BENCHMARKING WAREHOUSE PERFORMANCE STUDY

Summary of Results for Data Collected through April 2006 for Internet-based Data Envelopment Analysis for Warehousing

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Can a warehouse’s operational performance be improved? In order to answer that question, one needs to assess the warehouse's operational performance, relative to an achievable "standard" or "benchmark." This would let a particular warehouse to be compared to a large set of other warehouses. Also, this would allow learning which characteristics of the warehouses seem to be correlated with good performance. This is the objective of the Internet-Based Data Envelopment Analysis for Warehousing for system-based self-assessment of warehouses (iDEAS-W).

iDEAs-W is a tool developed to help warehouse managers understand and benchmark the performance of their warehouses. The iDEAs tool is a free service provided by the Keck Virtual Factory Lab at the Georgia Institute of Technology, and is accessed by pointing a browser to http://www2.isye.gatech.edu/ideas/. The tool is based on a generic performance model of warehousing developed by Hackman et al. (2001) and produces a system efficiency estimate considering several warehouse resources and several warehouse services. The tool uses a mathematical technique called data envelopment analysis to determine a relative efficiency by comparing a single warehouse to the best possible performance estimated from a set of peer warehouses.

By April 2006, there were 390 warehouses that had complete input and output data. After completing outlier detection, 216 warehouses were used to complete this study. However, not all the 216 warehouses answered every question about practices and attributes. The results of this study should be read with the understanding the presence or absence of a few data points can influence the conclusions for a particular analysis.

This report summarizes the results of analyzing these 216 warehouses. The results will be described in the following sections:

- Characterizing the warehouses
- Warehouse activity description
- Warehouse operations
- Performance analysis
- Conclusions

The results in this report measure efficiency and search for practices and attributes associated with high efficiency among the 216 warehouses. The model and metrics used are described in the Performance analysis section. Also, at the end of this document there is a glossary with the definition of the terms to be used.
Characterizing iDEAS-W Warehouses

By April 2006, there were 390 warehouses that had complete input and output data. After completing outlier detection, 216 warehouses were used to complete this study. In the following section we will explore the main characteristics that describe this sample of warehouses.

These warehouses can be classified according the type of industry sector that they belong. Figure 1 shows the distribution of warehouses by this classification. About half of them are wholesalers’ warehouses, as it is shown in the Figure 1.

![Figure 1: Distribution of Warehouses by Operation Type](image)

Typically, a larger warehouse will process more orders; therefore, costs can be diluted over a greater output, reducing the cost per unit. However, size may also bring complexity to the system, since there are more resources to control and organize. The size of a warehouse is a key characteristic to investigate in order to understand its operation. The warehouses in this study vary significantly in terms of space, investment, and total labor hours.

Most of the warehouses (~80%) are smaller the 350,000 sq. ft. in area, with an average of about 210,000 sq. ft. The size distribution is shown in Figure 2. As it can be seen in the figure, size varies greatly between the warehouses; the range is over 850,000 sq. ft. These warehouses were divided in two groups according to their size, and it was observed that smaller warehouses have a higher average broken case percentage than larger warehouses.
The amount of labor can also quantify the size of a warehouse’s operation. Figure 3 shows the distribution of this measure. Both direct and indirect labor is included in the total labor hours. About 80% of the warehouses use less than 300,000 labor-hours. This is equivalent to approximately 150 full time workers (2,000 hours/worker). Two groups of warehouses can be identified in terms of labor-hours: below and above 200,000 labor-hours (100 full time workers). These two groups could be observed in Figure 3. There is not a significant difference in the average productivity (measured in lines/hour) between the two groups. However, the first group has on average a greater percent of full case picks, while the second group has on average a greater percent of broken case picks. This difference is statically significant. This suggests that facilities with predominant broken case picking are very labor intensive. The group with more labor hours has also on average a higher labor turnover and a higher temporal labor percent (statistically significant).

