RAND Arroyo Center
ARMY RESEARCH DIVISION
Research Note

CWT and RWT Metrics Measure the Performance of the Army's Logistics Chain for Spare Parts

The U.S Army depends heavily on the readiness and operability of its weapon systems. Maintaining these weapon systems requires that spare parts be available where and when they are needed. Thus, the responsive functioning of the logistics chain for spare parts is critical to keeping equipment ready to operate. A responsive logistics chain for spare parts is also critical in deployments. When Army personnel know that parts can be quickly and dependably supplied through the logistics chain, units can deploy with fewer "just in case" supplies.

As part of its efforts to improve the logistics chain for spare parts, the Army must measure the performance of its supply system in filling orders for materiel.[1] Velocity Management (VM)[2] is a RAND-developed and Army-implemented system that measures such performance and seeks ways to improve it through its Define-Measure-Improve (DMI) methodology.[3] As the term DMI implies, measurement is central to this improvement approach.

Two metrics the Army uses to measure the performance of the logistics chain are customer wait time (CWT) and requisition wait time (RWT). Unfortunately, CWT and RWT are sometimes confused with each other, for a number of reasons: they are similar in terminology and related in concept; they are reported in the same unit of measurement (days) and in the same graphical formats; and, in some cases, they measure overlapping functions. Yet the two metrics serve distinct purposes and differ in how they are defined and calculated.

The purpose of CWT and RWT metrics is to provide feedback to activity and process owners (unit commanders, division commanders, and combatant commanders) and managers at all levels of the logistics chain who will help them pursue continuous improvement in performance for the ultimate customers—warfighters. The Army has made effective use of these metrics to identify processes that needed improvement. The goal of this research note is to increase understanding of each metric and its use in improving the Army's logistics chain.

DIFFERENT METRICS FOR DIFFERENT PERSPECTIVES

The Army uses both CWT and RWT because it must measure the performance of its logistics chain from two perspectives, which correspond to two types of Army customers of the supply system. These are the customers at the unit level and at the Supply Support Activity (SSA) level. The SSA is the military analog of a retail parts store, such as an auto-parts store, and the unit is the military analog to the customer of that retail store.

CWT measures supply chain performance from the unit perspective: the time it takes to satisfy a request for a part needed to make a repair. (The unit parts clerk orders parts for the maintainers and operators in the unit.) This measurement is important because poor CWT may decrease equipment readiness if the maintainer is forced to delay a repair because of a lack of parts. Long CWT may also increase maintainer workload by creating the

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[1]Although this research note uses repair parts (Class IX) in the illustrations, the subject metrics are used for other materiel requested through the Army Standard Supply System.

[2]The name Velocity Management is being changed to Army Distribution Management.

[3]See *Define-Measure-Improve: The Change Methodology That Has Propelled the Army's Successful Velocity Management Initiative*, Santa Monica, Calif.: RAND, RB-3020, 2000. References to the Army's implementation of and success in applying DMI can be found at http://www.cascom.lee.army.mil/adm/index.htm.

need for workarounds to compensate for parts that do not arrive in time to be used in repairs.

CWT includes all customer requests for spare parts from the Army supply system. In March 2000, the Department of Defense mandated CWT to be the key performance metric for logistics[4] because it measures the performance of all logistics processes involved in providing the materiel that maintainers need to repair broken equipment.

In contrast, RWT evaluates how well the logistics chain for spare parts serves the SSA itself: how much time is required to satisfy an SSA requisition for a part. These requisitions include both those submitted to replenish the SSA's own inventories and those submitted as "special orders" for spare parts that are needed by the unit but that the SSA does not stock or have available to issue.[5] This measurement is important for two reasons. For parts that the SSA is supposed to stock, poor RWT will force increased investment in local inventories as a buffer against slow replenishment times. Also, given that many parts are not available at the SSA and must be special ordered to meet a customer's need, RWT may directly affect CWT.

Figure 1 summarizes the different perspectives provided by the two metrics; note that the SSA is a supplier in one perspective and a customer in the other.

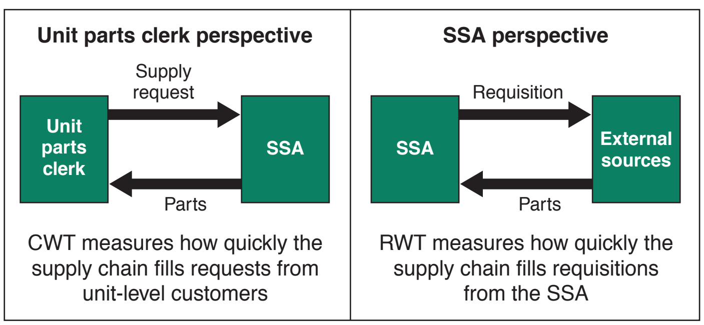


Figure 1. CWT and RWT Measure Logistics Chain Responsiveness from Two Perspectives

[4]Department of Defense Reform Initiative Directive #54, "Logistics Transformation Plans," Objective 3, Washington, D.C., March 2000.

