



SMU

SINGAPORE MANAGEMENT
UNIVERSITY

ANLY482 Analytics Practicum
Project Proposal

*Optimizing operations productivity and developing an interactive
dashboard for local supply chain company*

Team 03

Submitted by OPTTEAMIZATION

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Project Sponsor

Our sponsor is a home-grown supply chain solutions company and leading regional supply chain management partner to many of the world's leading brands such as Dell, Motorola, Samsung, LG, Exxon Mobil, Unilever and Heinemann. The company has operations all over Asia Pacific, such as China, the whole of ASEAN, India and Korea and they service various industry segments: Chemicals & Healthcare, Consumers & Retail, Electronics & Technology, E-Commerce and Cold Chain.

A strong advocate for technological and operational innovation, the company advocates productivity and sustainability improvements through interactive solutions so that they can provide their diverse consumer-base from various industry clusters with world-class logistics services.

Motivation

The company has stayed ahead of their competition by embracing technology in the early days and now, they are starting to dabble into analytics to help make use of the large amount of data that they have generated throughout the course of their business. Currently, these information is being stored in their proprietary Warehouse Management System (WMS) which captures transaction information whenever goods are moving in, out or within the warehouse. The amount of information being managed by the system is massive and it is very complicated, thus managers must spend time to use pivot tables in excel to better visualize the information being generated to get a better view of how the current operations is being run. This uses up valuable time which could have been used for other more important operational matters.

Also, man-hour management is also very important as the amount of volume that the material handlers can handle is limited to 7 containers for inbound and 7 containers for outbound. Any more than this and overtime will be required. Currently, material handlers are the ones that request for overtime hours whenever the volume of work exceeds the current baseline threshold. Thus, it is up to the judgement of the manager on the ground to make the final call on how long the material handlers need to overtime. As a result, there are cases of material handlers taking more overtime than necessary leading to increased cost which leads to the company having their margins beings reduced due to this inefficiency as the client would only pay for a certain number of overtime hours based on the agreed service level agreement.

Objectives

The main objectives of the project would be to do the following:

- Create an Operations Dashboard to visualize the following KPIs (The dashboard will be populated using data from the currently generated reports.)
 - a. Operations Productivity Chart
 - i. The purpose of this chart is to visualize the operations performance at each hour of the day and see if the drop in the productivity level is in-line with the break timings and if there are additional timings which are unproductive.

- ii. X-axis: Hour of the day
 - iii. Y-axis: Number of pallets successfully serviced
- b. Product Ranking Chart
 - i. The purpose of this chart is to find out which are the best-selling items and which are the least popular items.
 - ii. Treemap view of the products filtered by month / year
- c. Product Seasonality Chart
 - i. The purpose of this chart is to see the seasonality factors of the different products.
 - ii. X-axis: Month of the year
 - iii. Y-axis: Number of pallets
- d. Actual Overtime Hours Chart (Dual-axis Chart)
 - i. These charts will be made up of 2 lines, one for the total number of overtime hours incurred and another being the total number of containers that were completed for the day. One chart will be used for the morning shift and another chart will be used for the night shift.
 - ii. The purpose of this chart is to visualize the number of overtime hours for the month in a timeline view so that managers can see the overtime performance of the operations in relation to the number of additional containers that need to be serviced for the day.
 - iii. X-axis: Date of the month
 - iv. Y-axis: Number of overtime hours
 - v. Y-axis: Number of containers
- e. Overtime Performance Analysis Chart
 - i. The purpose of this chart is to use the historical timings to come-up with a baseline overtime hour required for varying number of additional containers.
 - ii. X-axis: Number of containers over the threshold limit
 - iii. Y-axis: Average time taken to complete the additional order
- Find out if the current operation performance is in-line with the baseline performance of 7 containers of inbound and 7 containers of outbound per working shift.

Data

The data provided by our sponsor are obtained from 3 of their in-house systems:

1. Warehouse Management System (WMS) - The warehouse management system is used to keep track of the movement of the goods coming in, going out and within the warehouse itself. The WMS is a proprietary system developed in-house.
2. Reporting System (RS) - This system provides the company with performance management systems which allow the company to manage their KPIs. Data from the WMS is being fed into the RS to generate summary reports.
3. Human Resources System (HRS) - This system provides information on the permanent employees' working hours and overtime hours.

For this project, our sponsor has provided us with data for one of their client, which is a company selling powdered milk cans. This includes the inbound and outbound products for the year 2017. There are several excel workbooks provided which we will explain below.

From Warehouse Management System

Handling In Report

There is a total of around 140,000 rows of data spanning across January to December 2017 for the Inbound orders for this client. Each row represents a pallet.

	A	B	C	D	E	F	G	H	I	J
1	AMS HANDLING IN REPORT									
2										
3	Criteria:									
4	PA_POST_DATE_FROM >= 01/01/2017									
5	PA_POST_DATE_TO <= 31/01/2017									
6										
7	STO_NO	PA_NUM	TRANS_CODE	GRN_CREATED_DATE	CONTAINER_ARRIVAL_DATE	PA_CREATED_DATE	PA_POST_DATE	PRODUCT_CODE	DESCRIPTION	SU_NO
8	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472294
9	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472295
10	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472296
11	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472297
12	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472299
13	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472300
14	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472302
15	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472303
16	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472307
17	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472309
18	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472310
19	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472311
20	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472313
21	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472314
22	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472315
23	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472316
24	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472317
25	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472318
26	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472320
27	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472321
28	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472323
29	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472324
30	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472325
31	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472326
32	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472327
33	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472329
34	2905069	PA00002529	ISC	05/01/2017	05/01/2017	05/01/2017	05/01/2017	10091191		2000472330

*The description is blanked out because it contains information about the client's products

Metadata Dictionary

Terminology	Description
STO No	Unique identifier for an inbound order. It is the same as the Customer Ref No in Inbound Order Status Summary Report from RS.
Trans Code	There are several trans code, but we will only focus on: IFP: Plant Transfer (Physical system change, movement of goods)
GRN Created Date	Goods Received Note. Once GRN is recorded, it means that inbound process is completed.
PA Created Date	The date when the putaway job is created.
PA Post Date	The date when the putaway job is completed.
Description	The product which will be stored in the warehouse e.g. Brand X 850g powdered milk cans or Brand X 400g powdered milk cans.

