

LECTURE 06

WAREHOUSE ACTIVITY PROFILE

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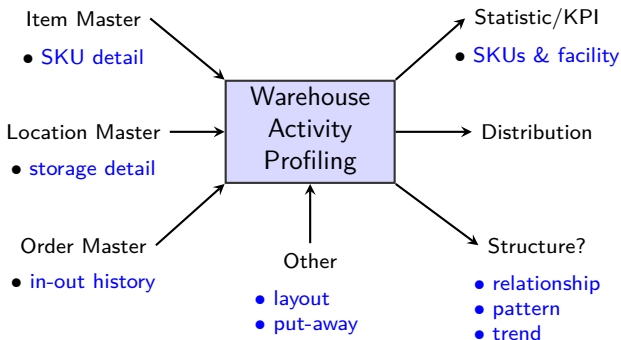
OUTLINE

- 1 CONCEPT OF WAREHOUSE ACTIVITY PROFILING
- 2 MASTER DATA FOR WAREHOUSE ACTIVITY PROFILE
- 3 WAP PROCESSES & EXAMPLES
- 4 CASE STUDY: CONSTRUCTION MATERIAL
- 5 OVERVIEW OF KEY PERFORMANCE INDEX

source: General references [BH09, Mul94, Fra02, ?]

WAREHOUSE ACTIVITY PROFILING

- **What:** improving warehouse by understanding **natures** & exploring **patterns**
- **Idea:** **data mining** with database program



INVESTIGATION = WAP

Crime Investigation

- gathering evidences & witnesses
- understanding motivates
- selecting suspects
- capturing murder

Warehouse Activity Profiling

- gathering data
 - understanding patterns
 - selecting causes & solution
 - improving efficiency & productivity
-

Questions & Data ⇒ Information ⇒ Success of profiling

BENEFITS OF WAREHOUSE ACTIVITY PROFILING

- Understand demands & patterns → layout, picking policy, labor management
- Calculate **Key Performance Index** (KPI) → snap shot of warehouse
- Managing SKU → select suitable equipment, package, **slotting**, default pick path
- Gather data for design

MASTER DATA

- **Item Master:** database related to **SKUs**
- **Location Master:** database of **inventory** at all **storage location**
- **Order Master:** database of **sale in-out** to warehouse (100+MB)

Questions

- What is **data**? → obtaining data, **time horizon**, meaning of each column, wired data
- How each data set **related**? → understanding big picture by interaction
- What is **primary key** of each set of data? → understanding big picture by interaction

PROFILING DATA: ITEM MASTER

- **General:** SKU ID, description, vender ID
- **Bulk break:** break SKU, box per pallet
- **Physical:** volume, width (length \times height \times weight)
- **Time:** received date, expired date
- **Ordering:** min-max, response person
- **Other:** picking note, shipping note, lot #, equipment

Example

Sku ID	Vendor ID	Description	Unit length	Unit width	Unit height	Unit weight
AAG47294	AAG	PLNR,'FAT LITTLE',BK	6.2	6.1	1.7	0.9

source: Warehousing Science <http://www2.isye.gatech.edu/fjb/wh/book/profile/activities/profilingexercise.html>

PROFILING DATA: LOCATION MASTER

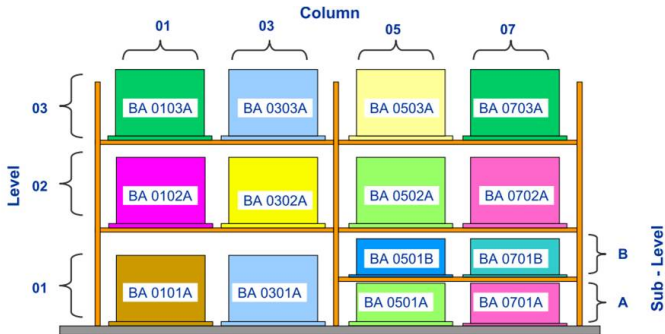
- **Header:** date-time that data are retrieved
- **Address:** zone, aisle, section, position
- **Unit:** quantity, case, pallet

Example

SKU ID	Zone	Aisle	Bay	Level	Position	Qty	Unit
SPRSP2-4915	A	102	A	2	B	20	Case
AVE05731	A	102	A	5	B	12	Case
WLJ36610	A	102	B	1	B	30	Case
SPR5084SP	A	102	B	3	B	10	Piece

source: Warehousing Science <http://www2.isye.gatech.edu/jjb/wh/book/profile/activities/profilingexercise.html>