[5]Originally called Order and Ship Time (OST), RWT was designed to measure the flow of information and materiel through the Army's distribution system. Because long back-order time is influenced more by procurement time than by distribution time, it was decided that including back orders in RWT would distort the true performance of the distribution system. Thus, RWT reports found on the Combined Arms Support Command (CASCOM) web site (http://www.cascom.lee.army.mil/adm/metrics2.htm) and provided to senior leadership to evaluate distribution system performance and stockage criteria do not include back orders. However, back orders are included in other RWT reports that are used to evaluate how well the logistics chain as a whole serves the SSA. These reports can be found at Integrated Logistics Analysis Program (ILAP) Version 6 (https://www.ilap.army.mil/; this is a password-protected site).

To some extent, CWT and RWT overlap in the populations of orders they measure: Some transactions are included in the data sets measured by both because some SSA orders originate from a unit-level parts clerk. Such unit-originated orders are analogous to the special orders that a retail auto-parts store places on a customer's behalf in order to obtain a part that is not ordinarily stocked at the store. Both CWT and RWT are computed using requests/requisitions that closed during the month of measurement.

MEASUREMENT OF CWT

CWT measures, in the aggregate, the performance of all logistics processes involved in providing the materiel that maintainers need to repair broken equipment; these processes include order fulfillment, stockage determination, component repair, and procurement. When requested parts are out of stock, and therefore not immediately available to issue, logistics processes may even include the manufacturing of new parts and the remanufacturing of used parts (e.g., rebuilding alternators and starters).

As previously discussed, CWT has a unit orientation. From the perspective of an Army unit mechanic who needs a part to repair a weapon system, the most important performance attribute of the Army's logistics chain is how long he or she must wait for an order to be filled. When parts are not quickly available, needed repairs may be delayed, and equipment may remain non–mission capable.

CWT focuses on supply requests, which are initiated by the maintainer, entered as requests into the supply system by the unit parts clerk (the customer in CWT), and forwarded to the SSA.[6] In today's Standard Army Management Information Systems (STAMIS), the measurement of total CWT begins when the unit clerk initiates a request for materiel and ends when the unit clerk receives the part. Currently, CWT is measured using data from the Corps/Theater ADP [Automated Data Processing] Service Center (CTASC). The data currently available allow for measurement in days.[7]

CWT can be segmented, as shown in Figure 2. Of the three segments, the Army currently can measure only the first two:

- **RON to SARSS-1:** This segment begins with the customer request, on the date assigned to the Request

[6]Army Regulation 710-2 states, "A supply request is initiated by a using (supported) unit to the Supply Support Activity (SSA)."

[7]In the future, it is possible that the Army may want more precision for CWT. The commercial sector frequently is able to supply parts to automobile repair shops in hours because customers expect their cars to be repaired in one day or less. On an Army installation, such responsiveness could potentially be achieved; however, many Army units operate in locations where such responsive supply is not feasible.

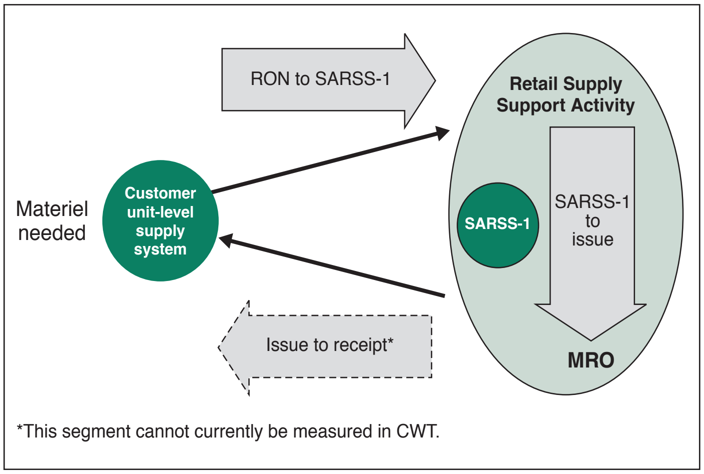


Figure 2. Currently, the Army Can Measure Only the First Two Segments of CWT

Order Number (RON), and ends when the request is entered into the Standard Army Retail Supply System (SARSS-1).

