Problem 06

Where did it go wrong?

Warehouse
Excellence Study

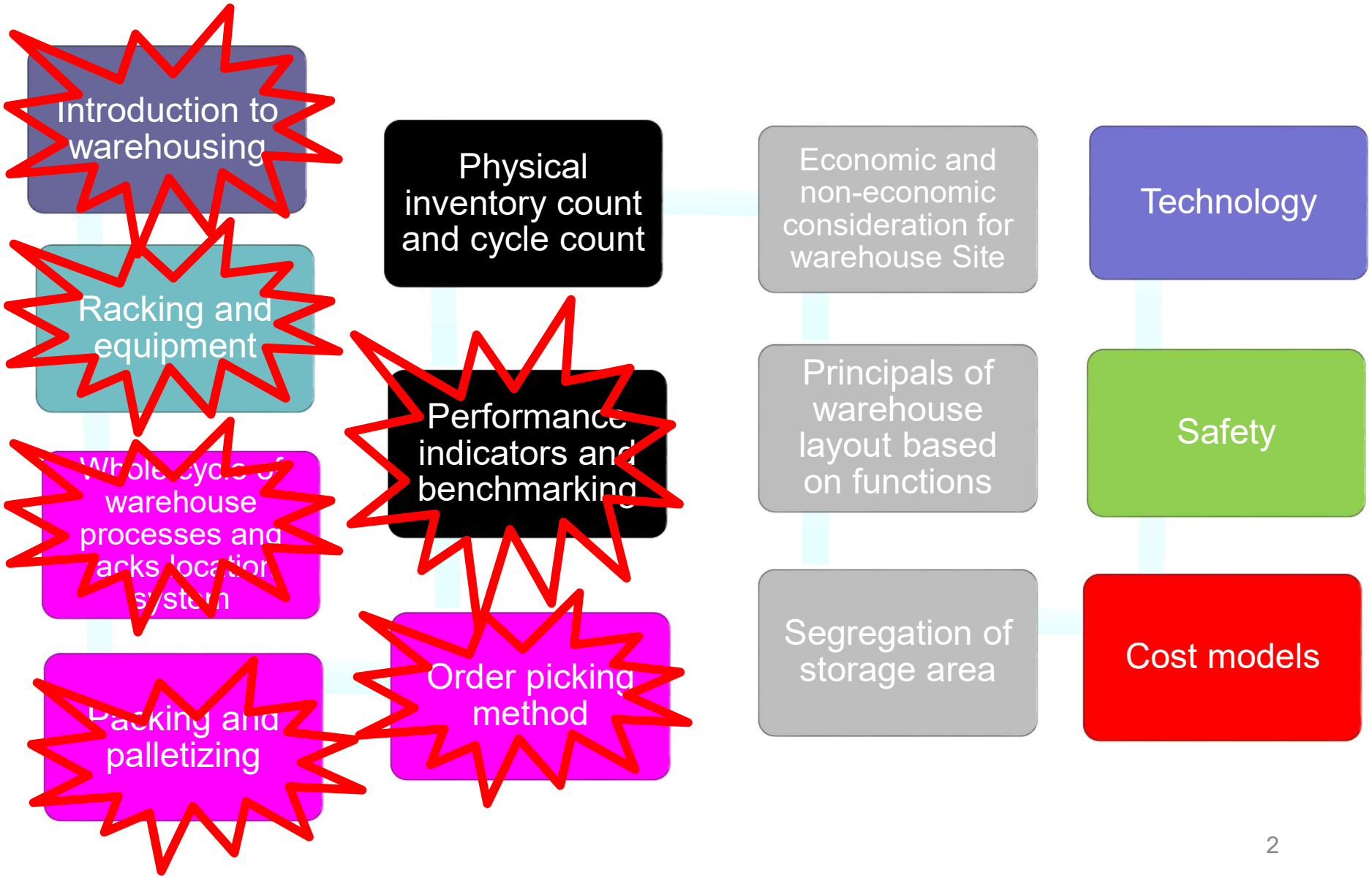
Institute for Material
Handling and Logistics

KIT – University of the State of Baden-Wuerttemberg and
National Research Center of the Helmholtz Association

SCHOOL OF ENGINEERING

E215 – Warehousing and Storage

E215 Warehousing and Storage Topic Flow



Learning Outcome

- Summarizing the different aspects and understanding of benchmarking

- Calculate the various suitable measures to be used for Warehouse KPI
  - Application of the formulas for the KPIs

Measuring Warehouse Performance

- Key Performance Indicator (KPI) is a series of measures against which the company performance is judged
- KPI is a metric to measure a company's performance in certain aspect
- It is commonly used for:
  - **Process Control**
  - **Process improvement**

Various forms of Warehouse KPI

Measurements can come in various form.

The common ones are:

1. Financial Performance
2. Productivity Performance
3. Quality Performance
4. Cycle Time Performance

1. Financial Performance

- A measurement of the performance of the warehouse in terms of cost.
- It is recommended that a warehouse establishes an **A**ctivity **B**ased **C**osting* (ABC) program to measure its financial performance.

