Statistical Process Control for Warehouse Operations Improvement

IE3100R Systems Design Project | Department of Industrial Systems Engineering and Management AY2016/2017

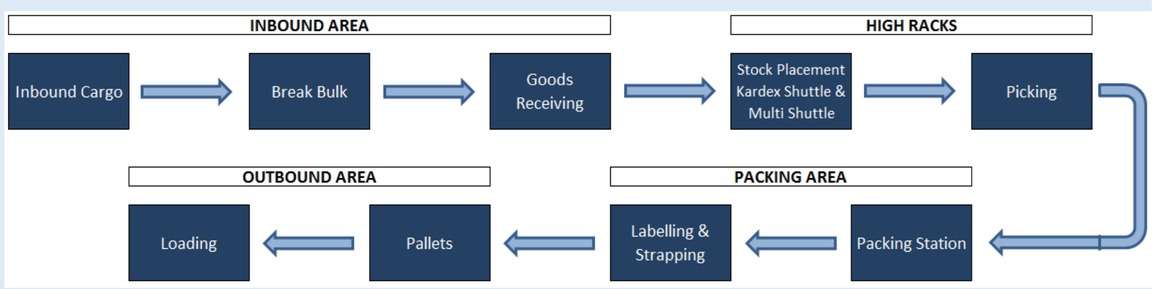
1. Introduction

Background: Statistical Process Control (SPC) has a long success story in manufacturing operations. However, SPC is rarely used at warehouse level.
Objective: Exploit the warehouse data to identify possible issues in warehouse operations and develop management tools for process supervision and improvement.
Choice of Site: Distribution Centre Asia

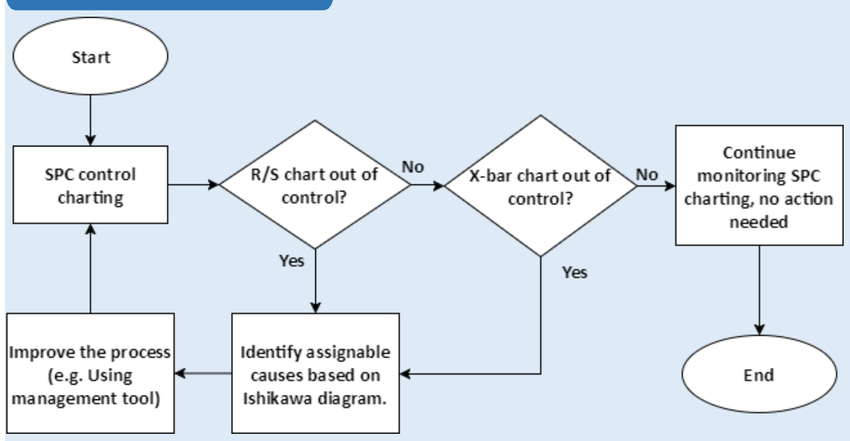
- Second largest warehouse in Infineon's global supply chain network
- Efficiency in warehouse management has large potential in further revenue contribution

Choice of Station: Packing Station

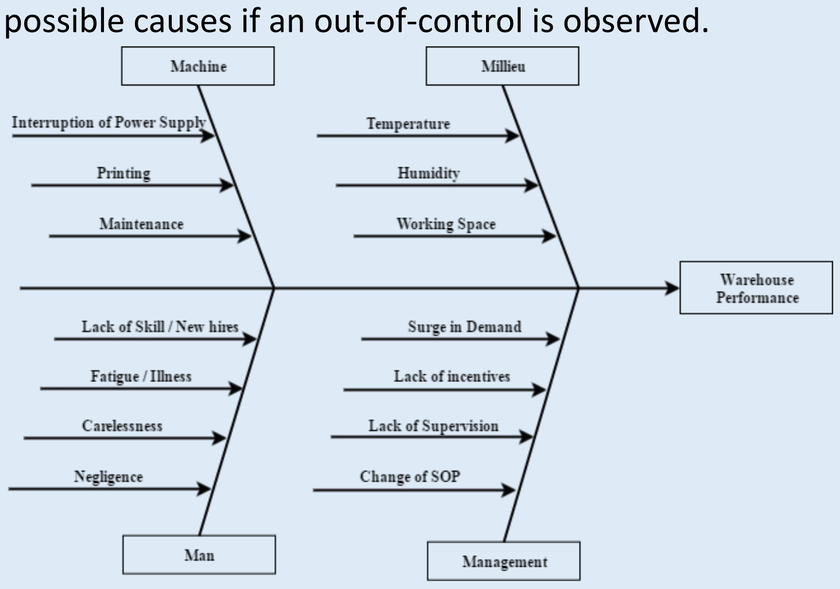
- High potential for process standardisation -> High potential for efficiency optimisation
- Steady feed of data through the system
- Intensive human factor -> High potential in applying management tools