- **SARSS-1 to Issue:** This segment begins on the date when the request is entered into SARSS-1 and ends when the SSA generates a Materiel Release Order (MRO).[8]
- **Issue to Receipt** (not currently captured in CWT): The third segment begins when the MRO is generated in SARSS-1 and ends when the requesting unit acknowledges receipt of the materiel. Because the Army currently is not able to capture the third segment,[9] the current endpoint for measuring CWT is the date that the MRO is posted in SARSS-1.

CWT is a function chiefly of the length of the second segment, which, depending on the source of fill, can vary greatly. Source of fill (also known as "fill source") refers to where the materiel is obtained to fill a request (e.g., SSA or wholesale distribution center).[10] When the requested item is on hand at the local SSA, this segment can be very short, comprising just the time from posting of the request to almost immediate issue. However, if the materiel is not on hand at the requesting unit's SSA, its issue will be delayed until the SSA receives the item from an external source. All the time from the posting of the customer request to the issue of the materiel is included in this segment, which accounts for the Active Army's overall average CWT for repair parts in FY2002 of 20 days.[11]

The measurement of average CWT reflects, but does not explicitly reveal, the wide variation a requesting unit can experience in CWT for specific requests. This variation is depicted in Figure 3. Of all requests, 26 percent were satisfied in the first two days (the first hump of a two-humped, or bimodal, distribution), corresponding to the large proportion of requests filled directly by the SSA. The second, slightly smaller hump corresponds to the large proportion of requests not available at the SSA but that were passed on to one of the national distribution centers (usually run by the Defense Logistics Agency (DLA)). This hump is centered roughly on seven days.

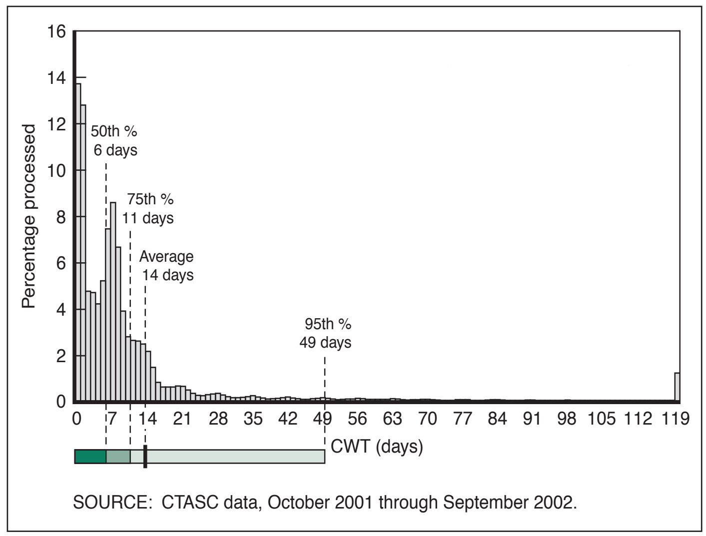


Figure 3. Distribution of CWT for Repair Parts (Class IX) Ordered by Active Army Units in the Continental United States

Note as well that the distribution of CWT depicted here includes a long tail extending into the hundreds of days, reflecting requests that cannot be satisfied until back-ordered items are received from external sources.

To prevent these few very long times for back-ordered items from having a disproportionate effect on average CWT, the Army supplements the traditional metric of average CWT with three additional CWT metrics: 50th percentile (median), 75th percentile, and 95th percentile. Under the VM initiative, these four metrics are reported in a stacked set of bars, as shown beneath the horizontal axis in Figure 3.

To better diagnose causes of delays, CWT is also reported by source of fill, illustrated in Figure 4. Total CWT is shown in the leftmost bar. The bold line in the center of each bar marks the average CWT on the left axis;

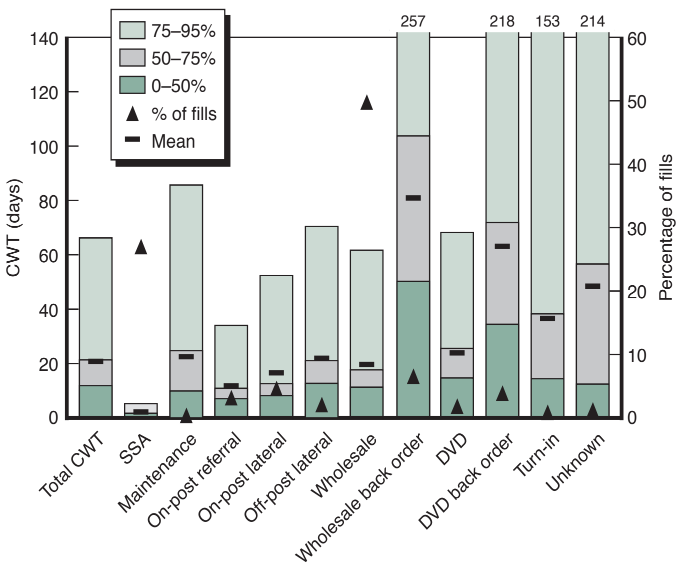
[8]An MRO is a directive to release materiel from stock on hand to a customer or supply activity.