Average labor/space ratio is around 1.02 labor-hours/sq. ft., with a 95% confidence interval ranging from 0.92 and 1.13 labor-hours/sq. ft. As expected, labor and space are positive correlated. Labor and space quantify size, and a larger warehouse implies more activity which requires more labor and space.
Equipment is another important resource used by a warehouse. In this study, in order to calculate the total investment, an inventory of equipment is collected for each warehouse and a standard cost is assigned to each equipment type allowing equipment to be aggregated to a single “standardized” investment input. About 80% of the warehouses have an investment less than $2 million. There is a great variability in the amount invested in these warehouses; the range of investment from smallest to largest is about $16 million. Wholesaler’s warehouses have on average a higher level of investment than retailer’s or manufacturer’s warehouses (statistically significant).

Figure 4 shows the distribution of the warehouses by investment. In the figure, a group of high investment warehouses can be observed on the right side of the graph. The average on-hand inventory measured in dollars of this high investment group is much bigger than the average of the rest of the warehouses ($226 million vs. $30 million respectively). This difference is statically significant. However, the difference between the average on-hand inventory (measured in units of inventory) of these two groups is not statically significant. This suggests that warehouses with higher value inventory tend to have more equipment investment.
The average ratio of investment/space is 7.06 (USD per sq. ft.), with the 95% confidence interval ranging from 8.28 and 9.94. As expected, investment and space are positively correlated. On the other hand, the average ratio of labor/investment is 0.26 (labor-hour per USD), with a 95% chance of being between 0.22 and 0.30. Labor and investment are also positively correlated. The relationship between labor and investment is shown in Figure 5. It can be seen in the figure that the relation between labor and investment is positive; however, the association between these inputs is not very obvious, and the data points are considerably spread out.
Figure 5: Labor vs. Investment
Warehouses Activities Description

How active is an ‘average’ warehouse? How many lines does it process? What types of lines: pallet, full case, broken case lines? Does the average warehouse face seasonality? Different types of activities and operational environments require different types and amounts of resources. It is important to describe the activities of a warehouse in order to understand its main limitations and challenges for obtaining higher efficiency levels.

One important characteristic that describes the activity of a warehouse is inventory turns. In this study, inventory turnover is, on average, equal to approximately 5.2 per year, or about 70 days of inventory on-hand. About 90% of the warehouses have an inventory turnover less than 10 per year. The complete distribution is shown in Figure 6. The warehouses with more than 9 turns per year (right side of the distribution chart) have on average a greater velocity-based slotting fraction, which suggests that assigning items strategically becomes more important the higher the throughput of the warehouse. This positive correlation between inventory turns and velocity-based slotting is statistically significant.

The activity level of the warehouse can vary throughout the year due to seasonality of demand. It is important to characterize this seasonality because warehouse resources are not completely flexible, making it neither possible nor practical to adjust all resources levels downward during low demand seasons. The average seasonality index is 2.12.
Approximately 80% of the warehouses have seasonality between 1 and 3. The complete seasonality distribution is shown in Figure 7.

Seasonality is strongly positive correlated with labor/space radio and temporary labor percent. The average labor/space ratio for the high seasonality group in the figure (seasonality index above 4) is 2.23 while for the rest of the warehouses is 0.92. This means that the ratio is almost 150% higher for warehouses with significant seasonality. Also, the high seasonality group has an average temporarily labor percent of ~32%, while the rest of the sample has an average of less than 5%. As expected, seasonality is faced with extra labor, which in this case seems to be mainly temporary.

Order lines may require goods in broken cases (pieces), full cases, or pallets. The demand that these warehouses face consists of all three. Figure 8 shows the distribution of warehouses according to the predominant type of picking. If a warehouses has a percentage greater than or equal to 80% of a certain type of line picking, then it is said that it has a predominant type of picking, otherwise it is said to be of mixed picking type.