2. Approach



- The Ishikawa diagram below is used to identify the possible causes if an out-of-control is observed.

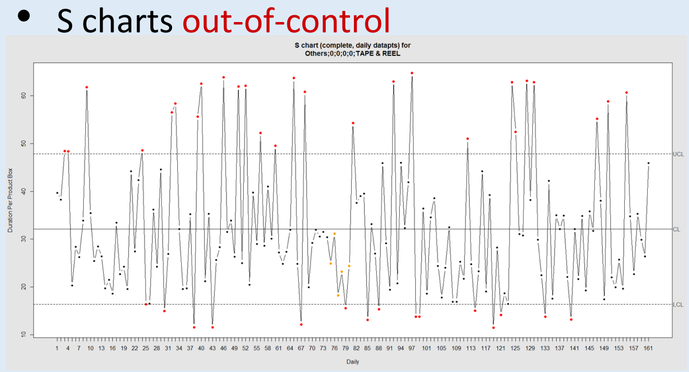


3. Data Analysis

3.1 Control Chart

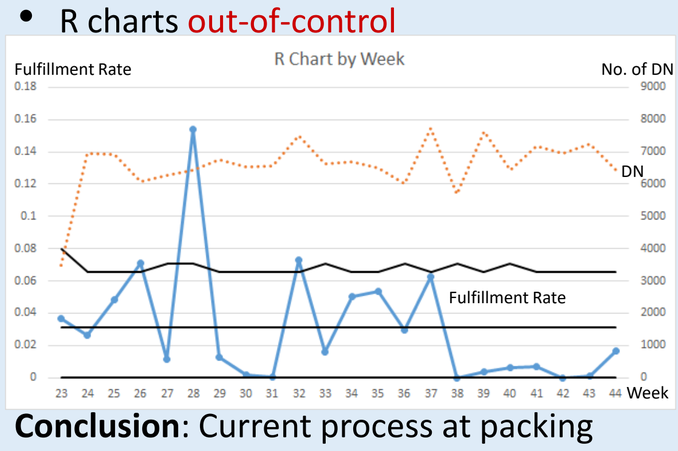
1. SPC on packing time

- All packers combined/Each individual packer
- S charts out-of-control



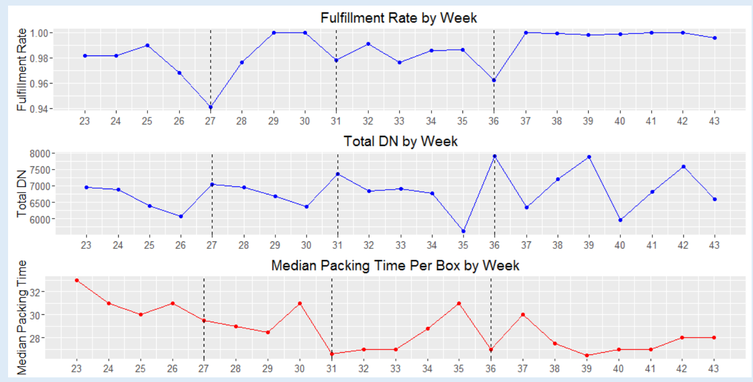
2. SPC on fulfilment rate

- Monthly/Weekly/Daily
- R charts out-of-control



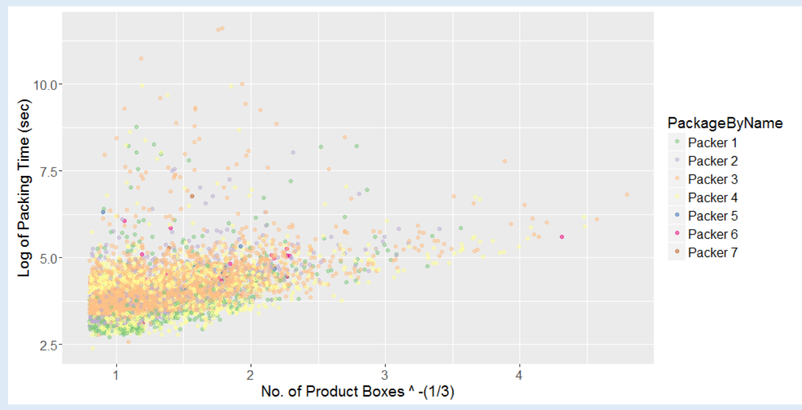
Conclusion: Current process at packing station is **out-of-control**

3.2 Identification of causes



Conclusion: The fall in fulfilment rate coincides with the surge in total DN and decreasing in median packing time per box.

3.3 Regression Modelling



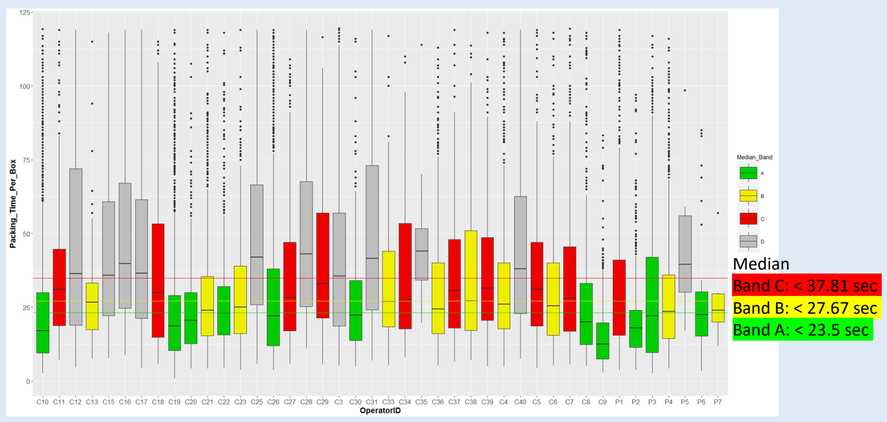