[9]Currently, CTASC has no visibility of receipts entered into the unit supply system (Unit Level Logistics System (ULLS) or Standard Army Maintenance System (SAMS)).

[10]The Army distinguishes between "source of fill" and "source of supply." Source of supply refers to the activity that receives requisitions for a given item and then determines where the requisition can be filled. Sources of supply include Army, Air Force, DLA, General Services Administration (GSA), etc. Army sources of supply disaggregate into air and missile, tank and automotive, communications and electronics, etc.

[11]For VM CWT reports, see https://www.cascom.army.mil/private/adm/metrics2.htm. This is a password-protected web site. For access, please send email to Web Master at vm@lee.army.mil.

the triangles show the volume of requests from the scale on the right axis. In this case, the bold line indicates that the average CWT for all parts requests from Active Army units in the United States during FY2002 was 20 days. The darker region at the bottom of each bar represents the 50th percentile of CWT; here, half the requests were satisfied in 11 days or less. The middle region of each bar shows the additional time required to receive 75 percent of the requests. The upper region of each bar shows the time needed to receive 95 percent of the requests. The bars to the right of the first one (Total CWT) show CWT for each fill source.[12]

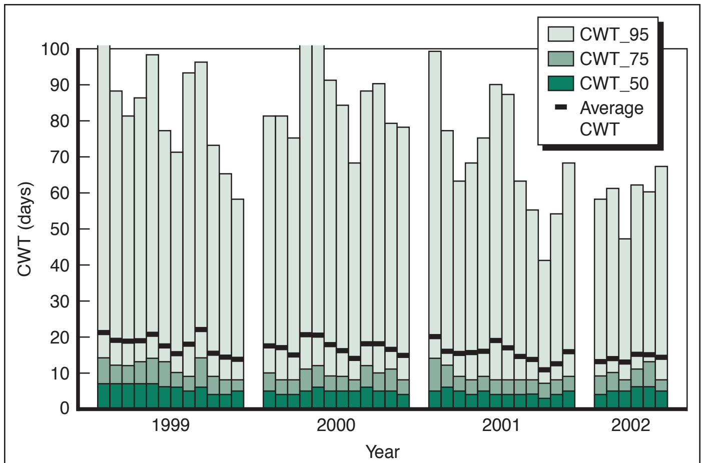


SOURCE: ILAP.
NOTE: DVD = direct vendor delivery.

Figure 4. CWT by Source of Fill for FY2002

If the part is available from a unit's SSA, CWT for that ordered part is fast and has almost no variability (the figure shows that the average CWT for orders filled from SSAs last year was 1.8 days, and the 95th percentile was 4.0 days). However, in FY2002, almost twice as many requests were filled through the wholesale distribution system—for which the average CWT was 19 days and the 95th percentile was 61 days—as by the SSA.

For all CWT metrics at Army installations, the trend since January 1999 has been toward shorter wait times, as Figure 5 shows for Fort Bragg (N.C.) through June 2002.[13] In 1999, the average CWT was just over 18 days; in 2002, the average CWT was just 14 days. Variability has been reduced, especially at the 95th percentile: from about 77 days in 1999 to 59 days by 2002.



SOURCE: ILAP.

Figure 5. Historical Trend of CWT for Repair Parts (Class IX) Ordered at Fort Bragg

MEASUREMENT OF RWT

We now examine RWT in more detail. The right side of Figure 1 illustrates the perspective captured in RWT, which focuses on *requisitions* submitted by the SSA to replenish stocks or to fill customer orders when stocks are not on hand.

While CWT has three main segments, RWT has five possible segments for continental United States (CONUS) shipments and 11 possible segments for overseas (OCONUS) shipments. As with CWT, the Army currently measures RWT in days. Figure 6 illustrates the segments of RWT for a requisition originating in CONUS. RWT begins either when a requisition is created at an SSA or when the SSA passes a customer order to an external source. It ends when the SSA posts a receipt. The first two segments in Figure 6 follow the flow of the requisition (i.e., information) from the SSA to the fill source; the remaining segments depict the flow of the materiel to the SSA.