TYPICAL WAREHOUSE ADDRESS



PROFILING DATA: ORDER MASTER

- **Header:** order ID, customer ID,
- **Detail:** SKU ID, date, time, quantity (Qty), unit
- **Note:** largest database (200+MB)

Example

Sku ID	Order number	Customer number	Order qty	Date	Time
BRTTN460	23926870	615413	4	2004-01-12	17:01:00
CMC5810-BE	23559658	10135	8	2004-02-08	14:45:00
KOK00172	23840414	614283	1	2004-01-11	10:41:00
SOF1500	23926870	615413	20	2004-01-12	17:01:00

source: Warehousing Science <http://www2.isye.gatech.edu/jjb/wh/book/profile/activities/profilingexercise.html>

PROCESSES IN WAP

- **Define questions:** What do you plan to improve (Pro VS Con)?
- **Gather data:** meaning of data & finding related data:
 - **Static:** SKU related, layout-zone, std. time, cut-off time
 - **Dynamic:** picker related, plan, OT, schedule
- **Import data:** 'connect with database', basic statistic analysis
- **Check data:** inconsistency, outlier → clean-up data
- **Analysis data:** create & explain distribution (figure)
- **Implementation:** gap analysis, saving analysis

BASIS WAREHOUSE STATISTIC

SKU Related Statistic

- **# active SKU each month:** → difficulty & nature of warehouse
- **# pallet receiving each day:** → workload from receiving
- **Volume of SKU shipping each day:** → material handling
- **# line per order:** → warehouse characteristics & channel
- **Seasonality index:** → balance of workload

Facility Related Statistic

- **# new SKU each month:** → stability of warehouse
- **Avg. inventory per SKU:** → workload, inventory policy
- **# workers in each activity:** → division of labor

EXAMPLES OF WAP

- **Order mixed distribution:** moving partial warehouse, re-range zone
- **Channel mixed distribution:** business analysis, outsourcing, direct shipment,
- **Line per Order distribution:** batch picking,
- **Pallet order incremental distribution:** requirement of equipment, sub-pallet
- **Item popularity distribution:** storage location, fast picking area, ABC analysis by 'pick'
- **Family pair analysis:** SKU in same order → zoning

CONSTRUCTION MATERIAL: PRODUCTS

- **Category:** roof (\uparrow labor), cement (time limit), paint (flammable)



roof tile



grey cement



home paint

CONSTRUCTION MATERIAL: SALE

- **Channel:** retail (↑ margin), whole sale (↑ qty), project (know in advance)