![Figure 7: Seasonality Index Distribution](image_url)
On average ~65% of picked lines are broken case lines. About 60% of these warehouses pick less than 1 million broken case lines. The complete distribution of broken case lines as a percentage of total lines is shown in Figure 9. It can be seen in the figure that there are two main groups: very low percentage of broken case lines and very high percentage. If we compare the average labor used by the two groups, there is a positive correlation between the percentage of broken case lines and the average labor used. The difference on these averages is statistically significant. This is also the case for the labor and space ratio, where a higher portion of labor is used when a higher percentage of broken case lines are picked.
Among these warehouses, about 75% processed less than 400,000 full case lines. On average, about 25% of the lines picked are full case lines. The complete distribution of the percentage of full case lines is shown in Figure 10. In contrast with the broken case distribution, here there no clearly identifiable groups. This is because most of the warehouses that pick full case lines, also pick broken case lines or pallet lines (mixed picking).

![Figure 10: Full Case Lines Percentage Distribution](image)

About 70% of warehouses picked less than 50,000 pallet lines, and about 20% picked more 100,000 lines. The percentage of pallet lines is ~8% on average, and pallet lines represent 20% or less of the total lines picked for about 80% of the warehouses. The pallet lines percentage, for this sample, is correlated positively with the order average volume and weight. When a warehouse has a pallet as a major handling unit, the orders tend to be heavier.

It is also relevant to mention that on average 6.3% of the lines picked are rush lines.

A traditional productivity metric in warehousing is total lines picked per labor-hour. Figure 11 shows that ~80% of the warehouses have a pick rate less than 15 picks per labor-hour, and about half of them have a pick rate between 5 and 15 lines picked per labor-hour. The average is 9.3 lines per hour. The average value of this metric is higher for wholesaler’s warehouses than retailer’s and manufacturer’s warehouses (the difference on these averages is statistically significant), and it is also positively correlated with the percentage of broken lines.
Typically the number of lines processed in a warehouse receives more attention than the number of orders. However, the number of orders is also an important measure of the work done by the warehouse. About 60% of the warehouses have less than 150,000 orders per year, and approximately 10% of the warehouses have more than 700,000 total orders per year. On average, about 10% of the orders are rush orders, but 15% of the warehouses claimed a rush order percentage greater than 20%. The number of rush orders is an indication of the percentage of orders that do not follow the standard product flow of the warehouse, causing disruptions.

While orders and characteristics of orders describe the work of the warehouse on the outbound side, replenishments characterize the flow of goods on the inbound side. Although time constraints on put-away are generally less severe than for order picking, the amount of labor required for this activity can be significant. About 65% of the warehouses have 300,000 or fewer replenishments per year. Approximately 30% of the warehouses claim to have more than 1,000,000 replenishments per year. The number of suppliers providing replenishments varies significantly between the different warehouses. Around 40% of the warehouses have fewer than 100 suppliers, and approximately 20% have 1,400 or more suppliers.

The number of active SKUs in the warehouses varies greatly. About 65% of the warehouses have a SKU span of 20,000 SKUs or less. Over 20% of the warehouses have a SKU span of more than 100,000 SKUs. It was observed that the total labor hours and the labor/space ratio are positively correlated with SKU span. In addition, the average number of suppliers and temporary labor percentage are smaller for the 65% of the warehouses with the lowest SKU spans. Figure 12 shows the distribution of the SKU span.
Pareto’s principle suggests that 80% of the activity of a warehouse is driven by 20% of the SKUs. From the total SKUs, the percentage of the SKUs that represents the 80% of the activity of the warehouses (in terms of number of lines shipped) is 20% or less for only 40% of the warehouses. When this Pareto’s percentage is significantly greater than 20%, it suggests that there are not many ‘fast movers’. On the other hand, the percentage of the total SKUs that make 80% of the total volume shipped is less than 20% for only one third of the warehouses.