*ABC Costing will be covered in the later topic in this module

2. Productivity Performance: Labour Productivity

Refers to an economic measure of output per unit of input

a. Labour Productivity

- Ratio of output to the input required to achieve that output.
- Output can also be units, orders, orderlines, weight shipped out of the warehouse.
- Input is usually the number of man-hours spent in operation, supervision and management of the warehouse in order to achieve the output.
- This indicator does not take into account the investment cost of MHEs, WMS, storage systems etc. Thus the company may have spent millions of dollars in automation to improve the labour productivity.

2. Productivity Performance: Asset Utilization

b. Space requirement per shipped loading unit

- A productivity indicator for floor space
- Total storage capacity (no. of racks) can be in terms of cartons, pieces, or pallets.
- Space requirement is the total square area of storage area.
- Storage density that is too low indicates underutilized facility. If it is too high, it may indicate overcrowded conditions.

3. Quality Performance

- There are 4 key indicators for quality performance and they can be divided into inbound and outbound handling.

a. Inbound handling
  - Putaway accuracy
  - Inventory accuracy

b. Outbound handling
  - Picking accuracy
  - Shipping accuracy

3a. Inbound Handling

- Putaway accuracy

$$\frac{\text{(Total \# Inbound items Received) - (Total \# Inbound items Putaway to the wrong location)}}{\text{Total \# of Inbound items received}}$$

  - To measure how accurate the putaway process is.

Example

- XYZ warehouse on an average putaway 2,000 items a month. During an audit, it was found that 20 items are at the wrong location.
- Thus the putaway accuracy is 1980/2000, which is 99%.

3a. Inbound Handling

- Inventory accuracy

$$\frac{\text{Total \# of storage locations with accurate match between Physical Inventory and Inventory Records}}{\text{Total \# of Storage location}}$$

  - A measurement of the percentage of the number of storage location in the warehouse that have the correct quantity in them.

Example

- XYZ warehouse has 500 storage location. During an audit, the auditor found that in 20 locations, the physical quantity of the items did not tally with the records.
- Thus in terms of inventory accuracy, this warehouse is at 96% (480/500).

3b. Outbound Handling

- Picking accuracy

$$\frac{\text{(Total \# of line picked) - (Total \# of line picked wrongly)}}{\text{Total \# of line picked}}$$

  - A measurement of how accurate the picking is. The formula above is in terms of line items.

Example

  - On average, 1,000 lines are picked per month in ABC warehouse. On average, during inspection of packing, 100 lines are found to have errors. Thus, the pick accuracy is 90% (900/1,000).
  - Some companies measure this in terms of pieces. For example, the order have 5 line items with a total of 100 pieces of items. 1 item is missing, thus only 99 items are picked. This affects one line but if the company measures by per piece, the accuracy will be 99%.

3b. Outbound Handling

- Shipping Accuracy

$$\frac{\text{(Total \# of lines shipped) - (Total \# of lines shipped wrongly or outside delivery window)}}{\text{Total \# of lines shipped}}$$

  - A measurement of how many lines are shipped out wrongly.

Example

- ABC warehouse ships around 20,000 lines per month. On average, customers feedbacks that 100 lines delivered with errors and 100 lines are delivered outside the delivery windows requested.
- Thus the shipping accuracy is 99%
- Some companies measure this by order instead of lines. For example an order with 5 lines, if 1 of the line is wrong or late/too early, the shipping accuracy will be 80%.

4. Cycle Time Performance

a. Dock to Stock time (DTS)

- Time from receipt arrival until availability for picking
- It is an important indicator because it shows how fast the stock can be made ready for picking from the time it arrives in the warehouse.

4. Cycle Time Performance

b. Warehouse order cycle time (WOCT)

- Time from the release of an order until it is ready for shipping
- This is a measurement of how fast can the available stock be made ready for shipment

Benchmarking

- Benchmarking is a measurement against a standard or against others in the similar industry or having similar processes.
- A method of learning, adapting and measuring outstanding practices and processes from any organization to improve performance.

Benchmarking

a. Internal: Within a single company

- Measurement of key performance indicators and comparing it within the same organization

b. External: Outside of the firm's industry

- Comparing with different industry but on similar processes or operations
- A good benchmarking partner is one who is:
  - Strong in areas that you are weak and vice-versa
  - Sensitive to confidential information
  - Willing to admit weakness and lesson learnt, but also at the same time able to share success and best practices

Benchmarking

c. Competitive:

- Benchmarking with firms in the same industry.
- Usually this benchmarking is done against one or more competitors.
- External consultants are usually hired to do this benchmarking.
- These external consultants will have access to information of participating companies but the identity of the participating companies are kept confidential.
- Using competitive benchmarking, the organization will be able to know where they stand in the industry and how far away they are from the best in class.