homemart retail



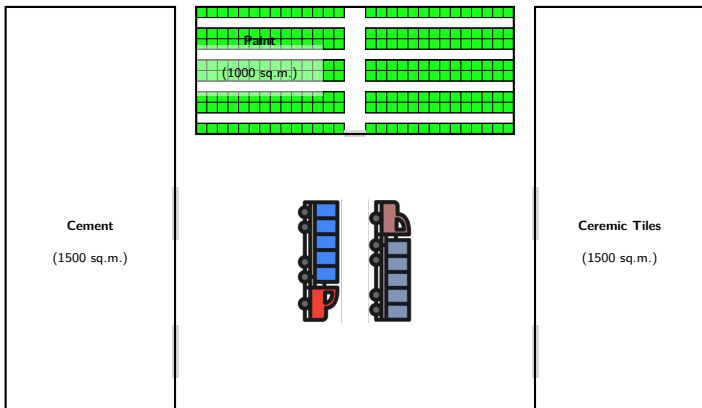
wholesale



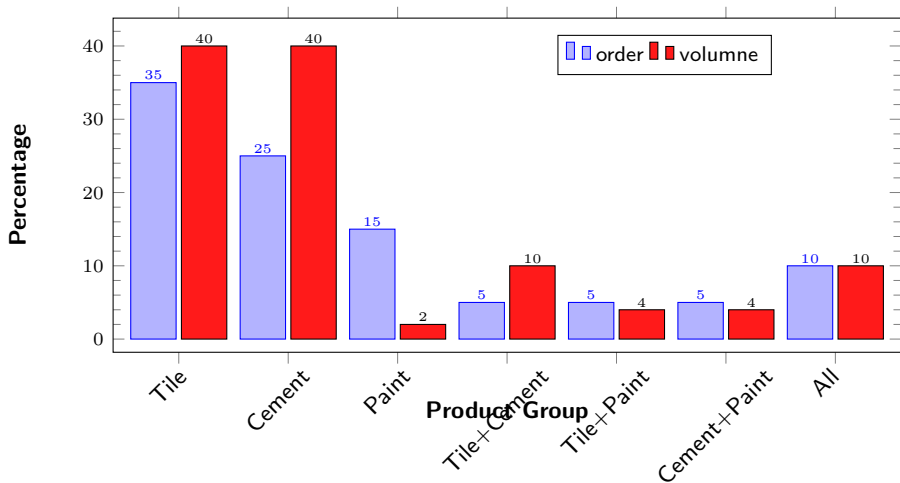
construction project

WAREHOUSE LAYOUT

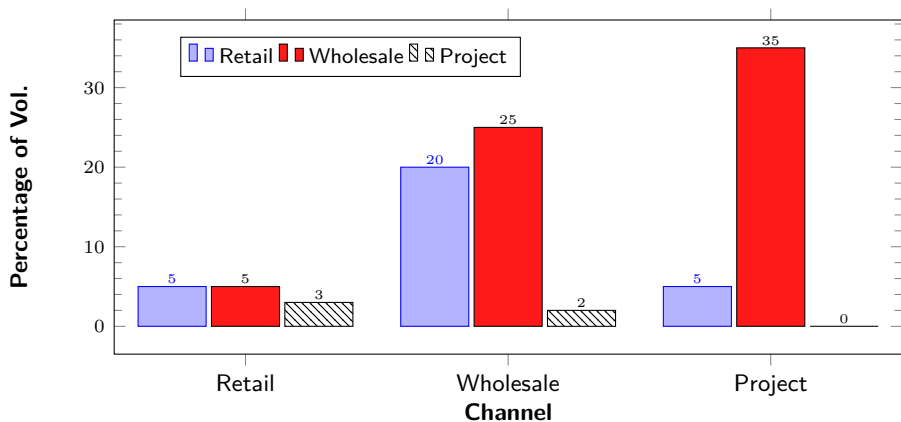
- never enough space → **space?**, qty?, SKU?
- high labor turnover → mgt?, worker?, task?, **policy?**, equipment?
- layout suck → **design?**, inventory?, slotting?



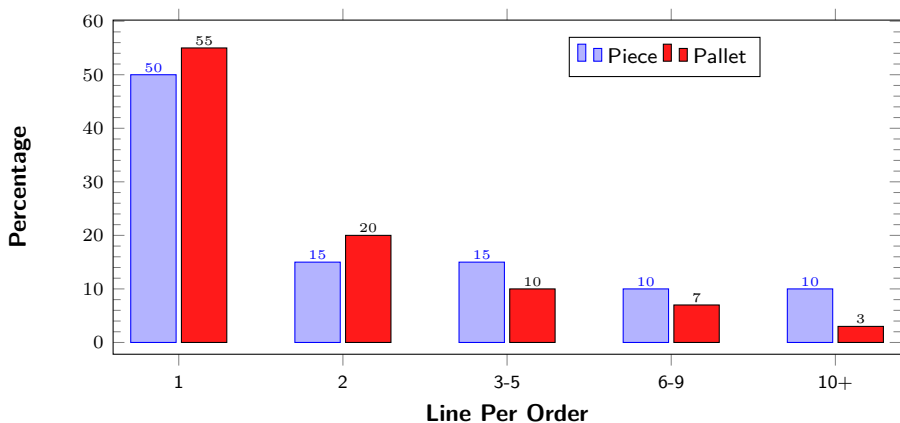
WHICH CATEGORY SHOULD BE RE-LOCATED?