Conclusion: **Human factors** contribute more to the performance at Packing Stations and currently there is no method to track each operator's packing speed

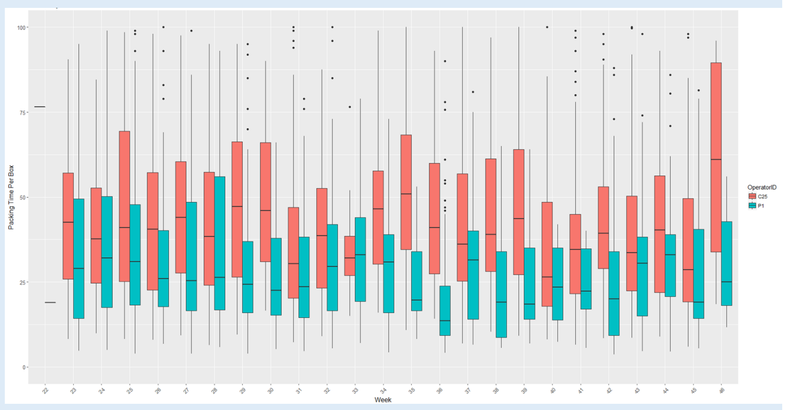
4. Recommendation

4.1 Identified Assignable Causes

Possible Causes	Recommendation
Surge in DN -> Drop in Fulfilment Rate	CLM contact customers for possible delay in delivery
Contract operators are not tracked consistently	Assign a consistent ID to every operator for better data quality
Lack of training for specific contract packer	Targeted training for contract packer
Long packing time not due to anomalies	Capture "pausing" of packing Capture erroneous products
Wrong products sent from High Racks	Check sheet for error frequency Subsequent Pareto Chart for error