Objectives of Benchmarking

- Continuous performance measurement according to a sustainable benchmarking
- Enable organization to identify opportunities to improve performance.
- Opportunity to learn and adapt others' best practices
- Enable management to set realistic targets
- Uncover own strengths and weaknesses
- Better resource plan to meet targets set.
- Allows examination of present processes

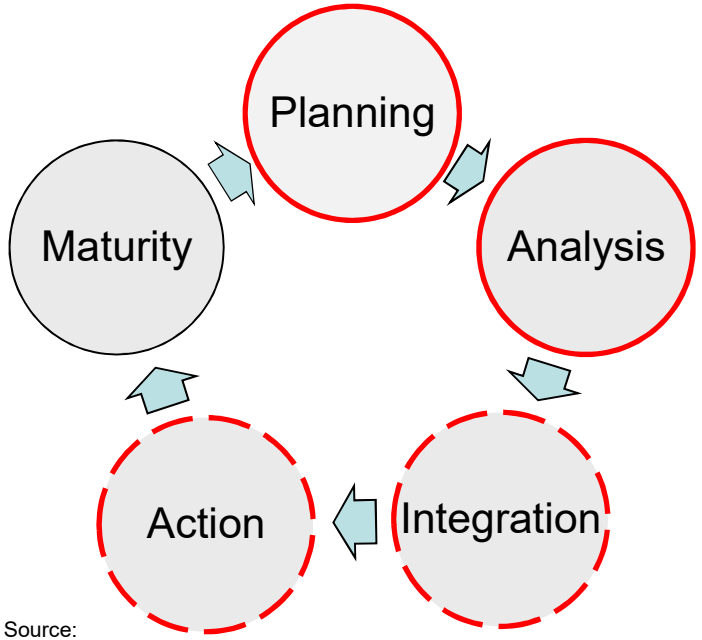
"If you want to break new ground, you'll have to stop paddling in front of your own coast"

(Armin Schmidt, Fa. ILG-Intra)

Example: Benefits of Benchmarking

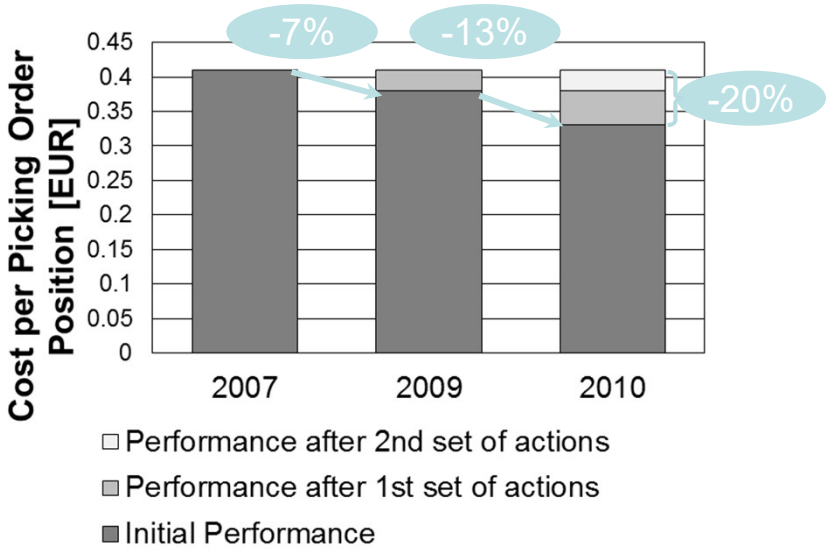
- Benchmarking can help to identify improvement actions and lead to substantial increases in productivity

The continuous process of benchmarking



Source:
Camp, R.C.: Benchmarking: The Search for Industry Best Practices that lead to Superior Performance. Milwaukee: ASQC Quality Press 1989.

Observed performance improvements



Source
Performance Data taken from the Warehouse Excellence Study

Legend:
- Realisation with the Warehouse Excellence Study
- Supported by the Warehouse Excellence Study
- Realisation without the Warehouse Excellence Study

Potential Challenges

- What is best for someone may not be best for you
- Benchmarks that are unclear or not defined properly may and will lead to wasted efforts and useless results.
- Comparison with the right organization is very important. If done wrongly, effort and money may be wasted.
- Need to share information, sometimes even sensitive information.
- No peer group or best practices available or identified for benchmarking.
- Gaps between current practice and industry best practices are captures but nothing is being done.

When Not to Benchmark

- Process or outcome that is not critical to the core business
- Customer's requirement is unclear
- Not of importance to key stakeholders
- Limited by resources
- No plan for implementing findings
- Unwilling or unable to share the information with other organizations

Benchmarking Process

1. Identify the process to be benchmarked
2. Measure and collect data on this process
3. Identify one or more benchmark partner(s)
4. Measure and collect data on this process of the partner/s
5. Analyse data and compare the results
6. Determine action plan for the company
7. Review the results and conduct regular review of this benchmark with the partner(s)

An example of Benchmarking tool

Distribution Center Reference Model (DCRM)