DIRECT SHIPMENT?: CEMENT OR ROOF



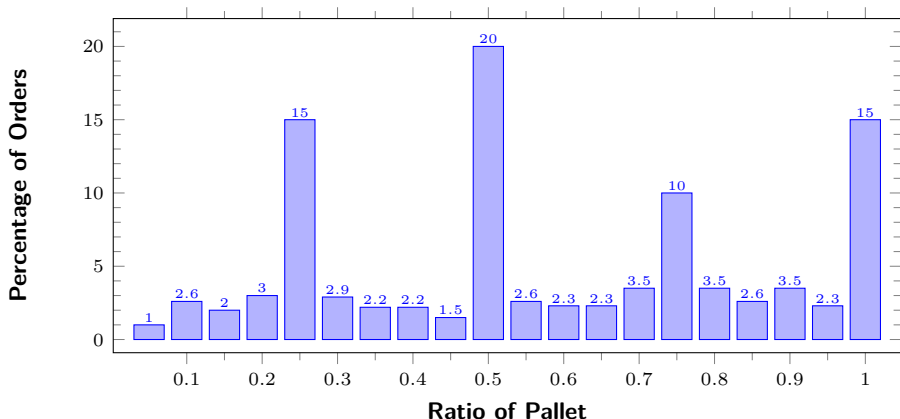
NUMBER OF LINE FOR BATCH PICKING



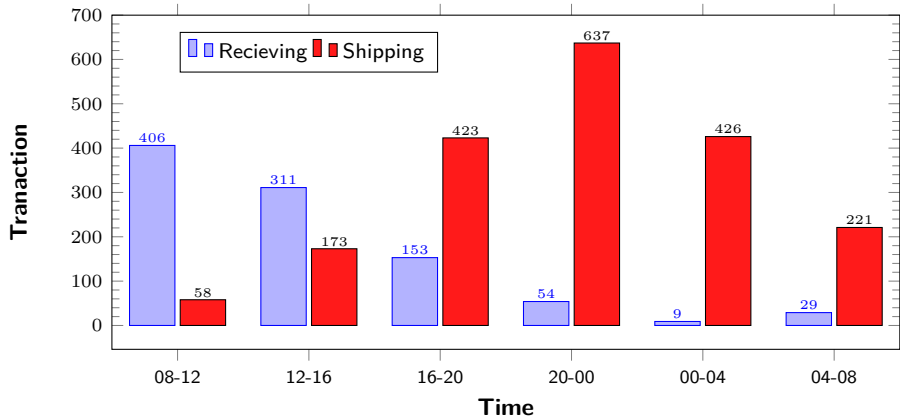
HOW TO DIVIDE SUB-PALLET?

Roof problems

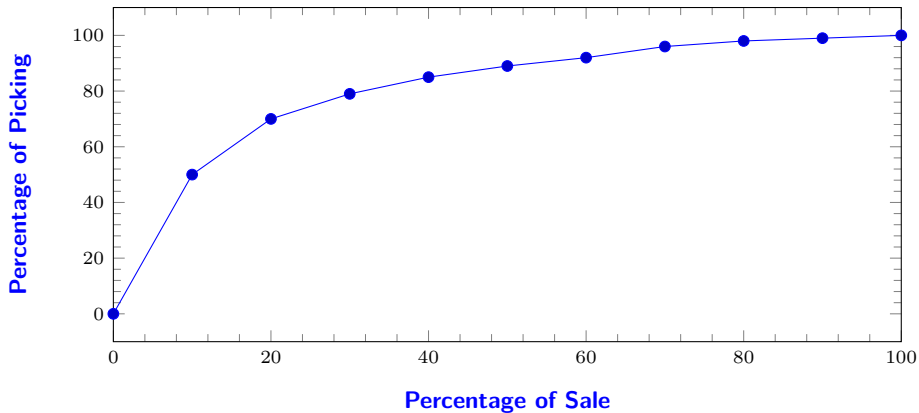
- **Roof problems:** require high labor, small order qty, easy damage
- **Question:** should do sub-pallet? & how much