Handling Out Report

The number of Outbound orders for this client from January 2017 to December 2017 is approximately 81,000 rows of data. Each row represents a pallet.

	A	E	F	G	H	I
1	AMS HANDLING OUT REPORT					
2						
3	Criteria:					
4	DO_POST_DATE_FROM >= 01/01/2017					
5	DO_POST_DATE_TO <= 31/01/2017					
6						
7	SO_DOC_NUM	TRANS_CODE	DO_CREATED_DATE	DO_POST_DATE	PRODUCT_CODE	PROD_DESCRIPTION
8	MRF2017-001	ORV	01/10/2017 11:27:08	10/01/2017	10078115	
9	MRF2017-002	ORV	01/10/2017 11:30:33	10/01/2017	10077097	
10	MRF2017-003	ORV	01/10/2017 11:34:01	10/01/2017	20001739	
11	MRF2017-003	ORV	01/10/2017 11:34:01	10/01/2017	20001739	
12	MRF2017-004	ORV	01/13/2017 11:32:56	14/01/2017	10092830	
13	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
14	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
15	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
16	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
17	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
18	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
19	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
20	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
21	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
22	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
23	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
24	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
25	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
26	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
27	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
28	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
29	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
30	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
31	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
32	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
33	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
34	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
35	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	
36	MRF2017-005	ORV	01/17/2017 09:42:29	17/01/2017	10094349	

*The prod_description is blanked out because it contains information about the client's products

Metadata Dictionary

Terminology	Description
SO Doc Num	Unique identifier for an outbound order. It is the same as the Order Num in Outbound Order Status Summary Report from RS.
Trans Code	There are several trans code, but we will only focus on: <ul style="list-style-type: none"> • ORV - Return to vendor • OSD - Meant for disposal • OSO - For shipment outbound These 3 trans codes are to be taken into consideration because there is a physical movement of goods.
DO Created Date	The date which the delivery order is created.
DO Post Date	The date which the delivery order is completed.

Product Code	Unique identifier of a product.
Prod Description	The product which will be stored in the warehouse e.g. Brand X 850g powdered milk cans or Brand X 400g powdered milk cans.

From Reporting System

Inbound Order Status Summary Report

There is a total of around 3,000 rows of data spanning across January to December 2017 for the Inbound orders for this client from RS. This number is significant lesser than the Handling In Report as it is an aggregation of the data from WMS. Each row represents a container, which contains 22 pallets.

A snippet of the data for an Inbound Order Status Summary Report is shown below.