Having a large number of active SKUs, with few ‘fast movers’, increases the complexity of the warehouse, but if the set of active SKUs is changing, this is a further complication. Over the total SKUs, the average percentage of SKU changing (SKU churn) is 20%. Over 75% of the warehouses experience a SKU churn between 10% and 30%, and about 15% of the warehouses have a SKU churn of 30% or higher.
Warehouses Operations

While the activities of the warehouse describe at a high level the characteristics of the demand and replenishment process, warehouse operations better describe the implementation issues. One characteristic of the operations of a warehouse is the space utilization. The average space utilization for this sample of warehouses is around 75%, and approximately 80% of the slots available are occupied on average. The complete distribution of space utilization is shown in Figure 13.

![Figure 13: Space Utilization Distribution](image)

Another important aspect of warehouse operations is the amount of inventory on-hand. More inventory typically improves customer service, but increases the number of resources necessary to process and maintain that inventory. Over 80% of the warehouses have an on-hand inventory smaller than 10,000,000 items. In terms of inventory value, about 60% of the warehouses have $25,000,000 USD or less as on-hand inventory and ~15% more than $50 million. On-hand inventory and on-hand USD are both positively correlated with space, while on-hand dollar inventory has a statically significant positive correlation with labor and investment too. Therefore, on-hand dollar inventory is a good predictor of overall operation size (labor, space, investment).

Within warehousing there are many specialized practices that can be implemented to improve warehouse operations. Table 1 shows the percentage of warehouses that use certain practices in their operations. As can been seen in the table, velocity-based slotting is a practice used for over half of the warehouses.
There are also specialized practices implemented to improve warehouse’s customer service. Value added activities take place in almost 85% of the warehouses. The average labor/space ratio of the warehouses that have value added activities is greater than the average ratio for the rest of the warehouses. This difference is statistically significant. This may imply the extra work required to complete these customer oriented activities. Compliant shipping is practiced by ~55% of this sample warehouses.

Another valuable feature of customer service is responsiveness. About half of the warehouses have a response time of less than 24 hrs, 34% of them have 24-48 hrs to fulfill the order, and 13% between 48 and 72 hrs (rest is over 72 hrs).

While the practices above are related to physical issues within the warehouse, there are also a variety of practices related to information technology. Information technology is not an attribute particular to a few technologically advanced warehouses; over 85% of the warehouses of this sample use WMS for inventory control. The complete distribution of WMS providers is shown in Figure 14. Barcoding and rf technology are used by 70% and 65% of the warehouses, respectively.

Table 1

<table>
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<tr>
<th>Practices</th>
<th>%</th>
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<td>Auto sortation</td>
<td>47%</td>
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<tr>
<td>Crossdock</td>
<td>44%</td>
</tr>
<tr>
<td>Task interleaving</td>
<td>28%</td>
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<tr>
<td>Pick to light</td>
<td>15%</td>
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<tr>
<td>Velocity-Based</td>
<td>53%</td>
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<td>Slotting</td>
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The increased complexity of many of warehousing practices is handled by supervision within the warehouse. Supervisors have less than one day for planning in 34% of the warehouses, one to three days in 40%, and more than three days in 26%. About 75% of the warehouses spend 15% or less of the budget on supervision. The average for this expense is approximately 11%. Similarly, close to 75% of the warehouses devote 5% or less of the budget in maintenance.

Labor is a critical resource for warehouse operation and one of the most important challenges for many warehouse managers. On average 8.6% of labor is temporary, and approximately 40% of the warehouses use a temporary labor percentage higher than 10%. About 90% of the warehouses report labor turnover less than 10%. Note that labor turnover is defined as follows: (Head count attrition + new hires)/ (beginning head count); where head count attrition is the number of employees leaving during a given year (retired, quit, fired. etc.), new hires are the number of employees hired during a given year, and beginning head count is the number of employees working in the warehouse at the beginning of the year. Labor turnover is positively correlated with labor, space and investment. This means that the bigger the operation, the higher turnover expected (as percentage).
Performance Analysis

Performance analysis helps to define which warehouses are performing well and which have room for improvement. Individual warehouse managers may benefit from performance analysis simply by learning how much room for improvement exists. However, there is another source of benefit from this which is learning what characteristics or practices of warehouses seem to be correlated with good performance.