4.2 Box Plot Management Tool

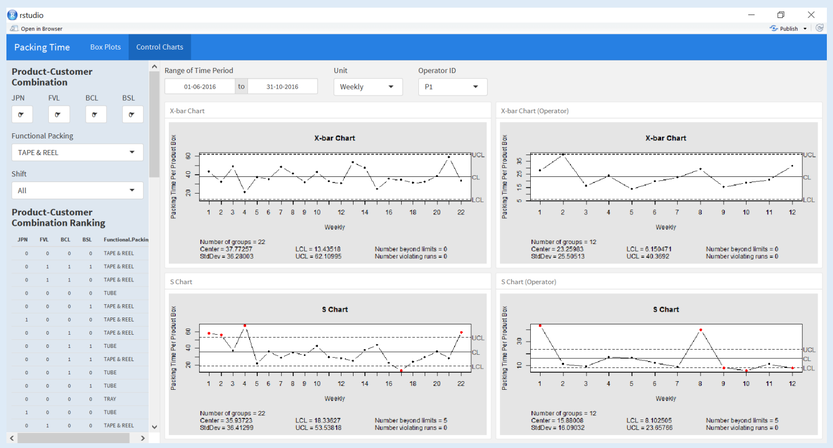




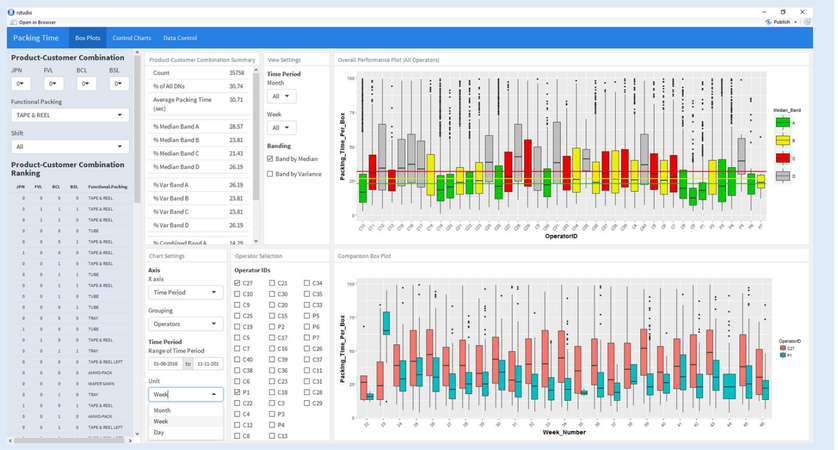
- **Visualize** operator's performance and use **Median and Variance** to analyse operator performance
- **Compare** performance level among operators
- **Compare** performance level of a specific operator over time

4.3 Deliverables Package

- R program
  - Generate box plot for operators
  - Generate control charts for packing time and fulfilment rate
- Instruction Manual
  - How to use the program
  - How to make changes to the program



R program user interface in showing control chart



R program user interface in showing box plot

5. Conclusion & Possible Continuation

5.1 Conclusion

- SPC may not be suitable for warehousing due to intensive human operations involved at current stage.
- However management tool can be used to supervise and improve human operator's performance.

5.2 Box Plot

- Research on optimal criteria weightage combination for operator monthly performance report
  - Performance Banding (Median & Variation)
  - Consultation with management and apply methods e.g. analytic hierarchy process (AHP)

5.3 Analysis on other station processes

- Implement real time data collection
- Analyse utilisation and identify bottleneck station

NUS Supervisors: Associate Professor Ng Szu Hui, Assistant Professor Michel Alexandre Cardin
Infineon Supervisor: Roxane Desmicht, Wong Kwang Yong, Low Sze Ping
Team members: Che Jia Yong Joshua, Li Jia Qi, Liang Jingyi, Lim Yong Kian Nicolas, Ng Chon Beng, Pang Yuwei