	A	B	D	F	G	H	I	L	M
	Customer Ref No	Owner	Trans Code	ASN Date	ASN Time	GRN Date	GRN Time	Putaway Date	Putaway Time
1									
2	508208551	Dummy_AMS	ASN	01-09-2017	01:40:12	01-09-2017	03:41:50	01-09-2017	10:28:47
3	508837053	Dummy_AMS	ASN	01-09-2017	04:36:08	01-09-2017	06:17:28	01-09-2017	07:30:42
4	508284252	Dummy_AMS	ASN	01-09-2017	06:08:08	01-09-2017	08:49:04	01-09-2017	09:30:43
5	508854103	Dummy_AMS	ASN	01-09-2017	09:36:07	01-09-2017	10:44:12	01-09-2017	11:24:42
6	508557537	Dummy_AMS	ASN	01-09-2017	11:08:07	01-09-2017	13:39:22	01-09-2017	14:23:42
7	508334282	Dummy_AMS	ASN	01-09-2017	12:08:09	01-09-2017	14:40:31	01-09-2017	15:21:42
8	508828504	Dummy_AMS	ASN	01-09-2017	14:24:10	01-09-2017	16:18:16	01-09-2017	17:07:42
9	508200089	Dummy_AMS	ASN	01-09-2017	17:14:48	01-09-2017	20:22:03	01-09-2017	21:30:43
10	508669778	Dummy_AMS	ASN	01-09-2017	19:08:08	01-09-2017	21:11:43	01-09-2017	22:55:44
11	508655133	Dummy_AMS	ASN	02-09-2017	01:40:11	02-09-2017	03:42:32	02-09-2017	04:05:43
12	508866004	Dummy_AMS	ASN	02-09-2017	04:24:11	02-09-2017	09:18:32	02-09-2017	10:52:43
13	508270373	Dummy_AMS	ASN	02-09-2017	09:24:16	02-09-2017	13:49:52	02-09-2017	14:28:43
14	508392782	Dummy_AMS	ASN	02-09-2017	10:24:09	02-09-2017	14:25:32	02-09-2017	14:46:46
15	508094798	Dummy_AMS	ASN	02-09-2017	12:12:09	02-09-2017	15:52:17	02-09-2017	16:19:43
16	508727623	Dummy_AMS	ASN	02-09-2017	14:24:09	02-09-2017	16:22:23	02-09-2017	19:24:45
17	508720638	Dummy_AMS	ASN	02-09-2017	15:52:07	02-09-2017	21:05:07	02-09-2017	21:37:47
18	508874502	Dummy_AMS	ASN	02-09-2017	19:36:08	02-09-2017	22:14:42	02-09-2017	22:52:43
19	508439167	Dummy_AMS	ASN	02-09-2017	23:52:08	03-09-2017	03:23:32	03-09-2017	04:08:44
20	508497531	Dummy_AMS	ASN	03-09-2017	02:24:23	03-09-2017	04:35:14	03-09-2017	05:17:44
21	508879203	Dummy_AMS	ASN	03-09-2017	05:24:09	03-09-2017	06:47:06	03-09-2017	07:16:46
22	508603618	Dummy_AMS	ASN	03-09-2017	08:52:09	03-09-2017	10:30:19	03-09-2017	10:48:43
23	508603619	Dummy_AMS	ASN	03-09-2017	09:36:09	03-09-2017	11:50:58	03-09-2017	13:33:43
24	508501536	Dummy_AMS	ASN	03-09-2017	15:24:08	03-09-2017	20:14:33	03-09-2017	21:19:42
25	508497532	Dummy_AMS	ASN	03-09-2017	18:52:08	03-09-2017	21:16:12	03-09-2017	22:01:41
26	508708399	Dummy_AMS	ASN	03-09-2017	21:08:08	03-09-2017	22:30:30	04-09-2017	04:53:45
27	508499032	Dummy_AMS	ASN	03-09-2017	22:52:16	04-09-2017	03:12:44	04-09-2017	05:03:41
28	508739809	Dummy_AMS	ASN	04-09-2017	02:24:09	04-09-2017	03:44:13	04-09-2017	05:07:41
29	508697012	Dummy_AMS	ASN	04-09-2017	04:36:07	04-09-2017	06:18:25	04-09-2017	08:31:42
30	508687876	Dummy_AMS	ASN	04-09-2017	07:08:07	04-09-2017	08:46:15	04-09-2017	09:20:41
31	508311689	Dummy_AMS	ASN	03-09-2017	14:24:08	04-09-2017	09:39:20	04-09-2017	10:53:42
32	508591774	Dummy_AMS	ASN	04-09-2017	13:10:25	04-09-2017	14:14:39	04-09-2017	14:58:42
33	508280999	Dummy_AMS	ASN	04-09-2017	09:52:13	04-09-2017	15:40:03	04-09-2017	17:04:42
34	508122065	Dummy_AMS	ASN	04-09-2017	15:08:11	04-09-2017	16:39:51	04-09-2017	18:22:41
35	508824107	Dummy_AMS	ASN	04-09-2017	16:52:08	04-09-2017	18:53:47	04-09-2017	19:45:41
36	508722838	Dummy_AMS	ASN	04-09-2017	16:08:11	04-09-2017	20:44:17	04-09-2017	21:22:43

Metadata Dictionary

Terminology	Description
Customer Ref No	Unique identifier for an inbound order. It is the same as the STO No in Handling In Report from WMS.
ASN Date/Time	Arrival Shipment Notice. It refers to the timing when the goods leave the production plant.

GRN Date/Time	Goods Received Note. Once GRN is recorded, it means that inbound process is completed.
Putaway Date/Time	The putaway timing refers to the time after which processing of a pallet is complete. It is usually 15 minutes after the reporting of GRN.

The difference between ASN Date/Time and GRN Date/Time is the total time taken for goods to finish its inbound process after leaving the production plant. This includes the travelling time and the handling in time. However, we are only interested in the handling in time which is the time taken for the workers to complete the handling in. Yet, this timing is not available because the time which the truck arrives at the warehouse for handling in is not recorded. Therefore, we will have to assume on the average time taken to travel from the production plant to the warehouse, which is from Tampines to Tuas. To ensure a more accurate timing of the actual handling in time, we will recommend our sponsor to start collecting this information as well.

Outbound Order Status Summary Report

There is a total of around 4,000 rows of data spanning across January to December 2017 for the Outbound orders for this client from RS. This number is significant lesser than the Handling Out Report as it is an aggregation of the data from WMS. Each row of data represents a container, which contains 22 pallets.

A snippet of the data for a typical Outbound Order Status Summary Report is shown below.