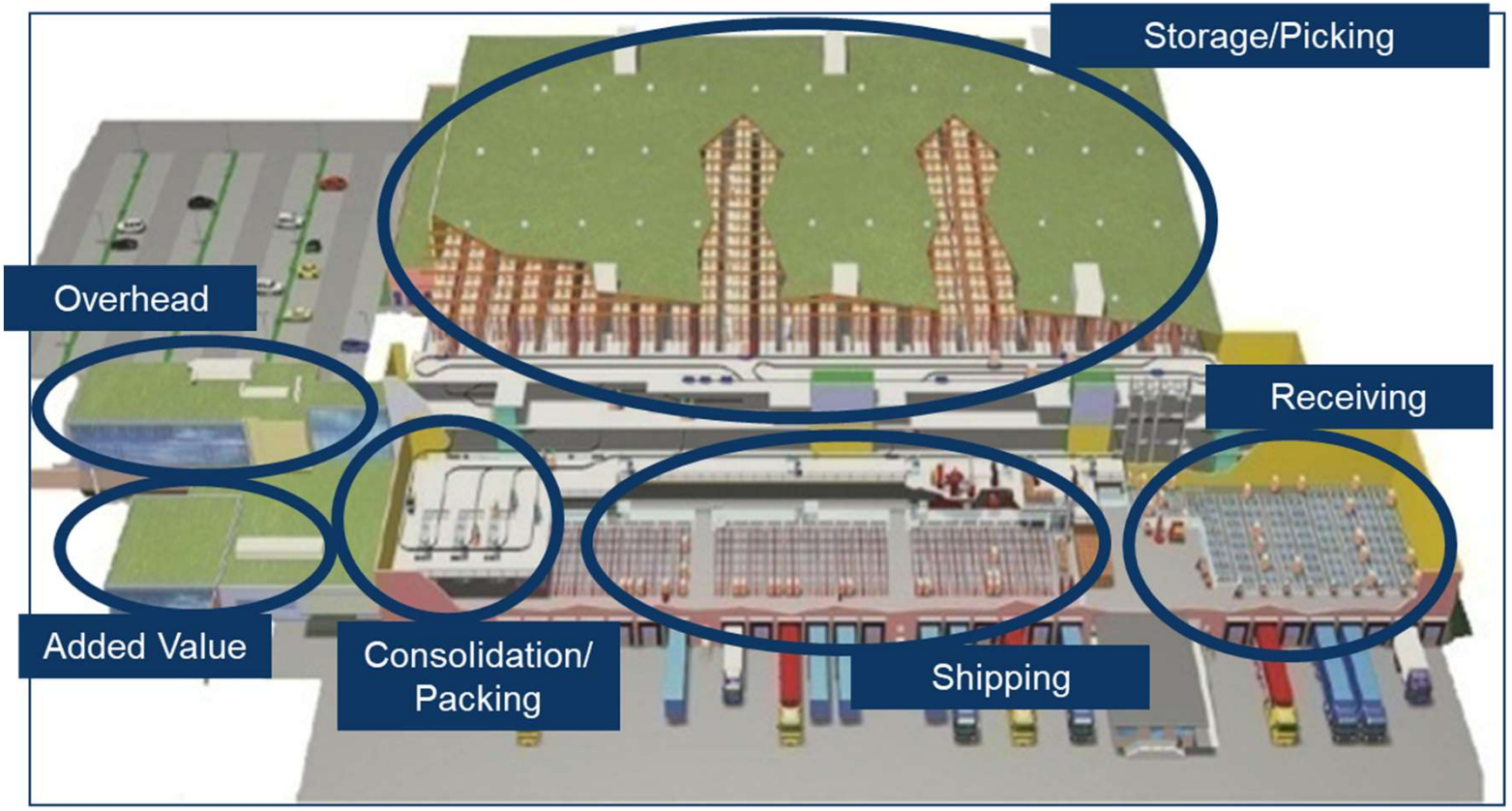


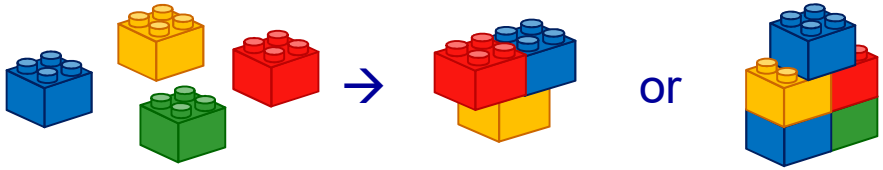
Figure: © swisslog

DCRM: Approaches

Task-oriented reference model

- Comparability due to consideration of the same task
  e.g. storage and picking of pallets.

- Modular construction system consisting of 26 well-defined tasks enables to structure each individual distribution center → Identification of the accomplished task



- Benchmarking of each identified task with all equivalent tasks → Different tasks may have different benchmarking partners

Sportsman A:

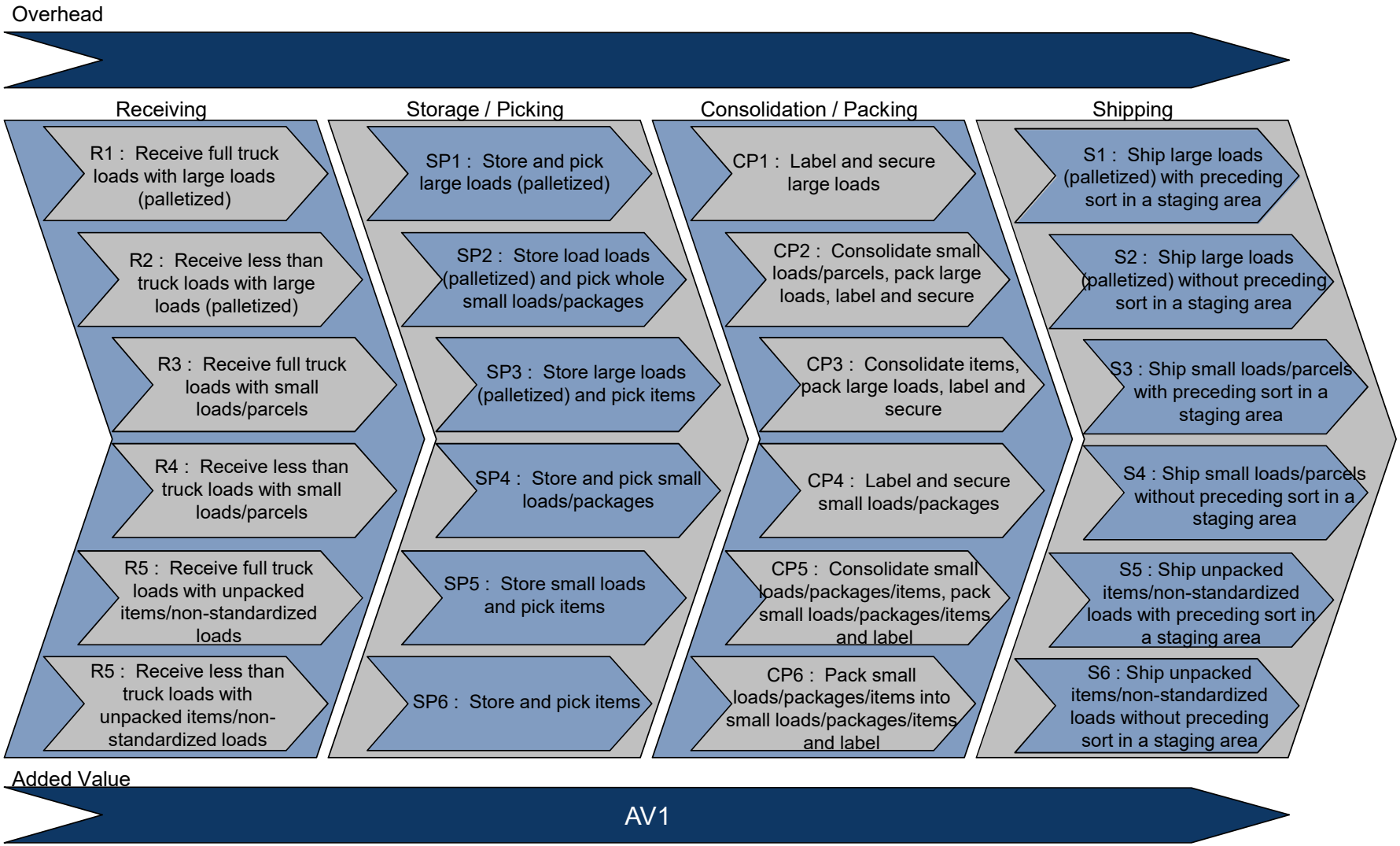
Sprint performance over 100m: 10 s

High jump performance: 2.00 m

→ Evaluation of the sprint performance: Comparison with all sprinters

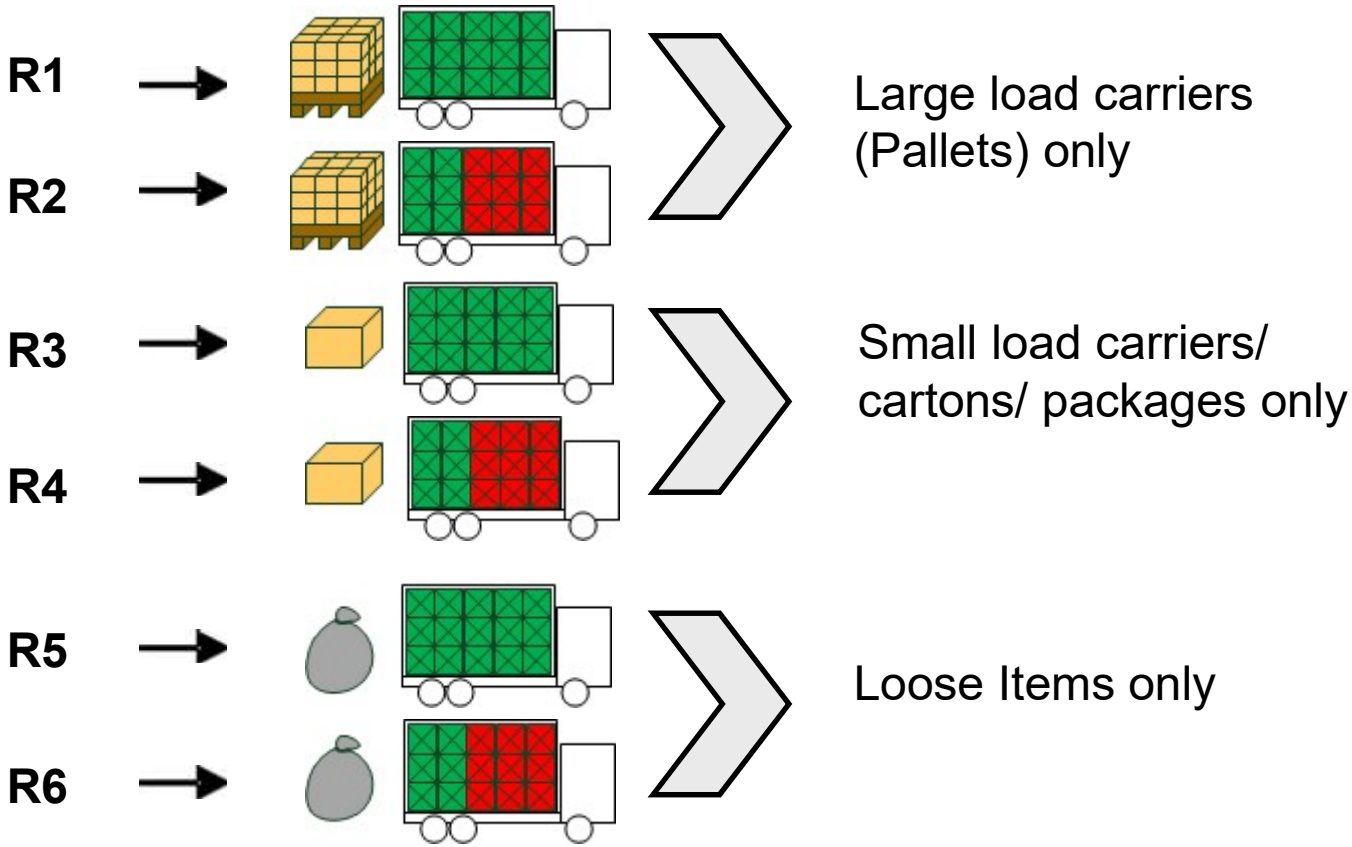
→ Evaluation of the high jump performance: Comparison with all high jumpers