The lengths of the five CONUS RWT segments are measured from a series of six time stamps (indicated by the numbers in the small circles in the figure) generated as the requisition and materiel flow through the supply system:

- **Date 1 (Doc date)**, assigned when a requisition to an external source is generated or when a customer order is passed to an external source.[14] This is the date on which RWT begins.
- **Date 2 (Established)**, assigned when the requisition is forwarded through the Defense Automated Addressing System (DAAS) or a gateway and on to a National Supply Management System or item manager.

[12]Not all fill sources are shown in Figure 4. For units in Europe, the Army has a distribution center in Germersheim, Germany.

[13]Fort Bragg is used for illustration because it is typical of a large Army installation.

[14]The Army calls customer orders passed by the SSA to an external source *dedicated requisitions.*

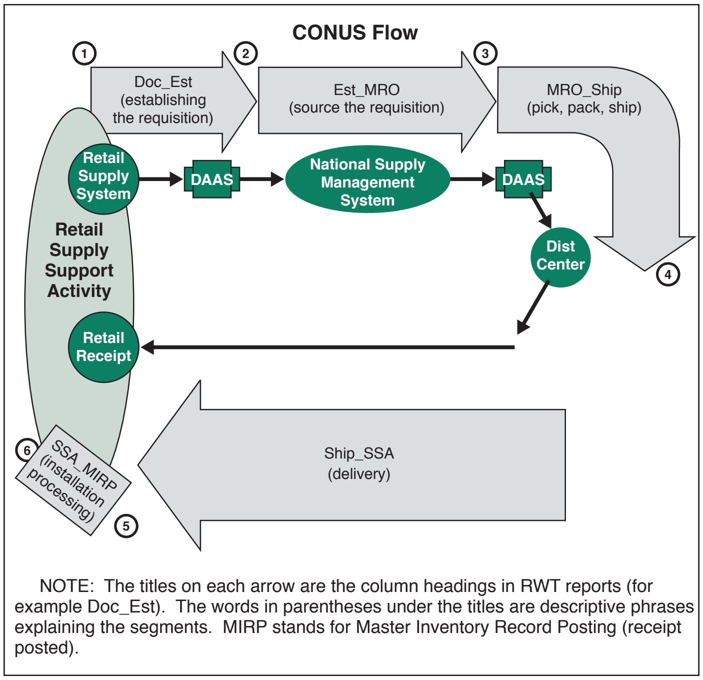


Figure 6. RWT for CONUS Involves Six Time Stamps

- **Date 3 (MRO)**, assigned when the National Supply Management System or an item manager generates an MRO, which directs a distribution center to issue the materiel.[15]
- **Date 4 (Ship)**, assigned when the materiel is shipped from a distribution center or vendor to a CONUS installation or a CONUS-based SSA.
- **Date 5 (Installation Receipt)**, assigned when the installation Central Receiving Point or SSA acknowledges arrival of the shipment.
- **Date 6 (Receipt Posted)**, assigned when the SSA processes the item and records the receipt. This is the date on which RWT ends.

For the Army, RWT can be measured with data from the Department of Defense's Logistics Response Time (LRT) file and the Army's Integrated Logistics Analysis Program (ILAP).

RWT for units stationed overseas is longer and more complex, given the need for movement of materiel to the port of embarkation (POE), change of transportation mode prior to ocean crossing (by plane or ship), and subsequent movement from the point of debarkation (POD) to the Army unit's position in the theater of operations.[16] For this reason, RWT for OCONUS may contain additional segments, as displayed in Figure 7. Note that the first three time stamps in the OCONUS flow are the same as those illustrated for CONUS. However, the OCONUS flow may generate a total of 12 time stamps as the requisition and materiel flow through the supply system.

The OCONUS time stamps shown in Figure 7 that are not part of the CONUS flow consist of

- **Date 4 (leaves the distribution center)**, assigned when the materiel is shipped to a containerization and consolidation point (CCP) or provided to a carrier.
- **Date 5 (arrives at CCP)**, assigned when the materiel is received at the CCP. The item is then put into a surface container or air pallet and readied for shipment. Note: If the item goes directly to POE (for example, for Federal Express shipments), there is no Date 5.
- **Date 6 (leaves CCP)**, assigned when the packed containers or pallets are shipped from the CCP to a POE.
- **Date 7 (arrives at POE)**, assigned when the materiel arrives at the POE, where items are then loaded onto a ship or aircraft for movement.
- **Date 8 (leaves POE)**, records the departure from the POE.