	A	C	D	F	L	M	N	R	S	T	V	Y	Z
1	Order Num	Trans Code	Tp Short Name	Qty In PLT	WT (KG)	Vol (M3)	Order Date	SP Start	ate	DP Complete Date	DO Start Date	DO Complete Date	
2	508723897	OSO	0056632473	22.00	11143.440	66.528	08/08/2017 04:08:07	22/8/17	21:39:42	23/08/2017 11:59:57	23/08/2017 12:01:04	04/09/2017 17:06:17	
3	508728306	OSO	0056632473	22.00	11143.440	66.528	08/08/2017 04:08:07	11/8/17	02:46:21	13/08/2017 08:18:36	13/08/2017 08:28:41	06/09/2017 18:26:34	
4	508728309	OSO	0056632473	22.00	11143.440	66.528	08/08/2017 04:08:08	22/8/17	20:04:30	23/08/2017 11:56:01	23/08/2017 11:57:03	04/09/2017 17:08:33	
5	508728326	OSO	0056632473	22.00	11143.440	66.528	08/08/2017 04:08:13	11/8/17	02:09:17	13/08/2017 08:15:01	13/08/2017 08:30:04	06/09/2017 18:28:05	
6	508738186	OSO	0056632473	22.00	11143.440	66.528	09/08/2017 04:08:05	23/8/17	22:26:13	24/08/2017 08:48:11	24/08/2017 08:49:32	05/09/2017 15:33:42	
7	508738188	OSO	0056632473	22.00	11143.440	66.528	09/08/2017 04:08:05	30/8/17	08:41:55	30/08/2017 09:59:54	30/08/2017 10:01:25	07/09/2017 14:52:17	
8	508738191	OSO	0056632473	21.67	10974.600	65.520	09/08/2017 04:08:05	24/8/17	01:36:36	24/08/2017 09:01:28	24/08/2017 09:03:03	07/09/2017 14:57:48	
9	508738197	OSO	0056632473	21.64	10962.540	65.448	09/08/2017 04:08:06	25/8/17	03:44:08	25/08/2017 11:21:50	25/08/2017 11:23:49	05/09/2017 17:17:49	
10	508738196	OSO	0056632199	22.00	16023.696	69.312	09/08/2017 04:08:07	1/9/17	22:08:08	02/09/2017 11:03:28	02/09/2017 11:04:55	04/09/2017 12:46:28	
11	508761079	OSO	0056631684	22.00	13157.760	44.352	15/08/2017 15:40:06	19/8/17	18:13:53	20/08/2017 11:09:20	20/08/2017 11:12:15	09/09/2017 12:36:40	
12	508761073	OSO	0056631684	22.86	16044.600	68.640	15/08/2017 15:40:07	18/8/17	20:45:50	19/08/2017 12:15:27	19/08/2017 12:17:07	09/09/2017 12:39:39	
13	508780401	OSO	0056632475	22.00	12300.288	59.136	16/08/2017 04:08:02	17/8/17	23:13:15	18/08/2017 15:35:54	18/08/2017 15:37:36	09/09/2017 12:41:13	
14	508794606	OSO	0056632487	22.00	13576.200	58.080	18/08/2017 14:08:01	21/8/17	18:10:57	22/08/2017 09:36:51	22/08/2017 09:38:36	09/09/2017 12:04:05	
15	508794611	OSO	0056632487	22.00	13576.200	58.080	18/08/2017 14:08:02	21/8/17	10:35:36	21/08/2017 13:38:35	22/08/2017 09:00:09	09/09/2017 12:04:48	
16	508794612	OSO	0056632487	22.00	13576.200	58.080	18/08/2017 14:08:02	22/8/17	02:37:12	22/08/2017 10:15:13	22/08/2017 10:17:51	09/09/2017 12:05:38	
17	508794613	OSO	0056632487	22.00	13576.200	58.080	18/08/2017 14:08:03	20/8/17	03:18:55	20/08/2017 12:33:45	21/08/2017 09:44:17	09/09/2017 12:02:21	
18	508794618	OSO	0056632487	22.00	13576.200	58.080	18/08/2017 14:08:05	20/8/17	19:02:52	21/08/2017 08:18:14	21/08/2017 09:45:14	09/09/2017 12:03:28	
19	508801127	OSO	0056632473	22.00	12418.560	44.352	19/08/2017 04:08:03	25/8/17	02:20:50	25/08/2017 11:32:44	25/08/2017 11:34:02	04/09/2017 15:42:42	
20	508801128	OSO	0056632473	22.00	15186.600	68.640	19/08/2017 04:08:03	5/9/17	02:47:40	05/09/2017 08:19:26	05/09/2017 08:20:56	11/09/2017 13:43:08	
21	508801123	OSO	0056632473	21.80	14688.828	67.632	19/08/2017 04:08:05	29/8/17	02:27:03	30/08/2017 14:14:59	30/08/2017 14:16:28	07/09/2017 14:57:03	
22	508801131	OSO	0056632473	22.00	12418.560	44.352	19/08/2017 04:08:08	25/8/17	02:57:42	25/08/2017 11:42:53	25/08/2017 11:53:38	04/09/2017 17:10:32	
23	508801133	OSO	0056632473	22.26	14482.680	50.976	19/08/2017 04:08:09	25/8/17	04:52:02	25/08/2017 10:57:52	25/08/2017 11:11:27	07/09/2017 14:54:44	
24	508801137	OSO	0056632473	22.00	12418.560	44.352	19/08/2017 04:08:10	26/8/17	03:10:19	26/08/2017 14:32:44	27/08/2017 11:43:44	05/09/2017 15:29:20	
25	508803703	OSO	0056705360	10.47	7606.800	33.600	21/08/2017 16:08:03	26/8/17	19:07:38	27/08/2017 11:24:08	27/08/2017 11:26:47	04/09/2017 12:43:48	

Metadata Dictionary

Terminology	Description
Order Num	Unique identifier for an outbound order. It is the same as the SO Doc Num in Handling Out Report from WMS.
Trans Code	There are several trans code, but we will only focus on: <ul style="list-style-type: none">• ORV - Return to vendor• OSD - Meant for disposal• OSO - For shipment outbound These 3 trans codes are to be taken into consideration because there is a physical movement of goods.
Qty in PLT	Quantity in Pallet, which will be rounded up to whole number.
DP Start Date	DP (direct picking) start refers to the operational trigger time when operation starts.
DP Complete Date	DP complete refers to the time when operation is completed. (actual timing is usually about 45 minutes after DP Start Date)

From Human Resources System

Overtime Hours Report

The report on the number of working hours and overtime hours for the permanent staff can be retrieved from the HRS. This information helps the Operations Manager to get a sense of the estimated number of overtime hours required for a client storing this type of products.

Given the nature of a warehousing business, a client typically releases a Request For Quotation (RFQ) and a logistics provider will bid for the project. The contract will consist of a service level agreement which determines the number of workers that can be used per shift, the total number of overtime hours that the client agrees to pay, the amount of transactions that the client must provide each month, etc.