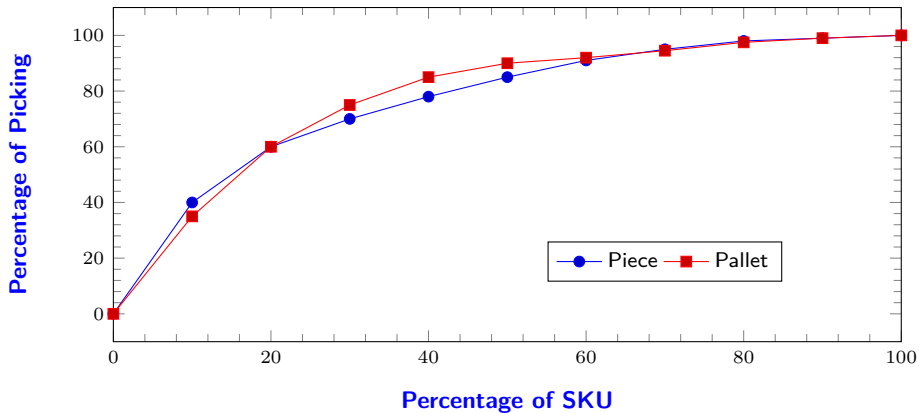
CONGESTION AT DOCK DOORS



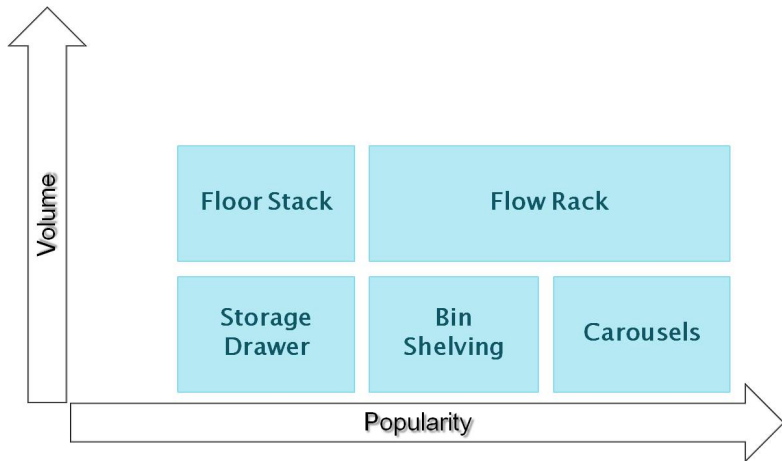
ABC ANALYSIS BY TOTAL SALE



ABC ANALYSIS BY HANDLING

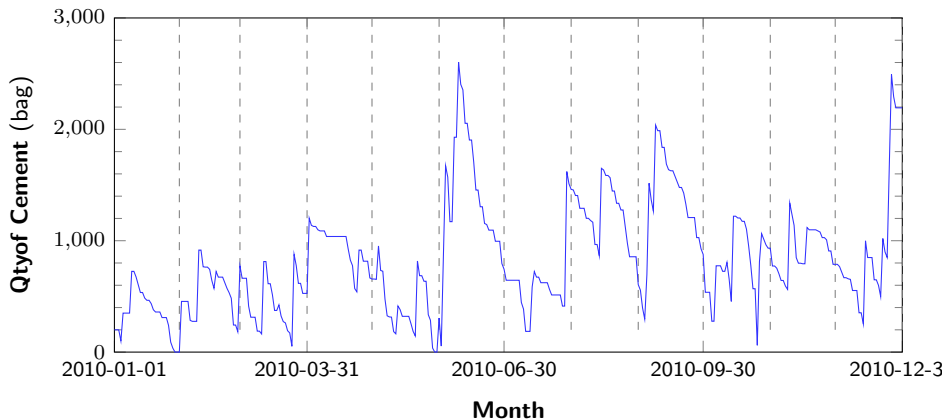


EQUIPMENT SELECTION



Adopted from Frazelle, E. 2002

CYCLE OF INVENTORY



COMMON QUESTIONS FOR WAP

Area	Questions	Profiles
Order picking & shipping process	<ul style="list-style-type: none"> ● batch size ● picking tour ● shipping mode separation 	<ul style="list-style-type: none"> ● order mix dist. ● line/order dist. ● line/order dist. ● cubes/order dist.
Receiving & put-away	<ul style="list-style-type: none"> ● receiving mode separation ● put-away batch size ● put-away tour 	<ul style="list-style-type: none"> ● order mix dist. ● lines/receipt dist. ● lines/receipt dist. ● cube/receipt dist.
Slotting	<ul style="list-style-type: none"> ● zone definition ● storage selection & size ● item location 	<ul style="list-style-type: none"> ● popularity dist. ● cube volume profile ● popular/volume dist. ● order completing dist. ● demand correlation

Adopted from Frazelle, E. 2002

WARNING ON WAP

- **Yielding unexpected turns:** profiling results \neq general believes
validate data & analysis \rightarrow new information & fact
- **Spending too much time:**
 - **Unavailable data:** e.g., volume
 - **Over analysis:** e.g., questions & profiling
- **Profiling periodically:** Data is **inconsistency** & **dynamic** \rightarrow WAP is non-stationary

WHAT IS KPI?