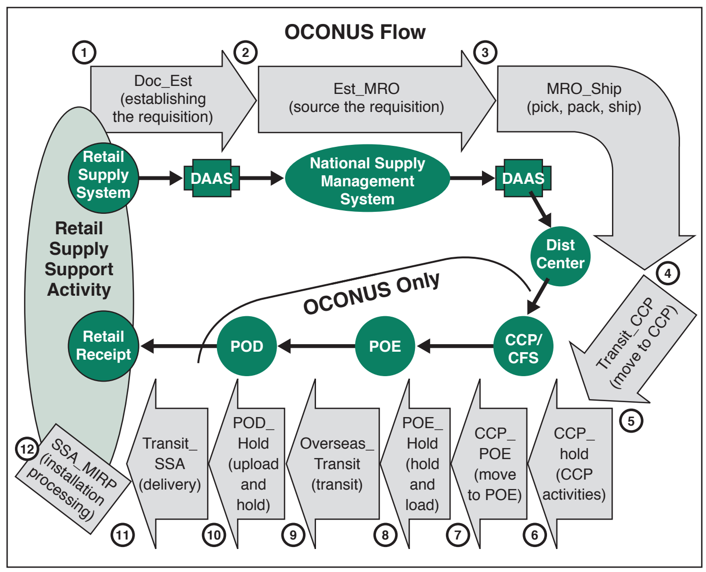


Figure 7. RWT for OCONUS Incorporates Additional Time Stamps

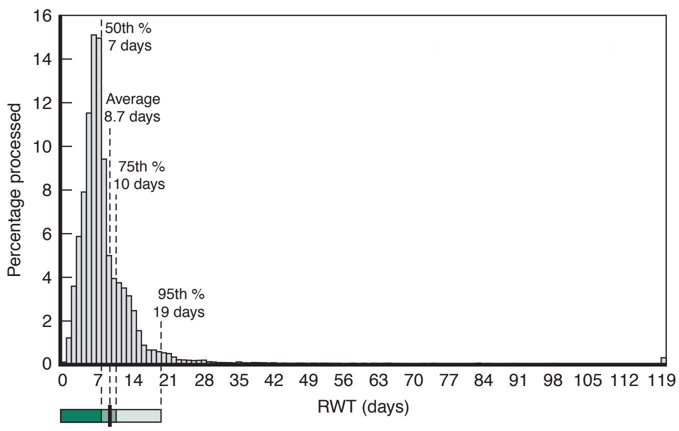
- **Date 9 (arrives POD)**, indicates the arrival of the materiel at the POD, where the containers or pallets are off-loaded.
- **Date 10 (leaves POD)**, assigned when the materiel is shipped to the in-theater SSA.
- **Date 11 (shipment received)**, assigned when receipt of the shipment is acknowledged.
- **Date 12 (receipt posted)**, assigned when the SSA processes the item and records the receipt. This is the date on which RWT ends.

[15]The distribution center may be another SSA (also called a forward distribution center) or a wholesale distribution center.

[16]Not all requisitions will have all 12 time stamps. For example, a part being redistributed (off-post lateral) from an SSA in the United States to an SSA in Germany could be shipped via World Wide Express. It would bypass time stamps 5–10.

Unlike CWT, RWT has a simple, single-hump distribution, as illustrated in Figure 8. The single hump reflects the fact that SSAs typically receive a preponderance of their parts from a single national source: a designated DLA distribution center. Another difference from CWT is that the distribution for RWT displays a shorter (although still long) tail because the Army's measurement of RWT does not include back orders.

Like CWT, RWT is measured and reported in percentiles designed to reveal not only the speed but also the reliability of the logistics chain. An example of the stacked bars used to report RWT appears beneath the curve in Figure 8.[17]

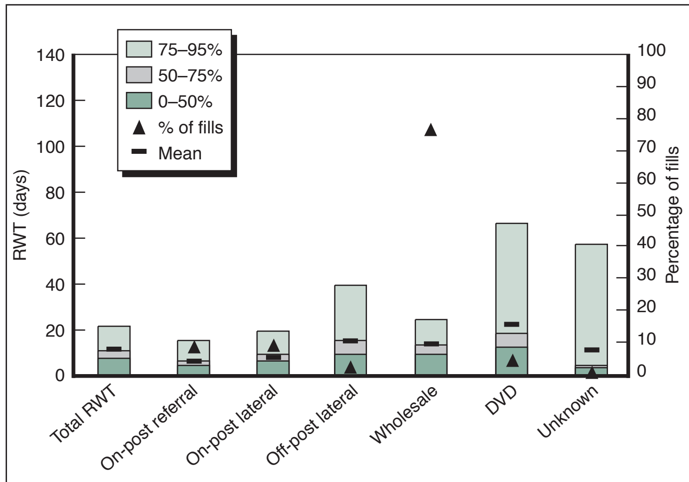


SOURCE: LIDB data, October 2001 through September 2002.

