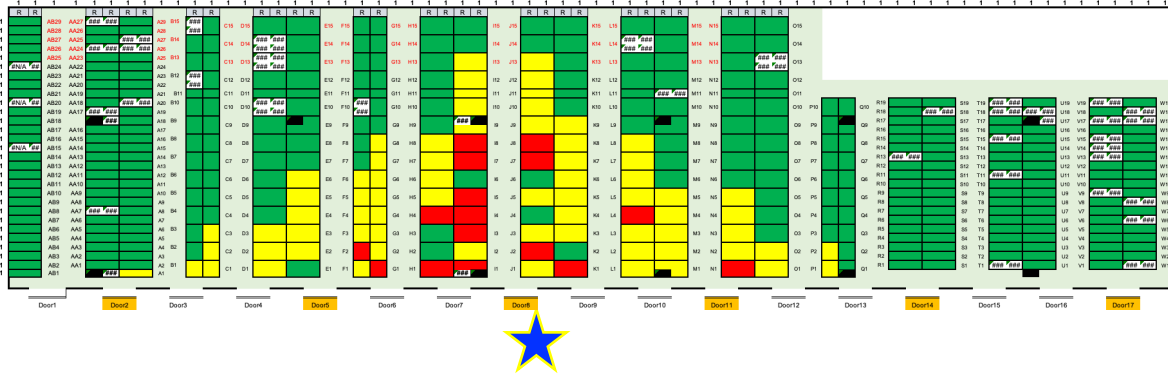
- Original : Total distance = 12,761,421 m.



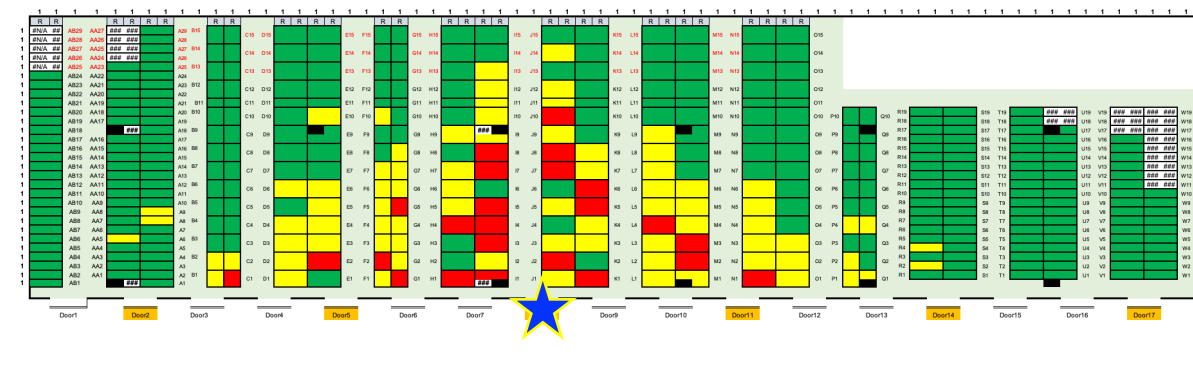
- SLAP : Total distance = 8,044,682 m.



- Class base and association : Total distance 8,780,195 m.



- Fix Association and SLAP : Total distance 10,213,880 m.