24 different warehouse tasks plus overhead and added value



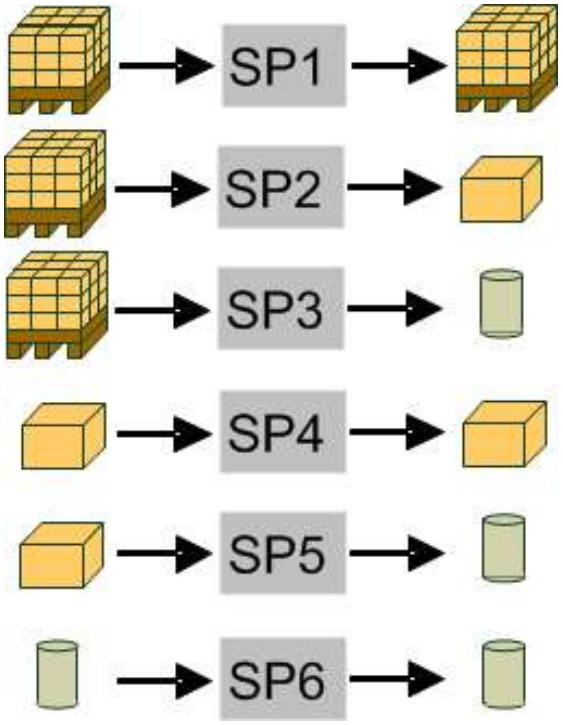
Warehouse Task: Receiving

When completing the questionnaire please keep in mind that the various tasks (R1, R2, …) have different loading units!!



Warehouse Task: Storage and picking

For the various tasks (SP1, SP2,…) the following combinations are applied:

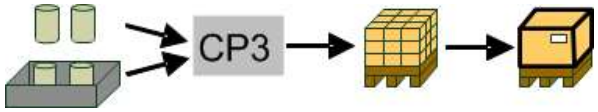


Store Pallet	→	Remove Pallet
Store Pallet	→	Remove Carton
Store Pallet	→	Remove Item
Store carton	→	Remove carton
Store carton	→	Remove item
Store Item	→	Remove item

Warehouse Task: Consolidating and packing

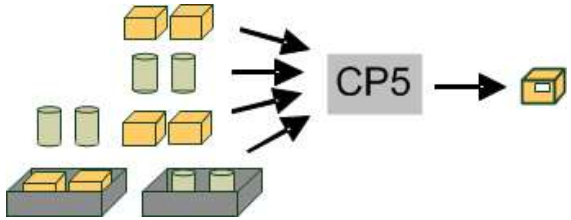
Label and secure large loads (pallets)

Consolidation small loads/packages, pack large loads (pallets), label and secure

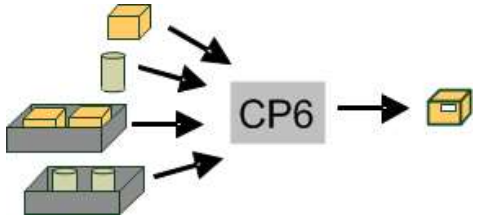


Consolidate items, pack large loads (pallets), label and secure

Label and secure small loads/cartons/packages



Consolidate/sort small loads/packages/items, pack small loads/parcels and label



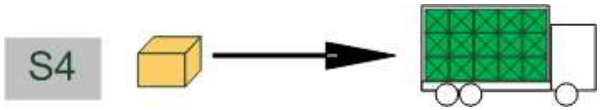
Pack small loads/packages/items into small loads/parcels and label

Warehouse Task: Shipping

S1: Shipment of large load carriers **with** previous sorting in a staging area
i.e. No effort required to search for shipments

S2: Shipment of large load carriers **without** previous sorting in a staging area
i.e. Effort required to search for shipments

S3: Shipment of small load carriers/packages **with** previous sorting in a staging area
i.e. No effort required to search for shipments