- **What:** a way to measure performance of organization/activity
- **Important:**
 - indicate success of each activity
 - evaluate main objectives
 - measure progress of implementation (historical comparison)
 - measure productivity & efficiency
- **Issues:** data collection, measurement, consistency

WHAT ARE CHARACTERISTICS OF GOOD KPI?

- related to the organization objective & mission
- accepted by everyone (supervisor, customers, industry)
- historical comparable & controllable → $\frac{\text{output}}{\text{resources}}$
- logical & suggesting solution
- required minimal of works for collecting & analyzing

Type of KPI?

- **Financial related KPI:** % warehousing cost per total cost, cost per shipped SKU
- **Non-Financial related KPI:**

KPI FOR EVERY ACTIVITY & ASPECT

Activity	Financial	Productivity	Utilization	Quality	Cycle-Time
Receiving	receiving-cost per line	receipts per man-hour	% utilization of dock	% receipts accurate	receipts CT
Put-away	put-away cost per line	put-away per man-hour	% utilization of labor	% perfect put-away	put-away CT
Storage	storage cost per item	inventory per square foot	% utilization of cubic	% available location	inventory days on hand
Picking	picking cost per line	lines per man-hour	% utilization of labor	% perfect picking lines	order picking CT
Shipping	shipping cost per order	order prepared for shipment	% utilization of dock	% perfect shipments	warehouse order CT
Total	total cost per order	shipped lines per man-hour	% utilization of capacity	% perfect order	total warehouse CT

Adopted from Frazelle, E. 2002

EXAMPLE OF NON-FINANCIAL KPI

- **Service Customer View:** **response time** (order cycle time), shipment accuracy (correct qty/total qty), **fill rate** (qty shipped/ordered qty)
- **Service Warehouse View:** dock-to-stock time, **inventory accuracy**, % cross-docking order
- **Productivity:** **lines per man-hour**, cases per person-hour, **cubic space utilization**, equipment up-time
- **Situation:** lines shipped per SKU, **inventory turnover**, investment pick accuracy, % of new SKUs, % active SKUs, labor turnover, lines per order, total lines shipped per day

Adopted from Hackman, S. 1982.

RATING OF SELECTED KPIs

KPI/Rating	Poor	Sub-Par	Par	Superior	Outstanding
responding time (hrs)	>48	24-48	12-24	4-12	<4
dock-to-store time (hrs)	>48	24-48	8-24	2-8	<2
lines per man-hour	<5	5-10	10-20	20-50	>50
cases per man-hour	8-25	25-50	50-100	100-250	>250
cubic utilization (%)	<65	65-75	75-85	85-95	0.95
annual lines per SKU	<50	50-100	100-250	250-400	>400
inventory accuracy (% qty)	>5.0	1.0-5.0	0.5-1.0	0.05-0.5	<0.05
inventory turn	<1.0	1.0-3.0	3.0-6.0	6.0-10.0	>12.0

source Hackman, S. *et al.* 2001 citehackman2001benchmarking.

USING KPIS

Project comparison:

- **Idea:** verify **success of project** with KPIs
- **Limitation:** 'wired' KPI, standardization, spilling effect

Historical comparison:

- **Idea:** compare KPIs **across period** e.g., month-by-month, year-by-year
- **Limitation:** situations (e.g., no picking, disruption), improving area

Benchmark comparison:

- **Idea:** compare KPIs **across organization**
- **Limitation:** type & scale of warehouses, confidentiality, interpretation
- **Method to compare:** **To-Be-Continue**

PROBLEMS

1. In warehouse activity profile, why do we prefer **Database software** (e.g., MS Access) rather than **Spreadsheet software** (e.g., MS Excel)
2. Based on WPA workshop, how many SKUs in Zone A/ Aisle 145?
3. Based on WPA workshop, what is the average line/order of SKU located in zone A?

SUMMARY:

- WPA = data mining of warehouse activity
- WPA → nature/ pattern, analysis tool, confirmation of problem
 - **WMS Data:** article master, shipping master, location master
 - **Important Data:** layout, policy, schedule,
 - **Most Difficult:** right questions and suitable KPI
 - **WPA in Action:** database, figure,

REFERENCE

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