Model and Metrics

The model used in this study to assess warehouse performance is a 3 output by 3 input model. Warehouses actually use other inputs and outputs, but this set of 6 measures is believed to capture the most important inputs used and outputs generated. A similar model was initially developed by Hackman et al. (2001) on a smaller data set, measuring performance with a 5 output by 3 input model.

The inputs are labor, investment, and space. Labor is measured as annual labor hours including both direct and indirect labor to perform necessary operations of receiving, moving, storing, retrieving, order picking and shipping. Some indirect labor, such as management, planning, and equipment maintenance, is included. However, indirect supporting personnel, such as security, cleaning staff, office assistants, accounting, human resources, customer service, and the labor assigned to the value-adding activities are not counted. Investment is generated by taking an inventory of the equipment used in the warehouse and assigning the equipment a standard value measured in U.S. dollars, regardless of its age, then multiplying the standard values versus the quantity and summing over all equipment types. Space is the area measured in square feet, dedicated to the warehouse operations of receiving, put away, storing, retrieving, order picking, packing and shipping. Areas for supporting activities, such as offices, rest rooms, cafeteria, or break rooms are not included. Space for returns processing and value added processing also are excluded.

The outputs are broken case lines shipped, full case lines shipped and pallet lines shipped. When items arrive at a warehouse, they typically come in cases stacked on a pallet. Depending on the customer types and demand patterns, warehouses will receive orders requesting a certain number of each holding size: pallets, cases, or items contained in the case. An order from a customer is made up of lines. Each line is particular to a SKU, or in other words, it is particular to a certain item in a certain holding size. Thus broken case lines shipped are the number of broken case lines summed over all shipped orders for the 12 month period in which data was collected. Similar definitions apply for full case and pallet lines shipped. These measures are used to characterize the outputs of the warehouse.
Results

For each warehouse an efficiency estimate was calculated based on the reported inputs and outputs. Figure 15 shows the distribution of these efficiency scores. About 21% of the warehouses have an efficiency score less than 0.4, ~33% of them have a score between 0.4 and 0.7, and about 22% of them have a score between 0.7 and 1.0. In addition 23% of the warehouses have an efficiency score of 1.0. In Figure 15 is evident that the largest portion of warehouses are either in a level of ‘medium-low’ efficiency (between 0.4 and 0.7) or in the maximum efficiency level (when efficiency equals to one). For about half of the warehouses, there is considerable room for improvement.

In order to investigate further the distribution of efficiency, we could segment the warehouses into the main groups according to their industry: wholesale, retail, and manufacturing. However, the average efficiency of each of these groups was calculated and no statistically significant difference was found between the different industry groups in this sample. Similarly, we could segment the warehouses according their predominant type of picking (broken case, full case, pallet, or mixed). The average efficiency was also calculated for these groups and compared pair-wise. No evidence of statistically significant differences were found.

To better understand the relationship between resources used (inputs) and efficiency estimates, data were analyzed to find correlations. Warehouses were divided in two groups: the higher efficiency group (warehouses with a score higher than 0.5) and the lower efficiency group, in order to look for significant differences between the average of the inputs used for each group. For this sample of warehouses, we found the following.

![Figure 15: Efficiency Scores Distribution](image-url)
Warehouses with higher score have on average less space. This conclusion is statistically significant. The relation between space and efficiency is shown in Figure 16. Whereas the relationship between space and efficiency is not very clear in the graph (the data points are very dispersed), an inverse relationship could be identified. Labor/investment ratio is positively correlated with efficiency, which means that warehouses with relative low investment (relative to labor) tend to be more efficient.

