Skip all front matter: Jump to Page 1

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Equipment Sustainment Data in Standard Army Management Information Systems

Needs, Gaps, and Opportunities

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Prepared for the United States Army

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Preface

The Army has been making policy, organizational, and information system changes to support Total Life Cycle Systems Management, the "cradle-to-grave" management of weapon and materiel systems. Recent reports, however, have described cases of critical life cycle management decisions and supporting analyses being hindered by problems with life cycle sustainment (LCS) data, i.e., information about the operations, support, and/or disposal of Army equipment. This document describes a RAND Arroyo Center study conducted to provide the Army with a comprehensive assessment of LCS data currently available in Standard Army Management Information Systems (STAMIS). Findings suggest that a range of data access, quality, and breadth issues need to be addressed to ensure that rigorous analyses can be conducted in support of critical LCM decisions. Recommendations include a combination of potential Army policy revisions, information system design changes, and steps to improve execution of sustainment data policies.

Results of this study should be of interest to Army managers, analysts, and information system developers in the acquisition and logistics communities. This research was sponsored by the Deputy Chief of Staff, G-4, Department of the Army, Resource Integration Directorate and was conducted in RAND Arroyo Center's Military Logistics Program. RAND Arroyo Center, part of the RAND Corporation, is a federally funded research and development center sponsored by the United States Army. Questions and comments regarding this research are welcome and should be directed to the director of the Military Logistics Program, Ken Girardini, at girardin@rand.org.

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Contents

Tables

Summary

In 2003 the Department of Defense (DoD) revised its acquisition policy to include the Total Life Cycle Systems Management (TLCSM) directive, which calls for "cradle-to-grave" management of weapon and materiel systems. In line with this revised policy, the Army made a substantial organizational change, creating Life Cycle Management Commands (LCMCs) in 2004 to give Army Materiel Command (AMC) logisticians more input into acquisition processes and move toward TLCSM. The Army has also made significant information systems changes, such as fielding the Logistics Information Warehouse (LIW), to facilitate life cycle management of equipment.

Still, recent reports have described cases of critical life cycle management (LCM) decisions and supporting analyses being hindered by problems with life cycle sustainment (LCS) data, i.e., information about the operations, support, and/or disposal of Army equipment. Additional steps may therefore be needed to ensure that Army information systems provide managers and analysts with access to high-quality, comprehensive LCS data. Recognizing this, the Deputy Chief of Staff, G-4, Headquarters Department of the Army (DA G-4), Resource Integration Directorate sponsored a study to assess the LCS data currently available in Standard Army Management Information Systems (STAMIS).

Specifically, we examined the extent to which STAMIS capture information needed for critical life cycle management decisions and analyses. Focusing on Army ground systems, our research approach included three components: a review of articles on military and commercial LCM decisions (to identify types of LCS data needed); interviews with personnel who regularly use, access, or manage Army LCS data; and the direct access, review, and analysis of standard Army database extracts by our research team.

Data Needs for Life Cycle Management Decisions

In evaluating Army LCS Data, we began by considering key LCM decision areas and associated analyses. The decision areas considered included acquisition strategy, upgrade planning, renewal planning, scheduled service updates, maintenance workforce planning, budgeting, new system design, and system performance. Based on documents on commercial and military LCM best practices, we then identified a set of prescribed LCS data elements for LCM analyses. The set includes vehicle demographics (information that uniquely identifies an item or describes its physical attributes, owner, or location); operations data (information about readiness and usage of an item); and maintenance and disposal data (information about maintenance actions and about the removal of assets from the fleet). We then investigated the degree to which STAMIS provides the elements for the various analytic needs.

Assessment of Life Cycle Sustainment Data

Our evaluation of STAMIS LCS data was based on criteria in three categories: ease of access and use, quality, and historical span of the data. Overall, the findings suggest that Army data policies, processes, and systems require substantial changes to support LCM analyses effectively.

General Obstacles to Access and Use of LCS Data

Statements from interviewees, along with the research team's own experiences with gathering LCS data, revealed a set of obstacles to data access; for example, it is not always clear whether certain data exist or where to find them. While many databases are centrally located in LIW, others are not and require a separate application to obtain a system account. Second, access request forms for some systems, like the Operating and Support Management Information System (OSMIS), ask the applicant to specify those portions of the information system he/she will need to access. The "catch-22" is that, to get an account, one must first specify the portions of the information system one will use, but one cannot determine which portions will be useful unless one already has an account with full access. Third, when applying for accounts, analysts who have security clearances, common access cards (CACs), and approval to work on Army-sponsored projects may nevertheless face long waits for approval. In some systems an account is later frozen or revoked if a user does not log on to the system for 30 days.