Thus, since the amount of overtime that the client is willing to pay is fixed, overtime must be properly planned so that the company will not exceed the agreed amount of overtime as this would lead to reduced margins from the client.

Methodology

In this section, we will explain the methodology which our team will implement to perform analysis on the data provided by our sponsor.

We will be using JMP Software and Microsoft Excel for Exploratory Data Analysis (EDA) to better understand the dataset given and its characteristics. As part of data preprocessing, our team will be performing the following steps to obtain a clean dataset. The steps will eventually be converted into a script which will be used to clean the data that is uploaded into the dashboard which we will develop for our sponsor.

Data Preprocessing

With every new dataset, we first must clean the data to remove irrelevant data that should not be included in our analysis. For data cleaning, the steps include:

1. Handling missing values. If there are missing values in a row of record, the entire row will be excluded because it will be inaccurate to include it.
2. Handling duplicate data. Duplicate data could occur when the employees double scan the barcode upon inbound of goods. Similarly, in the event of duplicate data, we will remove the entire row as well.
3. Resolving redundancies caused by data integration.

With the clean dataset, we will proceed to further explore the data and find out potential visualizations and analysis that can be done with the dataset to provide a more in-depth analysis and dashboard that will be useful for our sponsor.

Visualizations

The final product of our project is to create an Operations Dashboard to visualize the following KPIs:

1. Operations Productivity Chart
2. Product Ranking Chart
3. Product Seasonality Chart
4. Actual Overtime Hours Chart
5. Overtime Performance Analysis Chart

At the start of each day, the Operations Manager will upload 3 CSV files namely: Handling In Report, Handling Out Report and Overtime Hours Report for the day before. Upon uploading these files, the data cleaning script will be run and the relevant data will be stored into the database which will be used for data visualizations on the dashboard.

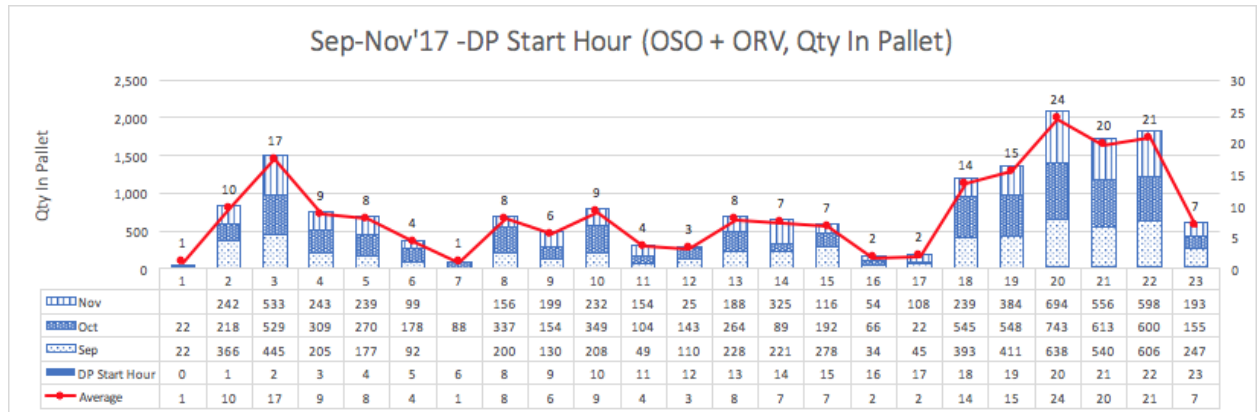
The visualizations to be used on our dashboard include Time Series Line Chart and Treemap. The Operations Manager will have the ability to select the period to view as well.

Bar Chart

Operations Productivity Chart

Using a bar chart, we can visualize the various operations productivity and performance level during each hour of the day to see if there is a generic trend throughout the day, or whether the productivity levels are in line with the break timings allocated to the operators. From here we can further identify

which time of the day could be better made use of to increase the overall productivity level, or whether there is an unexpected unproductive time in the day.

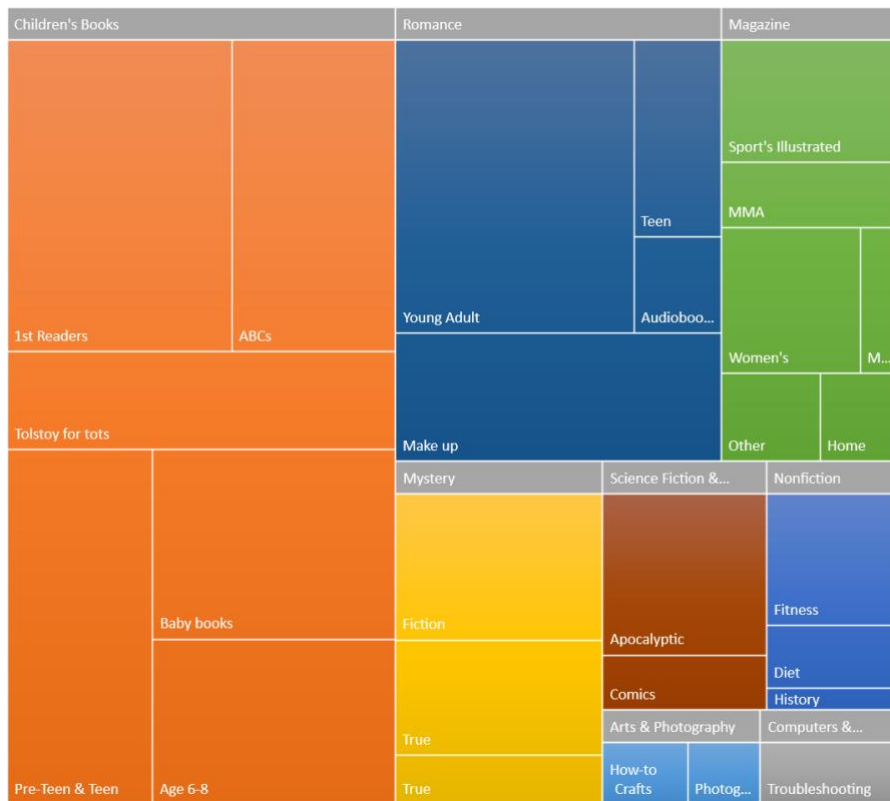


Example of a Bar Chart that describes the average number of pallets per hour across Sep to Nov 2017.