![Figure 16: Efficiency vs Space](image)

Lines/labor-hour is another ratio that is correlated with efficiency. These two metrics have a positive correlation that is statistically significant. This finding suggests that the partial productivity measure: lines/labor-hour, could give an idea of the overall input/output efficiency performance of the warehouse.

Regarding the attributes that describe the warehouses activity, seasonality does have a significant negative correlation with efficiency score. Warehouses with higher efficiency have on average a lower seasonality. Because resources are not completely flexible, high seasonality will cause some unavoidable negative effect on performance; however this effect could be reduced with good administration of resources, and with actions that seek to reduce seasonality itself. SKU span is another warehouse activity attribute that is negative correlated with efficiency. A very large SKU span brings complexity to the system, for example, slotting may become more challenging and require the use of extra resources.

Finally, there are some operational practices that are related to performance score. Velocity-based slotting is positively correlated with high levels of performance, i.e. warehouses that slot according the frequency of retrieval have on average a higher
performance that the rest of the sample. On the other hand, temporal labor percentage is negatively correlated with efficiency. Temporal labor is usually used to face changes in activity due to seasonality of demand. However, this relation between temporal labor and efficiency suggests that the flexibility of temporal labor is not fully utilized, or the productivity of a temporal worker is considerably inferior to the full time worker.
Conclusions

Through the analysis of inputs, outputs, attributes and practices we were able to develop a big picture of contemporary warehousing. We also catalogued some of the variables that are correlated with high and low levels of efficiency, in order to identify warehousing “best practices”. In the following, some of the main findings are highlighted.

• A very large proportion of warehouses are operating at or below 50% system efficiency (~35%). About half of warehouses are operating below average efficiency score (65%)

• A statistically significant correlation was not found between industry type (wholesale, retail, manufacture, etc.) and efficiency. Similarly, a significant correlation was not found between performance scores and the predominant picking type (broken case, full case, pallet)

• Big is not always better. Space is negatively correlated with performance scores. Investment is negative correlated with performance scores, but this correlation is not statistically significant. However, labor/investment ratio is positively correlated with efficiency

• Typically, facilities with predominant broken case picking are more labor intensive than the ‘average’ warehouse. Similarly, warehouses with higher value inventory tend to have more investment

• Warehouses with higher value inventory tend to have more equipment investment

• Labor turnover and efficiency scores are negatively correlated (statistically significant). Labor turnover percentage is positively correlated with labor, space and investment. This means that the bigger the operation, the higher turnover expected.

• Value added activities take place in almost 85% of the warehouses. The average labor/space ratio of the warehouses that have value added activities is greater than the average ratio for the rest of the warehouses

• Seasonality is also strongly positive correlated with labor/space radio and temporary labor percent. In addition, seasonality is correlated with lower levels of efficiency

• Warehouses that slot according the frequency of retrieval (velocity-based slotting) have on average a higher performance that the rest of the sample
• The number of turns per year is positively correlated with the velocity-based slotting fraction. This suggests that assigning items to storage locations based on the frequency of their retrieval is more widely used by warehouses with higher throughput.

Following these interesting observations, there are some actionable results in order to improve efficiency performance.

• Practice velocity-based slotting when possible. It may help to improve efficiency particularly if throughput is high

• Develop a strategy to reduce the impact of seasonality, for example developing an adequate product mix

• Make the most of the flexibility of temporal labor. Increase the productivity of the temporal-hour by appropriate training

• Extra resources expended in value added activities must be justified. Negotiating with the customers may allow the warehouse managers to reduce resources dedicated to some of these customer service activities
Glossary of Terms

**Broken Case Lines**
(unit: lines) The number of broken case lines shipped in the last 12 months.

**Compliant Shipping**
Compliant shipping is providing customers with specific labeling or otherwise handling the item to satisfy the requests of a specific customer.

**Full Case Lines**
(unit: lines) The number of full case lines shipped in the last 12 months.

**Inventory (On Hand Inventory, On Hand Dollar)**
(unit: items or units) On Hand Inventory measures the number of units stored in the warehouse summed over all SKUs.
(unit: $) On Hand Dollar measures the total inventory in terms of the value of the items stored.

