To Establish UPH (Units Per Hour) of Inbound/Outbound Activities for Warehousing Operations

Team: Aw Gan Zik Darrell, Charmaine Ng Ming Min, Foo Lin Xuan, Quek Kai Siong Desmond, Tran Thi Ngoc Mai
Supervisors: A/Prof Chai Kah Hin, A/Prof Ng Szu Hui | DB Schenker Supervisors: Mr.Winston Lim, Mr. Ng Poh Sing
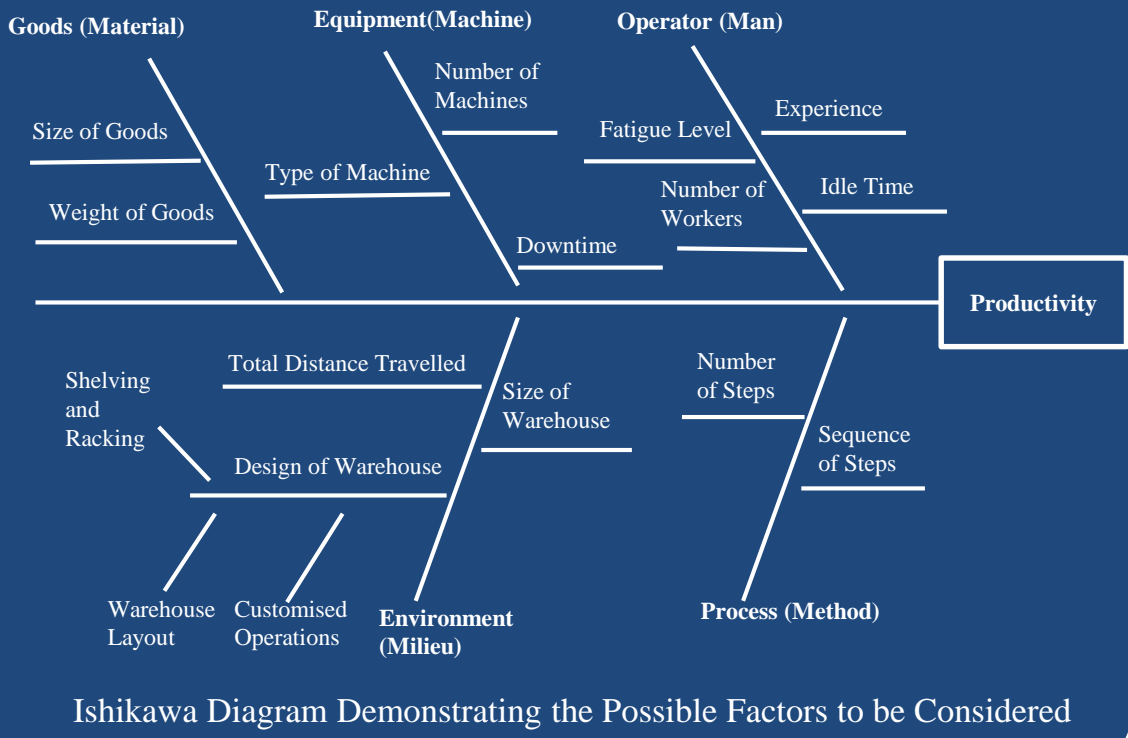
Project Description

Schenker Singapore (Pte) Ltd is a 3PL company set up in Singapore in the early 1970s. Today, it deals with customers with vastly different needs and industries. Schenker Singapore aims to provide value-added cost-effective supply chain solutions that would maximise customer satisfaction, achieve above-market returns and to become the employer of choice. With no internal and external tool to measure productivity of the warehouse operations and subsequently identify areas for process improvement, Schenker management approximates the productivity of the operations through financial profitability. While greater financial profitability would often be associated with greater productivity, using it alone to measure productivity paints an incomplete picture of the actual productivity of the warehouse.