Treemap

Product Ranking Chart

A treemap can be used to identify which product is the best-selling item and which is the least selling item. They are being ranked according to the size and proportion of their sales as compared to one another. As seen from the example below, we can identify the best-selling product by the proportion of its sales.

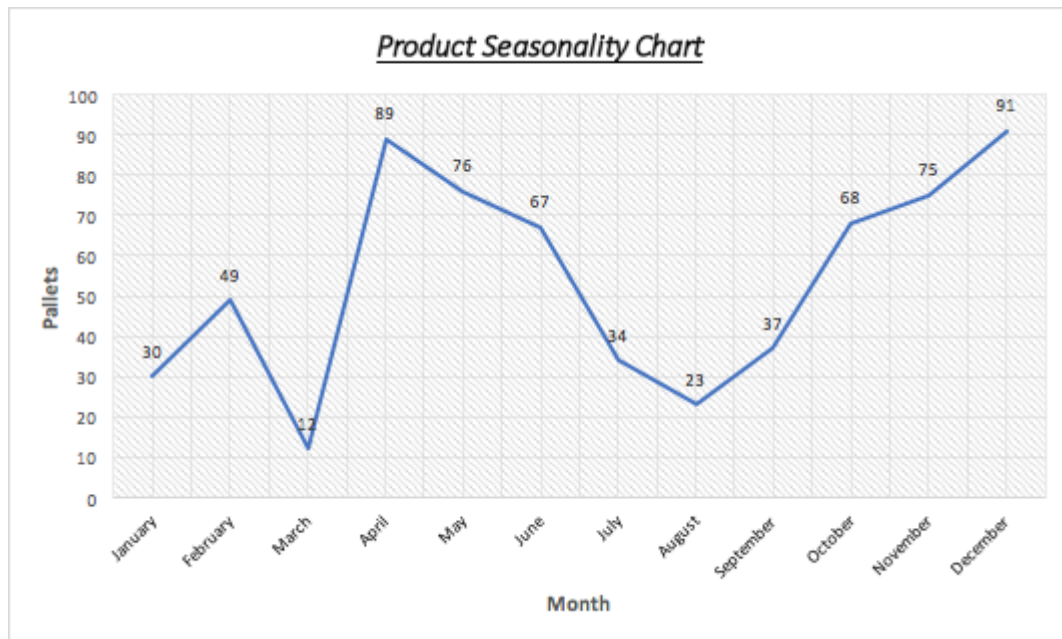


Example of a Treemap that is used to understand which is the best-selling categories of books.

Time Series Line Chart

Product Seasonality Chart

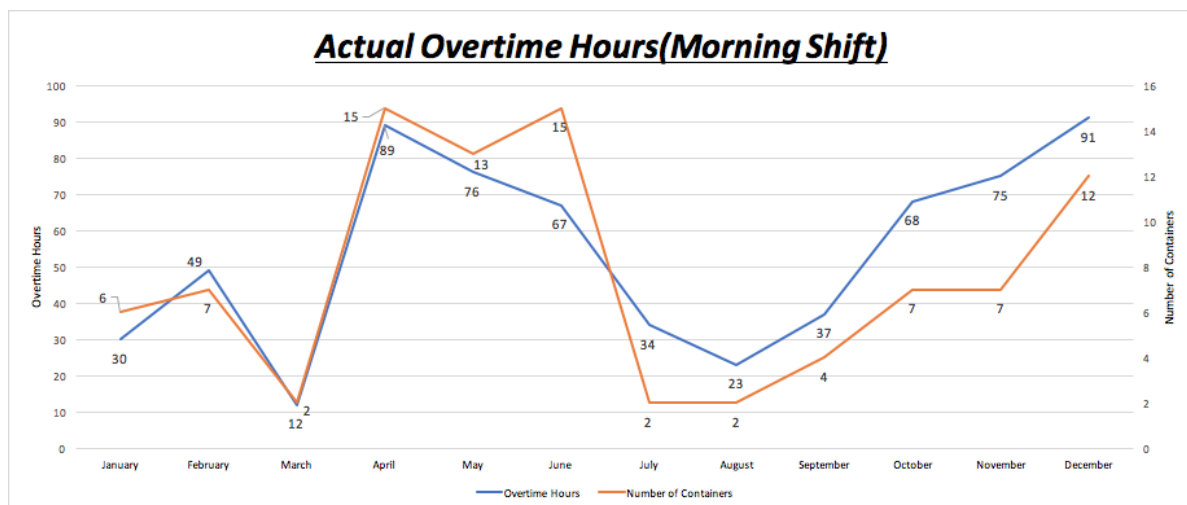
After identifying the ranking of the products by its sales volume through a Treemap, we can further drill down into the individual product seasonality performance through a Time Series Line Chart, where we can observe the sales of the product over the months or years.



Example of a Time Series Line Chart that describes the number of orders over the year.