Figure 8. Distribution of RWT for Repair Parts (Class IX) Ordered by Active Army Units in the United States

To better diagnose causes of delays, RWT may also be reported by source of fill, illustrated in Figure 9. Total RWT is shown in the leftmost bar. The bold line in the center of each bar marks the average RWT on the left axis; the triangles show the volume of requests from the scale on the right axis. In this case, the bold line indicates that the average RWT for all repair part requests from Active Army units in the United States during January 2003 was 13 days. The darker region at the bottom of each bar represents the 50th percentile (median) of RWT; here, half the requests were satisfied in 8 days or less. The middle region of each bar shows the additional time required to receive 75 percent of the requests. The upper region of each bar shows the time needed to receive 95 percent of the requests. The bars to the right of the first one (Total RWT) show RWT for each fill source.

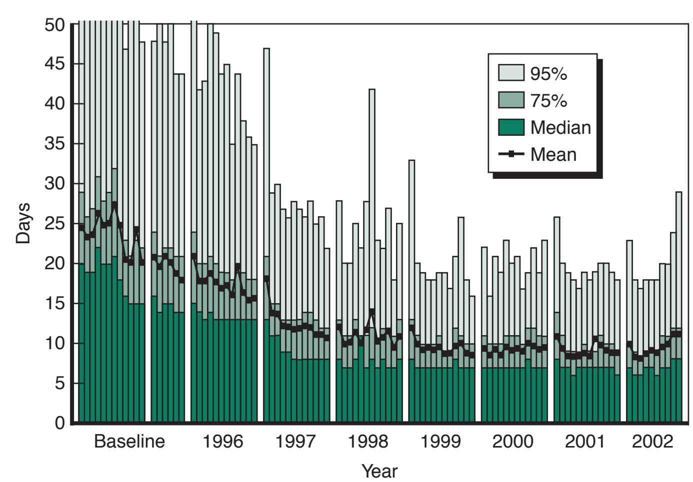
Under VM and related initiatives, the Army has had a great deal of success reducing RWT during the past five



SOURCE: ILAP.
NOTE: DVD = direct vendor delivery.

Figure 9. RWT (No Back Orders) by Source of Fill for January 2003

years. Since 1995, when RWT was first measured, the Army has dramatically decreased the variability of RWT (see Figure 10). As the Army has improved the processes underlying RWT, it has continually revised RWT performance goals. The reduction in average RWT from 22 days to today's goal of six days is testimony to the Army's commitment to improve supply processes.



SOURCE: LIDB data.

Figure 10. RWT for Repair Parts (Class IX) for Active Army Units in the United States

The process improvements that have led to decreases in RWT are exemplified by changes in two process segments.[18] Long "Doc to Establish" segment times were reduced by improving the order process: Army installa-

[17]The Army includes RWT reports in ILAP Version 6. These reports can be found at https://www.ilap.army.mil/. The reports contain RWT metrics both with and without back orders.

[18]For more examples, see Mark Y.D. Wang, *Accelerated Logistics: Streamlining the Army's Supply Chain*, Santa Monica, Calif.: RAND, MR-1140-A, 2000.

tions strengthened oversight, simplified rules, improved the performance of new requisitioning and receipting technologies and increased their proper use, reduced review processes, and reduced delays in receiving materiel.[19] Transportation times from distribution centers to installations were decreased by moving stock to the regional distribution centers and making scheduled truck service to large installations the primary delivery mode.[20]

SUMMARY COMPARISON OF CWT AND RWT

Table 1 summarizes the comparison of CWT and RWT, including Army goals. Goals are an important component of the DMI methodology. The "Improve" portion involves, among other things, setting and revising performance goals in terms of the selected metrics. After viewing the initial measurements of RWT, the Army set ambitious goals to reduce both the time and the variability of RWT. Those initial goals have been repeatedly revised over the past seven years to drive further improvement, and new goals for CWT have been established.

Table 1. Comparison of CWT and RWT

CWT	RWT
Measures logistics chain performance from the perspective of the unit	Measures performance of the logistics chain from the perspective of the SSA
Includes all sources of fill[a]	No back orders[b]
Performance Goals (CONUS, repair parts) • Average 10 days • 75% 8 days • 95% 50 days	Performance Goals (CONUS, repair parts) • Average 6 days • 75% 8 days • 95% 12 days
Data Source: CTASC/ILAP	Data Source: LRT/ILAP

[a]The Standard Army Supply System does not have visibility of materiel purchased locally, by credit card, or on the web. These transactions are visible only when the financial system pays the bill.

[b]As explained in footnote 5 above, back orders are not included in the RWT reports found on the CASCOM web site; however, ILAP Version 6 includes RWT both with and without back orders.