Objective: Develop the methodology to measure the actual productivity in terms of Units Per Hour (UPH)
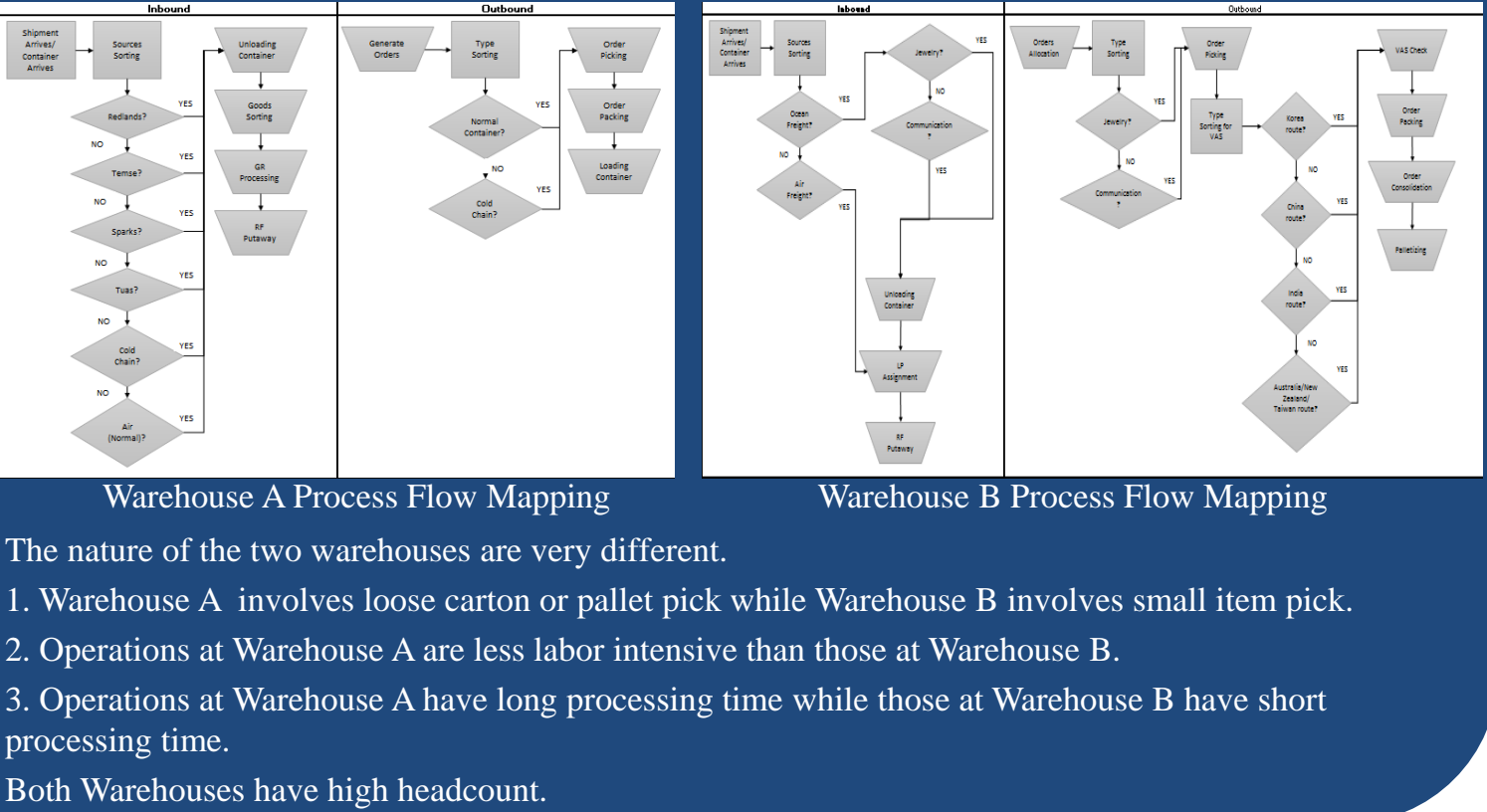**Method used**: Standard Time   **Approach**: Process Flow Mapping and Time Study

Methodology

Process Mapping and Validation → Selection of Process Map for Time Study Purposes → Identification and Selection of Factors → Time Study Execution → Data Analysis → Verification and Validation of Time Study Results

Productivity Factors

Ishikawa Diagram Demonstrating the Possible Factors to be Considered

Process Mapping

- A Process Flow Mapping is done with reference to the Work Instructions Manual.
- Calibrated and refined iteratively until it is a perfect representative of the warehouse operations.