Assessment of Demographic Data on Army Equipment

Our review of demographic data on Army equipment indicates that such data elements—especially serial numbers, manufacture dates, and weight/volume (cube) measurements—tend to be reasonably accessible but low quality. Serial number errors are widespread, and because of such errors, different databases often have different versions of the same serial number. Serial number discrepancies make it difficult to link vehicle data from different sources (usage and maintenance data) by serial number. Also, manufacture dates in the TAMMS Equipment Database (TEDB) have inaccuracies. Many do not correspond to the serial number sequence or are not plausible, for example, M2A2 ODS (Operation Desert Storm) vehicles that have manufacture dates preceding Operation Desert Storm.

Assessment of Data on the Operation of Army Equipment

Like equipment demographic data in STAMIS, operations data have considerable limitations. In particular, data on rounds fired are only available for a few end items and require several approval processes to access. Additionally, missing and implausible odometer readings are prevalent in Logistics Integrated Database (LIDB) usage data. Units often have many months of missing odometer readings. When odometer readings are present, errors are common, suggesting that vehicles have negative monthly usage or unreasonably high monthly usage.

Assessment of Data on the Maintenance and Disposal of Army Equipment

Our review of equipment maintenance and disposal data in STAMIS suggests that such data have moderate levels of accessibility and historical span but are low-to-medium in quality. There is little financial information about disposal of Army equipment. Also, there are few records of scheduled field maintenance and no records of non-deadlining, unscheduled, organizational-level field maintenance. In addition, Army STAMIS generally lack data on equipment renewal (reset, recapitalization, or refurbishment) by serial number.

Impact of Data Limitations

Key LCM Decisions Are Hindered by Data-Quality Issues

	Data Element	Acquisition strategy: Assess remaining life of current systems	Upgrade planning: Assess failure rates & profiles (end item and component)	Renewal planning: Assess failure rates, costs, & readiness over time	Scheduled service updates: Assess failure rates & profiles
Demographics	Serial Number	X	X	X	X
	Model	X	X	X	X
	Age (Manufacture Date)	X	X	X	X
	Weight/cube/cost	X (cost)	X (cost)		
	Unit				X
	Location	X	X	X	X
Oper-ations	Readiness levels & dates	X	X	X	X
	Usage (miles, hours, rounds fired, fuel consumed) & dates	X	X	X	X
Maintenance/ Disposal	Configuration mgmt.	X	X	X	X
	Maintenance type (sch/ unsch) & echelon (field, sustainment, renewal) & dates	X	X	X	X
	Parts used & cost	X	X	X	X
	Labor hours & cost	X	X	X	X
	Maintenance capacity			X	
	Disposal	X			

RAND   LC Sustainment Data 31 01/10

After evaluating LCS data elements available in Army STAMIS, we found that most LCM analyses are not well supported by available data. The table above shows data elements in rows, decisions and associated analyses in columns, and an X indicating each data element (row) needed for a given analysis (column). The cells are shaded based on a data element quality rating: green for high, yellow for medium, and red for low. Most cells were shaded red or yellow, an indication that existing data are not sufficient for effective analyses and quantitatively well-supported decisions in the areas of acquisition strategy (with respect to replacement), upgrade planning, renewal planning, and scheduled service updates. A similar table in the main text (see page 55) shows that existing data also do not support decisions and analyses related to maintenance workforce planning, budgeting, new system design, and system performance as well as they should. Consistent with these tables, Army personnel interviewed for this study described negative effects of LCS data gaps on critical analyses and decisions.

Factors Contributing to Data Issues

It is likely that three sets of factors contribute to the aforementioned data issues and their effects: (1) policy factors (limitations of existing Army maintenance policies), (2) design factors (information system design features), and (3) execution factors (how Army doctrine and policy are carried out by personnel). An example of a policy factor is that Army Regulation (AR) 750-1 specifies relying heavily on Program Managers (PMs) to ensure that renewal data are gathered and analyzed but does not specify that STAMIS should archive such data by serial number. A system design factor is that serial numbers, manufacture dates, odometer readings, and maintenance data are input manually; consequently, they are subject to keystroke and logic errors as well as input reliability problems. A policy execution factor is the tendency for deployed units to treat usage and readiness reporting as optional, and another is the lack of enforcement of reporting policies. Also not well executed are policies concerning Army access to contractor maintenance data.