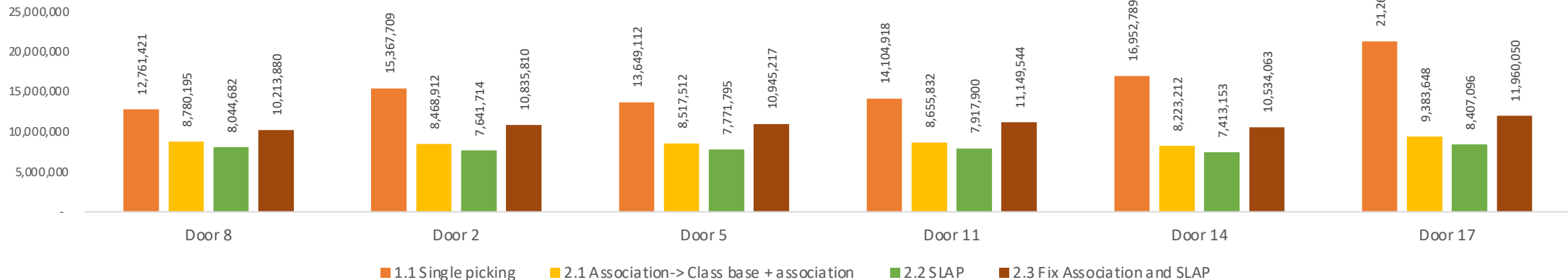
Results & Discussion

Part II : Effects of door location on traveling distance

| | Based | | | | | | Min |
|--|------------|------------|------------|------------|------------|------------|------------|
| | J1 | A1 | E1 | N1 | R1 | V1 | |
| Oct | Door 8 | Door 2 | Door 5 | Door 11 | Door 14 | Door 17 | |
| 1.1 Single picking | 11,602,772 | 14,521,188 | 12,508,505 | 12,858,104 | 15,571,376 | 19,658,161 | 11,602,772 |
| 2.1 Association-> Class base + association | 8,787,580 | 8,627,673 | 8,576,391 | 8,699,425 | 8,381,652 | 9,610,036 | 8,381,652 |
| 2.2 SLAP | 7,822,845 | 7,436,973 | 7,552,924 | 7,694,991 | 7,215,624 | 8,190,529 | 7,215,624 |
| 2.3 Fix Association and SLAP | 9,818,187 | 10,374,178 | 10,430,104 | 10,617,443 | 10,079,738 | 11,489,909 | 9,818,187 |
| Nov | Door 8 | Door 2 | Door 5 | Door 11 | Door 14 | Door 17 | Min |
| 1.1 Single picking | 12,761,421 | 15,367,709 | 13,649,112 | 14,104,918 | 16,952,789 | 21,262,736 | 12,761,421 |
| 2.1 Association-> Class base + association | 8,780,195 | 8,468,912 | 8,517,512 | 8,655,832 | 8,223,212 | 9,383,648 | 8,223,212 |
| 2.2 SLAP | 8,044,682 | 7,641,714 | 7,771,795 | 7,917,900 | 7,413,153 | 8,407,096 | 7,413,153 |
| 2.3 Fix Association and SLAP | 10,213,880 | 10,835,810 | 10,945,217 | 11,149,544 | 10,534,063 | 11,960,050 | 10,213,880 |
| Dec | Door 8 | Door 2 | Door 5 | Door 11 | Door 14 | Door 17 | Min |
| 1.1 Single picking | 11,974,926 | 14,590,144 | 12,840,569 | 12,977,776 | 15,207,058 | 19,190,643 | 11,974,926 |
| 2.1 Association-> Class base + association | 8,579,005 | 8,410,150 | 8,361,951 | 8,479,588 | 8,170,553 | 9,397,098 | 8,170,553 |
| 2.2 SLAP | 7,663,171 | 7,290,065 | 7,399,588 | 7,536,296 | 7,071,914 | 8,041,565 | 7,071,914 |
| 2.3 Fix Association and SLAP | 8,173,617 | 10,101,951 | 10,141,156 | 10,316,153 | 9,814,741 | 11,213,584 | 8,173,617 |

| Compare with original Door | | | | |
|----------------------------|--------|---------|---------|---------|
| A1 | E1 | N1 | R1 | V1 |
| Door 2 | Door 5 | Door 11 | Door 14 | Door 17 |
| -25% | -8% | -11% | -34% | -69% |
| 2% | 2% | 1% | 5% | -9% |
| 5% | 3% | 2% | 8% | -5% |
| -6% | -6% | -8% | -3% | -17% |
| A1 | E1 | N1 | R1 | V1 |
| Door 2 | Door 5 | Door 11 | Door 14 | Door 17 |
| -20% | -7% | -11% | -33% | -67% |
| 4% | 3% | 1% | 6% | -7% |
| 5% | 3% | 2% | 8% | -5% |
| -6% | -7% | -9% | -3% | -17% |
| A1 | E1 | N1 | R1 | V1 |
| Door 2 | Door 5 | Door 11 | Door 14 | Door 17 |
| -22% | -7% | -8% | -27% | -60% |
| 2% | 3% | 1% | 5% | -10% |
| 5% | 3% | 2% | 8% | -5% |
| -24% | -24% | -26% | -20% | -37% |