Warehouse A Process Flow Mapping   Warehouse B Process Flow Mapping

The nature of the two warehouses are very different.
1. Warehouse A involves loose carton or pallet pick while Warehouse B involves small item pick.
2. Operations at Warehouse A are less labor intensive than those at Warehouse B.
3. Operations at Warehouse A have long processing time while those at Warehouse B have short processing time.
Both Warehouses have high headcount.

Assumptions

- Standardised Operating Procedure (SOP) for each process is followed.
- Same workers work with the same speed for the same process.
- Workers are constantly allocated work.
- There are only non pre-empt failures.
- The worker will perform the process till completion.

Time Study Factors

- Identify factors that will affect the timing and performance of the processes.
- Rate the factors according to the Significance and Feasibility Matrix.
- Select factors to be measured for Time Study.
- Method of collection is determined.

Significance and Feasibility Matrix
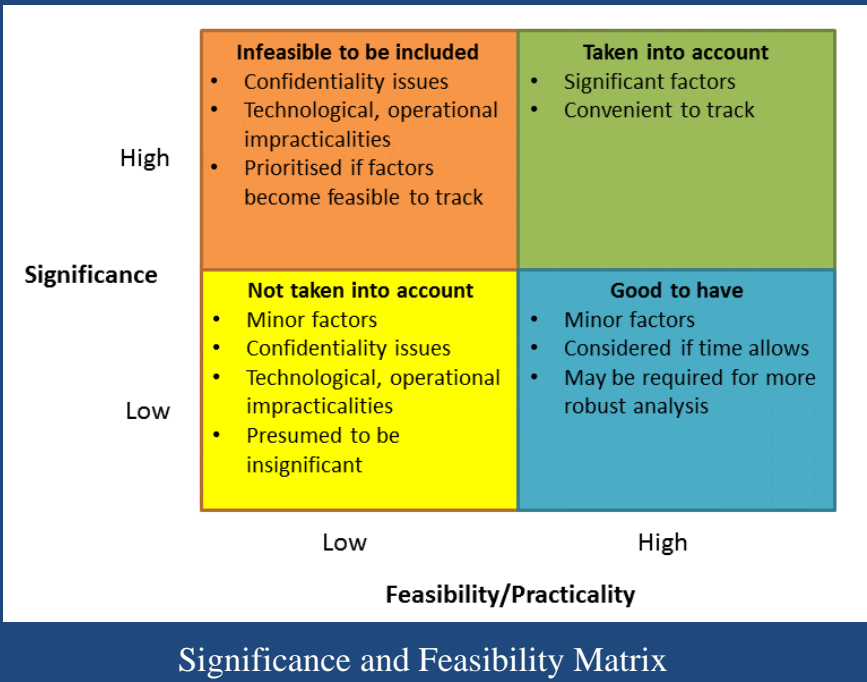
Time Study Methodology

Sample Size
- Based on cycle time of the processes

Timing Methods
- Snap-back Timing
- Continuous Timing

Workers
- Warehouse staff
- Physically fit
- Experienced in the task performed
- Perform the task consistently and in the same manner as stated in the SOP document
- Comfortable with Time Study procedures

Observation Guidelines
- Position behind or to the side of the worker
- Do not distract workers or encourage conversation
- Make sure the worker follow SOP
- Record or stop the stopwatch for any lost time or interruptions

Collection Guidelines
- Remove first few data points of each process
- Randomise processes and workers
- Remove the data points when the process is disrupted
- Collect data points only after the setup of the process is completed

$$UPH \text{ for a Process} = 1/Standard \text{ Time for a Process}$$
$$Standard \text{ Time} = Observed \text{ Time} * Performance \text{ Rating} * (1 + PFD \text{ Allowance})$$

- **Observed Time**: Timing taken for the process during Time Study.
- **Performance Rating**: Pace at which the worker is working on the process.
- **PFD Allowance**: Account for the lost time due to personal needs, fatigue or unforeseen delays in the performance of the process. It is set at 15% in this Time Study.