The Army has made effective use of CWT and RWT metrics to identify aspects of processes needing improvement. Activity and process owners and managers at all levels of the logistics chain are pursuing continuous improvement in performance as a result. As indicated by the differences in the distributions of the two metrics (compare Figures 3 and 8 above), the strategies for improving these metrics will need to be different, although overlapping. CWT has four critical improvement points; the first three improvements target the three highest fill sources:

1. The Army must continue to increase SSA fills because they yield the fastest and most reliable CWT. This information provides the impetus for the Army's decision to implement an improved SSA stockage algorithm, Dollar Cost Banding.[21]
2. The Army must continue to increase fill and decrease processing and transportation time from the national distribution points (DLA distribution centers) because these points are the second-fastest and most reliable sources of fill.
3. The Army must reduce the frequency and duration of back orders. National back orders are the third-largest source of fill for the Army's repair parts. As seen in Figure 4, back orders account for most of the variability in CWT performance. That variation also degrades average CWT.
4. The Army must decrease time for redistribution of assets to improve CWT. More requisitions are filled from redistribution than are filled from back orders.

The second improvement strategy for CWT (increasing fill and decreasing time from the national distribution points) will also decrease RWT. The frequency of scheduled truck service depends on the volume of materiel being shipped from the distribution center to the installation. As the volume changes because of activity levels and location of parts, the number of trucks should also change. Distribution centers must always try to put parts on the next scheduled truck. Activities at the distribution centers affect the "MRO to Ship" segment of RWT. Efforts to improve these processes are under way. RWT-segment data can be used to identify areas for additional process improvement.

Additionally, RWT has other critical improvement points, such as adjusting stockage algorithms throughout the logistics chain, and improving stock positioning at all levels. The Army now has the opportunity to implement new coordinated stockage algorithms at the installations

[19]John Dumond, Marygail Brauner, Rick Eden, John R. Folkeson, Kenneth J. Girardini, Donna Keyser, Ellen M. Pint, and Mark Wang, *Velocity Management: The Business Paradigm That Has Transformed U.S. Army Logistics*, Santa Monica, Calif.: RAND, MR-1108-A, 2001, p. 24.

[20]"The analyses suggested strongly that the delays and variability in the depot and transit segments could be greatly reduced if the Army and the DLA would establish scheduled trucks (similar to regular mail deliveries) as the primary shipping mode to large Army installations" (Dumond et al., 2001, p. 25).

[21]The Army considers the current SSA fill rates to be too low and has adopted a new RAND-developed algorithm called Dollar Cost Banding to improve SSA stockage. Limited funds for purchasing parts as well as weight and space constraints make it difficult for SSAs to achieve the same level of customer satisfaction that commercial parts stores provide their customers. SSAs must take all their supplies with them when units deploy for military operations; thus, the weight and space occupied by supplies are always a consideration when applying stockage algorithms.

and distribution centers.[22] These algorithms can be used to set stockage levels across regional distribution centers as well as those forward positioned in the SSA, thus better allocating the quantity and location of parts through the Army. These stockage improvements will further improve both CWT and RWT.

[22]The Army's implementation of Single Stock Fund has created this new opportunity to implement "multi-echelon" stockage algorithms for optimal allocation of parts.

RELATED RAND PUBLICATIONS

Accelerated Logistics: Streamlining the Army's Supply Chain, Mark Y.D. Wang, Santa Monica, Calif.: RAND, MR-1140-A, 2000.

Define-Measure-Improve: The Change Methodology That Has Propelled the Army's Successful Velocity Management Initiative, Santa Monica, Calif.: RAND, RB-3020, 2000.

Establishing a Baseline and Reporting Performance for the Order and Ship Processes, Kenneth J. Girardini, William Lewis, Rick Eden, and Earl Gardner, Santa Monica, Calif.: RAND, DB-173-A, 1996.

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Velocity Management: An Approach for Improving the Responsiveness and Efficiency of Army Logistics Processes, John Dumond, Rick Eden, and John Folkeson, Santa Monica, Calif.: RAND, DB-126-1-A, 1995.

Velocity Management and the Revolution in Military Logistics, Thomas J. Edwards, and Rick Eden, Santa Monica, Calif.: RAND, RP-752, 1999.

Velocity Management: The Business Paradigm That Has Transformed U.S. Army Logistics, John Dumond, Marygail K. Brauner, Rick Eden, John R. Folkeson, Kenneth Joseph Girardini, Donna J. Keyser, Eric L. Peltz, Ellen M. Pint, Mark Y.D. Wang, Santa Monica, Calif.: RAND, MR-1108-A, 2001.

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