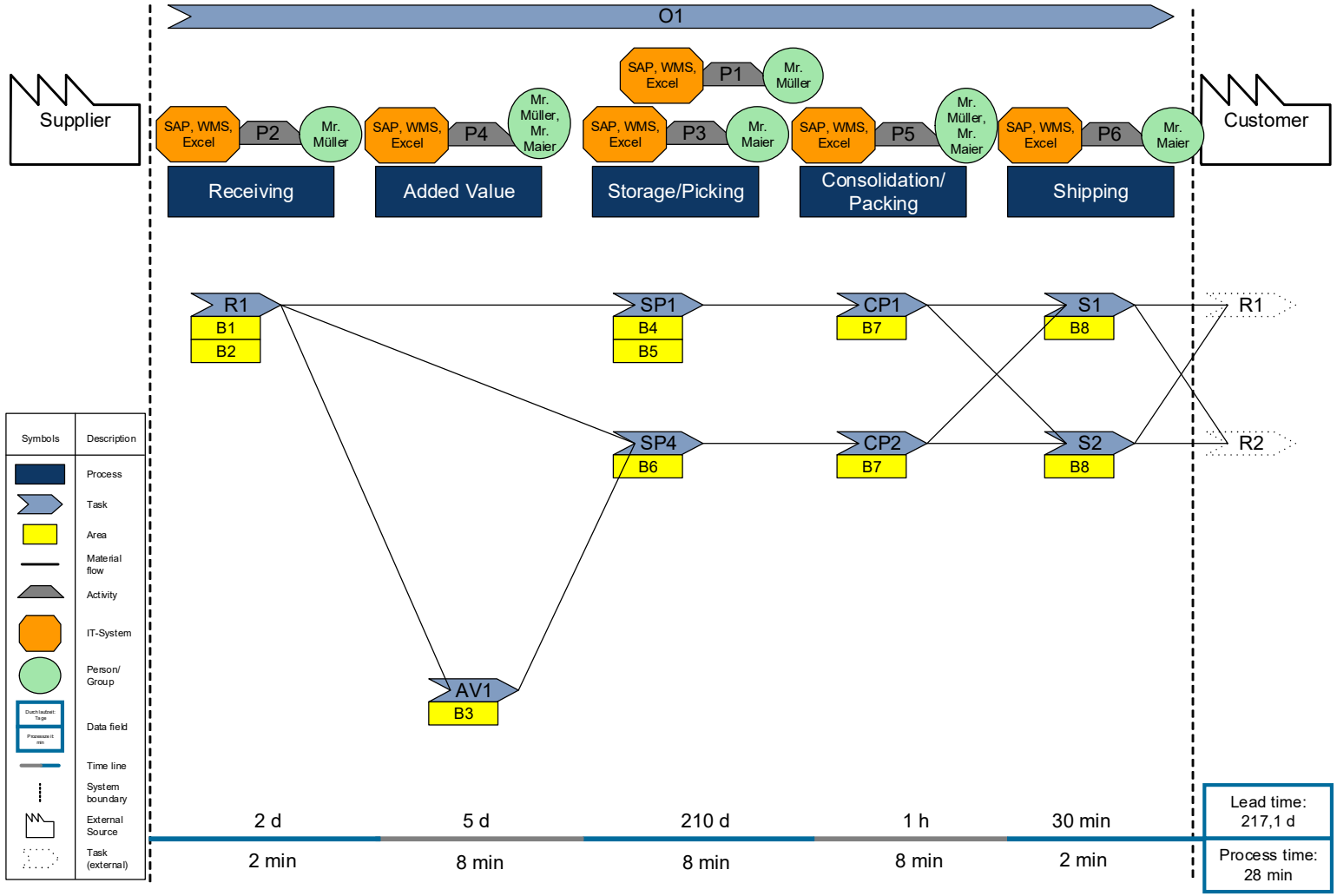
S4: Shipment of small load carriers/packages **without** previous sorting in a staging area
i.e. Effort required to search for shipments

S5: Shipment of loose/not standardized goods **with** previous sorting in a staging area
i.e. No effort required to search for shipments

S6: Shipment of loose/not standardized goods **without** previous sorting in a staging area
i.e. Effort required to search for shipments

Summary: DCRM map

- The DCRM map is a one-pager that summarizes the DCs tasks and material flow



DCRM: Financial Performance

Annual total costs = sum of investment costs, operating costs and surface costs

- Surface costs: According to the surface that each task requires
- Investment costs: According the equipment that each task requires and, respectively , if the same or comparable equipment is required by each task then allocate according to the surface
- Operating costs: Staff costs by allocating the working hours, energy costs by surface allocation, maintenance cost by allocation of investments

DCRM: Financial Performance

Example of a warehouse activity with each cost populated)

	Surface Cost	Investment costs	Operating Cost	Total Cost
Receiving	$180,000	$19,000	$35,000	**$234,000**
Storage and picking	$290,000	$28,000	$509,000	**$332,000**
Consolidating and packing	$109,000	$43,000	$180,000	**$827,000**
Shipping	$128,000	$9,000	$170,000	**$307,000**
Overhead	$115,000	$18,000	$280,000	**$413,000**
Value-Added Activities	$178,000	$17,000	$100,000	**$295,000**
Total Cost	**$1,000,000**	**$134,000**	**$1,274,000**	**$2,408,000**

In the above example, we can see that the operating cost for storage and picking is high, at 36%. This shows that this is an important activity, improvement plans can be focus there.