Data Analysis

- Multi-variate Scatter Plot
- Tukey's Range Test/ANOVA/Multi-variate Analysis
- Adjust original data to obtain one population using Performance Rating
- Adjust Observed Time values to obtain Standard Time
- Statistical Analysis to obtain the mean UPH, Standard Deviation and 95% Confidence Interval.
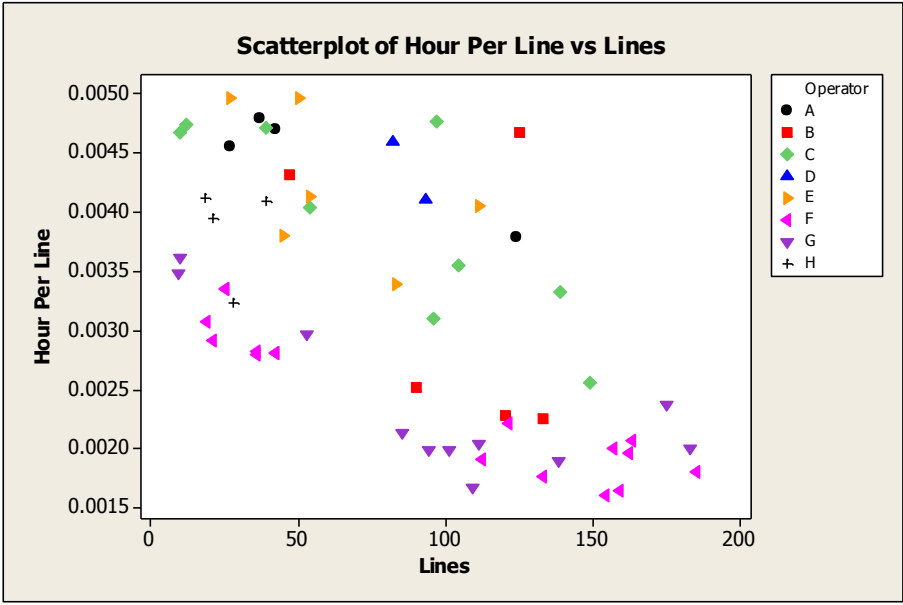
Multi-variate Scatter Plot for Order Picking
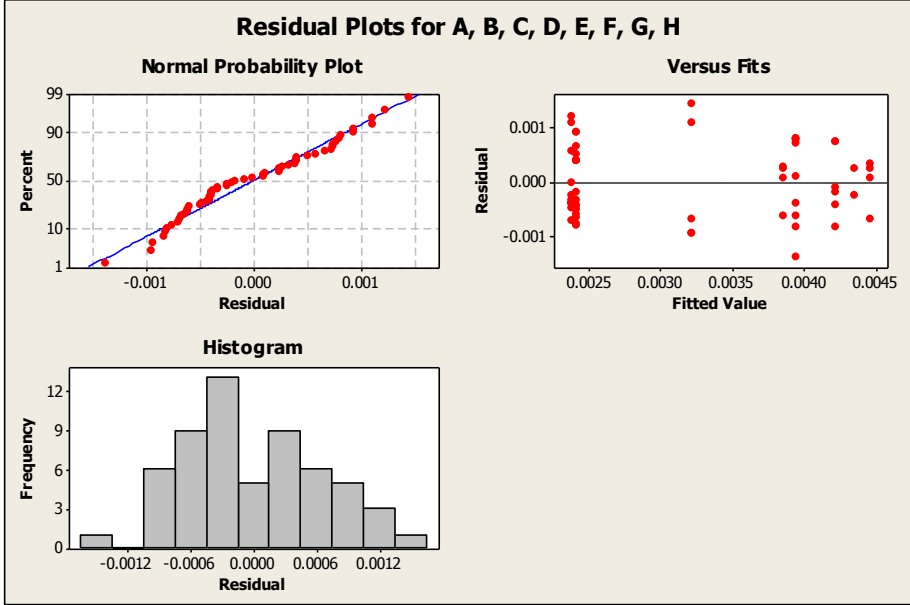
Residual Plots for different Pickers
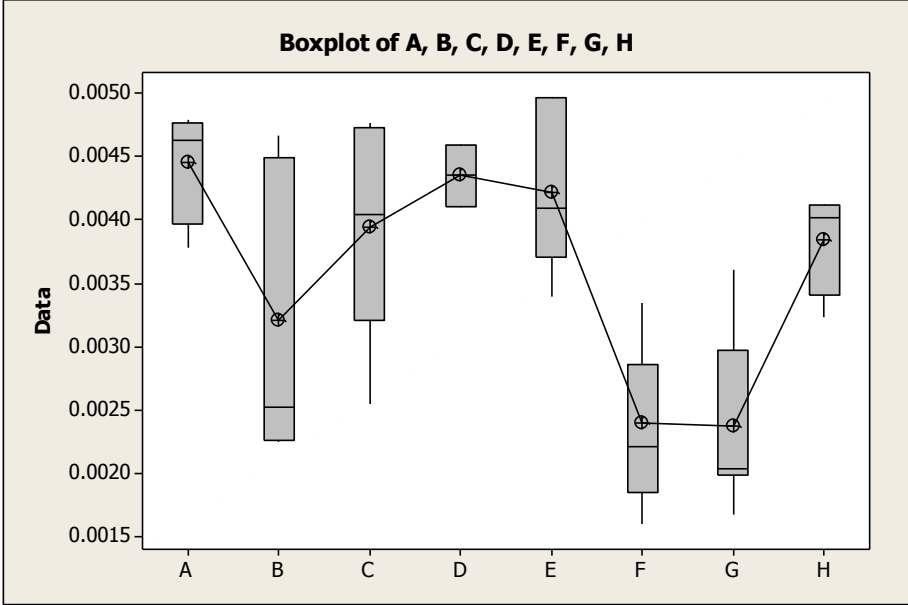
Boxplot of Hour Per Line for different Pickers