Actual Overtime Hours Chart (Dual-axis Chart)

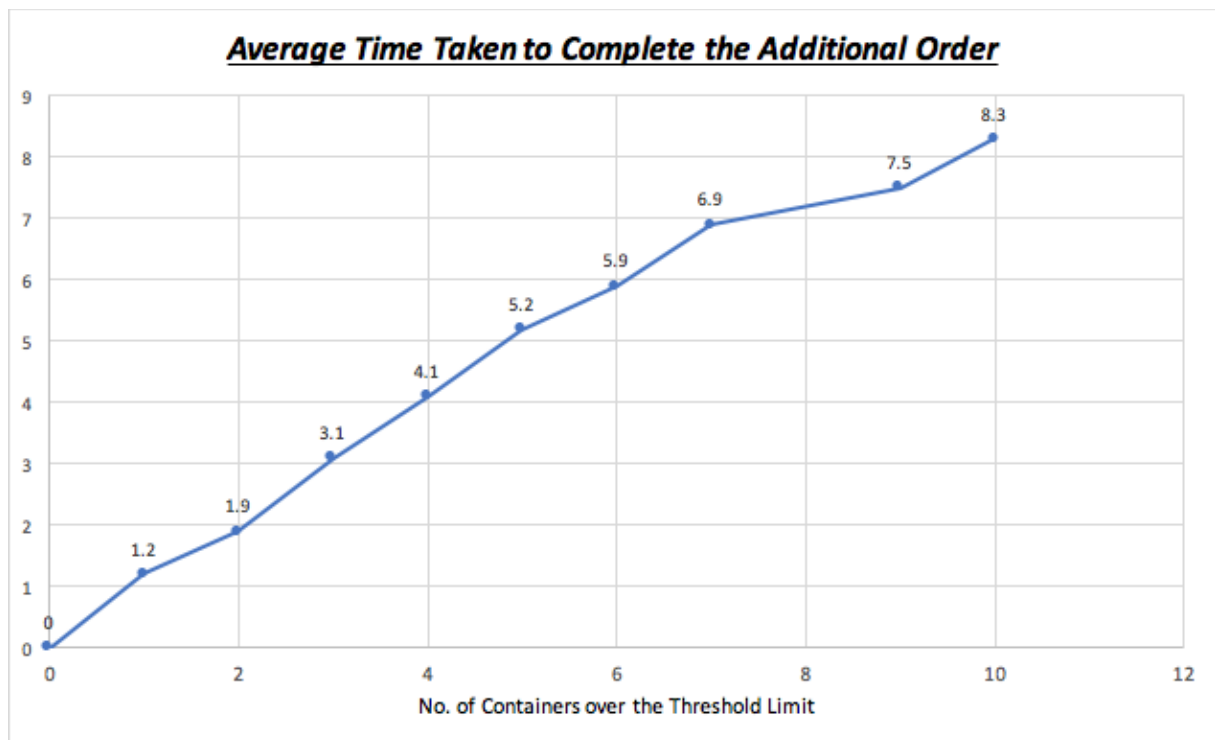
These charts will be made up of 2 lines, one for the number of overtime hours and one for the number of containers. The purpose of this chart is to visualize the number of overtime hours for the month in a timeline view so that managers can see the overtime performance of the operations in relation to the number of additional containers that need to be serviced for the day.



Example of a Time Series Line Chart that describes the number of containers and overtime hours for Morning Shift.

Overtime Performance Analysis Chart

With the chart, we can tell from historical data on how much time in hours is taken to fulfil and handle the number of specified containers that exceeds the threshold limit of a daily operation.



Example of a Time Series Line Chart that describes the time taken to fulfil an additional order.

Technology

We will be utilising several tools to aid us in the development of our dashboard. This includes:

JMP Software	JMP Software is developed by the JMP business unit of SAS institute and it is a powerful tool for analytics. Our team plans to use JMP Software for Exploratory Data Analysis.
Highcharts and JavaScript	Highcharts is a simple-to-use charting library written in JavaScript which allows us to add interactive charts to our web application for the dashboard. It will be used to develop our dashboard for the various visualizations mentioned above.
Python	Python is a programming language which we will use to create a script meant for cleaning the dataset when it is uploaded.
PostgreSQL	PostgreSQL is an object-relational database management system which will be used to store the data from the CSV files.

Scope of Work

The following describes the scope of work which the team will be working on across the span of the next few months till the final submission.

Data Gathering and Scoping

Our sponsor has given us various excel spreadsheets with data for 2017, as mentioned above, for a client selling powdered milk cans. Our project scope includes analysing the products ranking, products seasonality, operations productivity and overtime hours used to meet the demand. With the data, we will perform Exploratory Data Analysis using JMP Software.

Data Cleaning, Wrangling and Restructuring

Our team aim to combine the various excel spreadsheets into one for Inbound and one for Outbound by using their unique identifier to link the data together. Data cleaning will be done using Python to handling missing values and duplicate data, after integrating the data.

The team will also use Python to write a script which will combine the various excel spreadsheets and extract the relevant fields before consolidating them into a single spreadsheet that will be used as an input for the analysis and the Operations Dashboard. All the data that is uploaded will be stored into a PostgreSQL database, which serves as the database of information for the dashboard.

Data Visualization and Reporting

Once the data is cleaned and combined, we will extract the data and create a dashboard with various visualizations as mentioned earlier. This will be done using Highcharts and JavaScript. The interactive dashboard will allow managers to have easy access to visualizations showing the performance of the current operations as compared to past operations.

We will also analyse the data provided so that we can evaluate if their current operations are operating within their current baseline threshold and is the current operations sustainable. Lastly, we will also research on the feasibility of doing a model to help the Operations Managers find out how much overtime hours are required based on the amount of outstanding work and workers on hand.