DCRM: Productivity Performance Formulas

1) $$Number\ of\ picked\ orderlines\ per\ day =$$

$$Number\ of\ pick\ tours\ (trips)\ per\ day \times number\ of\ picked\ orderlines\ per\ pick\ tour$$

2) $$Working\ minutes\ per\ picked\ orderline =$$

$$Total\ average\ working\ minutes\ per\ day \div Number\ of\ picked\ orderlines\ per\ day$$

3) $$Number\ of\ units\ picked\ per\ day\ (Also\ known\ as\ throughput) =$$

$$\sum_{All\ SP} (Number\ of\ picked\ orderlines\ per\ day \times Number\ of\ picked\ units\ per\ picked\ orderline)$$

Formula 1 and 2 calculated the ratio of output (orderlines) to the input (working minutes). SP1 to SP6 are calculated respectively.

Formula 3 measures the throughput of the warehouse. All picked units are calculated respectively and then totaled.

DCRM: Productivity Performance: Calculation

Description	SP5	SP6
Average number of pick tour per day	10	12
Average Number of picked orderlines per pick tour	20	24
Average Number of picked units per picked orderline	30	36

$$Number\ of\ orderlines\ per\ day\ (SP5) = 10 \times 20 = 200$$

$$Number\ of\ orderlines\ per\ day\ (SP6) = 12 \times 24 = 288$$

Given that the total average working minutes per day is 240mins for SP5 and 360mins for SP6

$$Working\ minutes\ per\ customer\ orderline\ (SP5) = 240 \div 200 = 1.2$$

$$Working\ minutes\ per\ customer\ orderline\ (SP6) = 360 \div 288 = 1.25$$

$$Number\ of\ units\ picked\ per\ day\ (SP5) = 10 \times 20 \times 30 = 6000$$

$$Number\ of\ units\ picked\ per\ day\ (SP6) = 12 \times 24 \times 36 = 10368$$

$$Throughput\ of\ SP5\ and\ SP6 = 6{,}000 + 10{,}368 = 16{,}368$$

Proposed Solution: Productivity Performance -

We start by calculating the working minutes required per orderlines.

$$Number\ of\ orderlines\ per\ day\ (SP5) = 10 \times 30 = 300$$
$$Number\ of\ orderlines\ per\ day\ (SP6) = 20 \times 20 = 400$$

$$Working\ minutes\ per\ customer\ orderline\ (SP5) = 600 \div 300 = 2min$$
$$Working\ minutes\ per\ customer\ orderline\ (SP6) = 600 \div 400 = 1.5min$$

The throughput of SP5 and SP6 is :

$$Number\ of\ units\ picked\ per\ day\ (SP5) = 10 \times 30 \times 30 = 9{,}000$$
$$Number\ of\ units\ picked\ per\ day\ (SP6) = 20 \times 20 \times 36 = 14{,}400$$

$$Throughout = 9{,}000 + 14{,}400 = 23{,}400\ units$$

Proposed Solution

Putaway accuracy (%)

- (80,000 - 139)/80,000 = 99.8%

Inventory accuracy (%)

- (8,000 - 29)/8,000 = 99.6%

Picking accuracy

- (92,000 - 270)/92,000 = 99.7%

Shipping accuracy (%)

- (99,000 – (210 + 360))/99,000 = 99.4%

Proposed Solution

- However, what do all these figures mean? It does not tell us whether or not the warehouse is doing well or not.
- This is where benchmarking comes in.
  - By benchmarking performance with competitors or partners, will know how the warehouse is performing and will be able to decide his next course of action.

Proposed Solution

- The KPIs of the warehouse where Yao's logistic could measure can be of the following:

TABLE 3-4 Warehouse Key Performance Indicators (WKPIs)

	Financial	Productivity	Utilization	Quality	Cycle Time
Receiving	Receiving cost per receiving line	Receipts per man-hour	% Dock door utilization	% Receipts processed accurately	Receipt processing time per receipt
Putaway	Putaway cost per putaway line	Putaways per man-hour	% Utilization of putaway labor and equipment	% Perfect putaways	Putaway cycle time (per putaway)
Storage	Storage space cost per item	Inventory per square foot	% Locations and cube occupied	% Locations without inventory discrepancies	Inventory days on hand
Order picking	Picking cost per order line	Order lines picked per man-hour	% Utilization of picking labor and equipment	% Perfect picking lines	Order picking cycle time (per order)
Shipping	Shipping cost per customer order	Orders prepared for shipment per man-hour	% Utilization of shipping docks	% Perfect shipments	Warehouse order cycle time
TOTAL	Total cost per order, line, and item	Total lines shipped per total man-hour	% Utilization of total throughput and storage capacity	% Perfect warehouse orders	Total warehouse cycle time = Dock-to-stock time + Warehouse order cycle time

Learning Outcome

- Summarizing the different aspects and understanding of benchmarking
- Calculate the various suitable measures to be used for Warehouse KPI
  - Application of the formulas for the KPIs