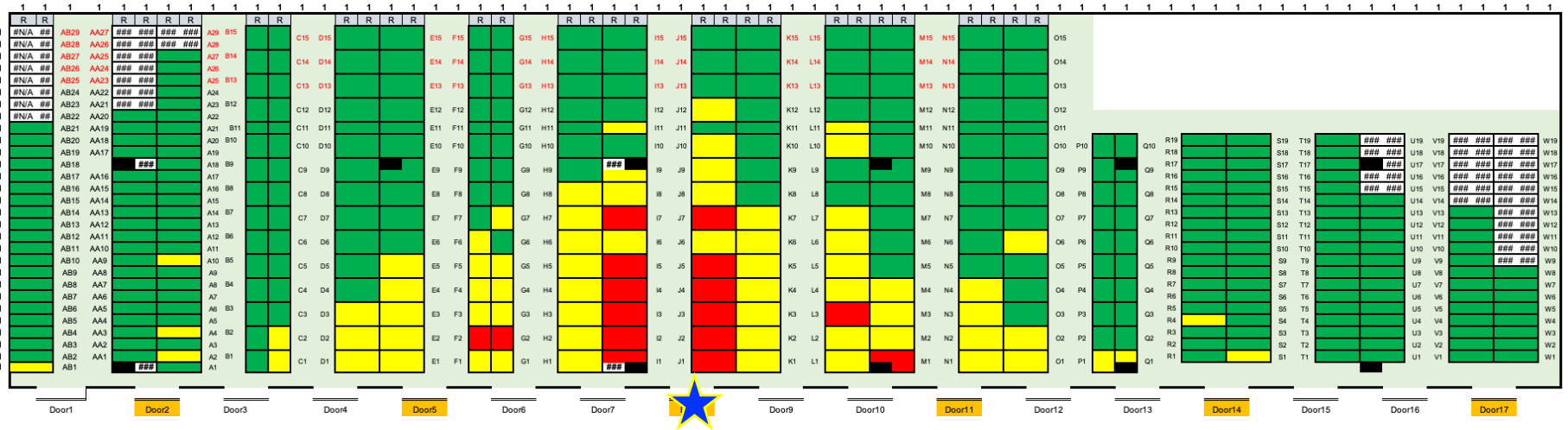
Total traveling distance in Nov



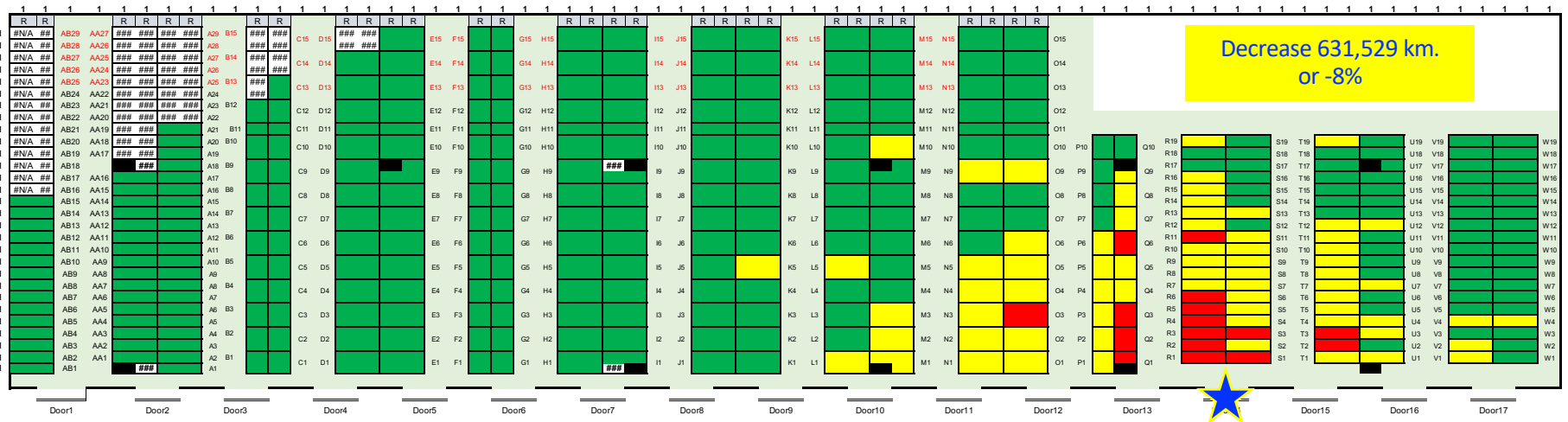
Results & Discussion

Part II : Effects of door location on traveling distance

- SLAP with door no.8 : Total distance = 8,044,682 m.



- SLAP with door no.14 : Total distance = 7,413,153 m.



สรุปผลการศึกษา

จากผลการศึกษาเพื่อหาแนวทางในการลดระยะทางในการเดินหยิบสินค้า พบว่าวิธีการกำหนดตำแหน่งพื้นที่การจัดวางสินค้าด้วยวิธี SLAP ทำให้ระยะทางการเดินหยิบสินค้าสั้นที่สุด โดยสามารถลดระยะทางจากการหยิบสินค้าตาม Picking list ในเดือนพฤศจิกายนมากที่สุด จาก 12,761,421 เป็น 8,044,682 เมตร คิดเป็น 37%

และจากการวิเคราะห์ปัจจัยที่มีผลต่อประสิทธิภาพในการหยิบสินค้า พบว่าการกำหนดจุดเริ่มต้นและจุดสิ้นสุดที่ประตูตำแหน่งหมายเลข 14 จะทำให้ระยะทางการเดินหยิบสินค้าสั้นที่สุด

ข้อเสนอแนะ

ในการศึกษาครั้งนี้ได้กำหนดจุดเริ่มต้นและจุดสิ้นสุดของการเดินหยิบสินค้าเป็นจุดเดียวกัน ซึ่งอาจส่งผลทำให้ระยะทางทั้งหมดเพิ่มมากขึ้น ซึ่งในอนาคตอาจจะมีการขยายการวิเคราะห์ โดยการกำหนดจุดเริ่มต้นและจุดสิ้นสุดเป็นคนละตำแหน่งกัน เพื่อดูว่าจะส่งผลต่อระยะการเดินทางที่ลดลงหรือไม่



THANK YOU

ANY QUESTIONS?