**Inventory Turnover**
A ratio that shows how many times the inventory of a firm is sold and replaced over a specific period.

**Investment**
(unit: $) Represents the value of the equipment invested. Rather than attempting to capture actual cost, or book value, for this study an equipment inventory was captured, and then a standard cost was applied to determine an equipment investment that is normalized across all warehouses.

**Items**
Is the number of physical units requested depending on variant modes, e.g. pallet, case, or each (piece).

**Labor (Labor Hour)**
(unit: hr) Labor is measured as annual labor hours including both direct and indirect labor to perform necessary operations of receiving, moving, storing, retrieving, order picking and shipping. Some indirect labor, such as management, planning and equipment maintenance are included. However, indirect supporting personnel, such as security, cleaning staff, office assistants, accounting, human resources, customer service, and the labor assigned to the value-adding activities, should not be counted. To determine hours from head
counts we assumed that each full time equivalent person worked 2,000 hours per year.

**Labor Turnover**
Turnover is defined as: (Head count attrition + new hires)/ (beginning head count). Head count attrition is the number of employees left during a given (last) year (retired, quit, fired, etc.). New hires is the number of employees hired during a given (last) year. Beginning head count is the number employees working in the warehouse at the beginning of a given (last) year.

**Line**
Line is also called "product" or "SKU". Number of lines is the number of different product types in an order.

**Maintenance Expense**
Percentage of maintenance expense comparing to total operating budget measures the maintenance intensity. Maintenance expense should NOT include support services or value adding services.

**Orders**
Customer orders specify the details of customer demand which a warehouse needs to fulfill. A customer order generally includes product types (SKU) and the quantity for each product type.

**Pallet Lines**
(unit: lines) Number of pallet lines shipped (shipped in pallets) in the last 12 months.

**Seasonality Index**
The seasonality index is defined as (volume in the peak month / average volume per month), where volume is based on items (pieces, or units).

**Planning Horizon**
The planning horizon refers to how far into the future to use information (demand, order composition forecast) in making the current decisions.

**Response Time**
Response time is defined as the time between an order arrival and the order completing within the warehouse.

**Rush Order**
The order requiring to be handle in rush.

**Rush Line**
The line requiring to be handle in rush.
SKU Span
(units: number of SKUs) The number of active SKUs

SKU Pareto
Percentage of the total SKUs that represents the 80% of the activity of the warehouse, measured in terms of total lines or total volume shipped.

SKU Turnover (SKU churn)
This metric captures that volatility. The question of "What fraction of skus changes from year to year? " is used for this metric, and it is defined as (skus dropped last year+skus added last year)/ (beginning total skus last year).

Slots (occupied)
A slot is a designated location where you store stuff. It could be a pallet location on the floor, or a pallet storage "lane". It could be a rack location, or a shelf location. The key is that it's identified, so, for example, you could dispatch an order picker to the location to retrieve items.
Average storage space utilization based on avg number of slots occupied (%) asks, what percentage of your slots actually have something in them?

Space
(unit: sq. feet) Space is the area (measured in square feet) dedicated to the warehouse operations of receiving, put away, storing, retrieving, order picking, packing and shipping. Area for supporting activities, such as office, rest room, cafeteria or break room, is not included. For multistory buildings, total square footage should be reported, rather than building footprint. However, multistory buildings will be an attribute captured to reflect the construction cost and operation environment.

Supervision and Management Expense
Percentage of supervision and management expense comparing to total operating budget measures the maintenance intensity. Maintenance expense should NOT include support services or value adding services.

Total Replenishment Number
Counts the replenishment (inbound) activities and is the annual total number of replenishment for all skus. For example, if you have sku A and B only, and A restocked twice and B restocked 12 times last year, the total number of replenishment is 14.

Velocity-Based Slotting
Assigning items to storage locations based on the frequency of their retrieval.