Work Plan

The following Gantt chart shows the task allocations to each member for each iteration, as well as the important project milestones which we will prepare for.

Tasks	Task Allocation	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	
Iteration 1: Project Proposal Preparation		20th Dec 2017 - 14th Jan 2018																	
1	Meeting Client to understand project specifications	JY & Russ	✓																
2	Internal Meeting 1: Discuss methodology and segregation of work	JY & Russ	✓																
3	Internal Meeting 2: Analyze dataset and work on wiki	JY & Russ	✓																
4	Internal Meeting 3: Finalize proposal	ALL	✓																
Milestone 1: Project Proposal Submission		14th Jan																	
Iteration 2: Analyze and Clean Data		15th - 28th Jan																	
5	Data Cleaning and Exploration	Russ & Weilun																	
6	Model Research	JY																	
7	Update Wiki	Weilun																	
Iteration 3: Model Selection + Automation Script		29th Jan - 11th Feb																	
8	Automation script	Weilun & Russ																	
9	Model Selection	JY & Russ																	
10	Update Wiki	JY																	
Iteration 4: Run Models and Evaluate Accuracy		12th - 25th Feb																	
11	Model Selection	ALL																	
12	Architecture Diagram	Russ																	
Milestone 2.1: Interim Report Submission		25th Feb																	
Iteration 5: Interim Report & Presentation Preparation		26th Feb to 11th March																	
13	Finalize wiki	Weilun																	
14	Report	ALL																	
15	Presentation slides + Rehearsal	ALL																	
Milestone 2.2: Interim Report Presentation		26th Feb to 4th March																	
Iteration 6: Web-Service and Dashboard		12th - 25th March																	
16	Implement Web-service	Russ & Weilun																	
17	Dashboard implementation	JY																	
18	Update Wiki	Weilun																	
Iteration 7: Abstract preparation + Post Processing		26th March - 8th April																	
19	Prepare abstract	ALL																	
20	Update Wiki	ALL																	
21	Data post-processing	ALL																	
Milestone 3: Abstract Submission		1st April																	
Milestone 4: Full paper Submission		8th April																	
Iteration 8: Final Submission Preparation		9th April - 29th April																	
22	Finalize poster (14th - 15th)	ALL																	
23	Conference paper	ALL																	
24	Finalize wiki	ALL																	
25	Presentation preparation	ALL																	
26	Final submission	ALL																	
Milestone 5: Conference Day		14th - 15th April																	
Milestone 6: Final Submission		22nd April																	

Limitations

As with any other real life projects, there are limitations which we face especially with regards to the availability of data.

S/N	Limitations	Conclusion
1	The current data provided only consists of information from 1 company, which sells powdered milk cans, that our sponsor company is handling.	We assume that the same analysis can be replicated for the logistic warehousing of other companies' products which are similar in nature.
2	There is a lack of information on the exact time taken to complete the inbound storage as they do not record the timestamp when the truck arrives at the warehouse for handling in to take place.	With the lack of this information, we cannot analyse the time to complete an order and predict the time required to complete an inbound order. We will recommend our sponsor to record this information because we feel that it will be useful to analyse the operations productivity. For our project, we will come up with an estimate for the travelling time from the production plant to the warehouse.

3	Out of the 12 workers involved in the logistics work for this company, there are 3 contract staff. However, there is also a lack of information on the overtime hours of these contract workers.	The lack of information on overtime hours for contract workers will affect the accuracy of our findings and analysis. However, we will assume that the average overtime hours of the contract staff is the same as the average overtime hours of the permanent staff.
4	The workers allocated to work for Inbound can also help the staff allocated to work for Outbound and vice versa. For overtime, staff working on Inbound can help to do overtime for Outbound processes. However, there is no record on which worker is allocated for Inbound and which worker is allocated for Outbound process.	We will assume that all overtime work will be split based on the excess demand, which is determined by more than 7 trucks, for Inbound and Outbound. For example, there are 10 Inbounds and 9 Outbounds for a shift and the overtime hours are 10 hours in total, the overtime used for Inbound = $10 / ((10-7) + (9-7)) * (10-7) = 6$ hours.
5	The data provided from the WMS may not be totally representative of all the Inbound and Outbound transactions for this client as there may be human errors involved e.g. Worker did not scan the barcode	However, as the data size provided is sufficiently large (over 100k of data), the small percentage of potential human errors can be neglected. Therefore, the analysis conducted will still be considerably accurate.

Important Information about the Business Process

1. One container can hold up to 22 pallets.
2. Morning shift is from 08:00 to 17:30. Night shift is from 18:00 to 07:30. Refer to the table below for an exact schedule for both shifts.
3. Each shift is made up of 6 people, 4 for outbound, 2 for inbound but they can do the roles of the other function if they have nothing to do.
4. The morning shift does more inbound activity while the night shift does more outbound activities due to the nature of the drivers. Drivers work normal office hours, so there is more inbound activity for the morning shift.
5. There are 6 forklifts being used throughout the operations, there is a break to charge the forklifts from 00:00 - 01:00 every day.
6. The current baseline level of operations activity per day is 14 containers, 7 for inbound and 7 for outbound. Anything more than this and overtime will be required.
7. For the data coming from the WMS, each row represents one pallet while for data coming from the RS, each row represents one container (22 pallets).

Daily Schedule

08:00 to 17:30	Morning Shift
10:00 to 10:15	Break

12:00 to 13:00	Lunch Break
17:30 to 18:00	Dinner Break
18:00 to 07:30	Night Shift
22:00 to 22:15	Break
00:00 to 01:00	Supper Break
03:00 to 03:15	Tea Break