Pickers	Mean	Grouping
A	0.0044536	A
D	0.0043487	A
E	0.0042155	A
C	0.0039380	A
H	0.0038479	A
B	0.0032071	AB
F	0.0024033	B
G	0.0023764	B

Grouping of the different Pickers

Key Findings

Difference in Workers' Performance

Recommendation
- Identify the factors contributing to high performance
- Detailed Time Study and Interview with the best performers
- Adopt the best practices into the SOP

Addition of Manpower may not Increase UPH

Recommendation
- A Task Analysis on the 2 and 3 men team
- Identify and balance the work allocation among the workers

Bottleneck Identified at VAS/Packing Station

Recommendation
- Merging VAS and Packing Stations into 1 station
- Removal of repeated steps in VAS and Packing processes

Limitations

Confounding Effects from Factors not Tracked

Recommendation
- Recreate the path the worker took during Order Picking or use fitness trackers to trace distance travelled
- Record information such as size and quantity of items in the database

Convenience Sampling and Lack of Sample Size

Recommendation
- Additional samples to be collected by Schenker Singapore's own staffs
- Processes with the most unreliable UPH should be prioritized

Time Consuming Data Collection

Recommendation
- Integrate Harmonised Warehouse Management System (HWMS) with the Warehouses
- Automate data collection using the HWMS

Inability to Monitor UPH Real Time

Recommendation
- Develop the capability of HWMS
- Integrate HWMS into the warehouse
- Use of Standard Time as a benchmark for workers