Potential Impact of STAMIS Changes in Progress

Over the past decade, several programs were initiated to change STAMIS structure and content: the Global Combat Support System-Army (GCSS-A), the Logistics Modernization Program (LMP), and, more recently, Item Unique Identification (IUID). Subject matter experts indicate that all three may address some of the data issues discussed in this document, potentially providing improved asset visibility, faster run times for reports, better database access, and less manual data entry.

However, interviewees also raised concerns that suggest these initiatives should not be seen as a cure-all for LCS data issues. Some cautioned that Army business rules do not yet incorporate the broad, enterprise perspective needed for GCSS-A and LMP. While GCSS-A promises to capture needed field-level maintenance data that are currently missing or of low quality, doing so will also require changes in maintenance reporting practices, and GCSS-A data quality cannot yet be evaluated in an operational environment. It was reported that LMP does not capture key data elements that legacy systems have overlooked—renewal data by serial number, for one. In the case of IUID, a concern is the potential for varying degrees of implementation, given that it is an unfunded requirement.

Recommendations

Although the impact of GCSS-A, LMP, and IUID is still uncertain, it is clear that there are currently a number of opportunities for improving the ease-of-access/use, quality, and historical span of Army LCS data. Further expanding LIW to centralize additional data and streamlining account approval processes (via a list of authorized account users for unclassified systems) would increase ease of access. Additional query options—such as eliminating restrictions that require data to be extracted in a piecemeal fashion—would increase ease of use by analysts.

Data quality could be enhanced by greater error- and mistake-proofing in information systems. To reduce manual data entry, a one-time input of a vehicle's serial number and manufacture date could populate multiple systems. Also, embedded automated data-reporting instruments could be required in new Army vehicles and added to vehicles with onboard diagnostic systems that already capture needed data.

To improve LCS data capture overall, a particularly valuable step would be a methodical review and revision of Army data policies, with analyst input in the review process; this step may better align data policies with strategic decision-making and analytical needs. Army policies should specify all data elements that STAMIS need to capture.

Additionally, an in-depth examination of GCSS-A and LMP should be conducted against the data needs identified in this research; this could reveal modifications needed for new systems to provide critical LCS data elements. Taking a comprehensive approach to LCS data improvement will help ensure that managers and analysts have the information needed to manage Army equipment life cycles effectively.

Acknowledgments

We would like to thank the Army managers and analysts who participated in interviews for this study. Also, we very much appreciate the helpful feedback received from HQDA G-4 managers and RAND researchers as the study progressed. We are especially grateful for the support of Mr. Robert Turzak, Director of Resource Integration, HQDA G-48, who sponsored this research; COL Brent Penny, who oversaw the research for Mr. Turzak; and Mr. Dan Kenny, the project action officer, who provided valuable input throughout the study. In addition, we would like to thank RAND Military Logistics Program Director Ken Girardini for his feedback, as well as RAND colleagues Lionel Galway and Louis Miller, who provided thoughtful reviews of this document.

Glossary

AEL	Army Equipment Loss
AEPS	Army Electronic Product Support
AMC	Army Materiel Command
AMSS	Army Materiel Status System
AR	Army Regulation
ASA[ALT]	Assistant Secretary of the Army [Acquisition, Logistics, and Technology]
ASV	Armored Security Vehicle
AWPS	Army Workload Performance System
CAC	Common Access Card
CCSS	Commodity Command Standard System
CE/MHE	Combat Engineer/Material Handling Equipment
COTS	Commercial Off-the-Shelf
DAU	Defense Acquisition University
DFPS	Defense Forces and Public Security
DMOPS	Depot Maintenance Operations Planning System
DOL	Directorate of Logistics
DoD	Department of Defense
DRMO	Defense Reutilization and Marketing Service
DS	Direct Support
ECR	Equipment Control Record
ERP	Enterprise Resource Planning
ESA	Enterprise Soldier Aviation

FEDLOG	Federal Logistics Database
FORSCOM	Forces Command
FSC	Federal Supply Classification
GAO	Government Accountability Office
GCSS-A	Global Combat Support System-Army
GCV	Ground Combat Vehicle
GS	General Support
HEMMT	Heavy Expanded Mobility Tactical Truck
HQDA	Headquarters Department of the Army
IFV	Infantry Fighting Vehicle
ILAP	Integrated Logistics Analysis Program
ILSC	Integrated Logistics Support Center
IUID	Item Unique Identification
KPP	Key Performance Parameter
LCM	Life Cycle Management
LCMC	Life Cycle Management Command
LCS	Life Cycle Sustainment
LIDB	Logistics Integrated Database
LIN	Line Item Number
LIW	Logistics Information Warehouse
LMP	Logistics Modernization Program
LOGSA	Logistics Support Activity
LRIP	Low-Rate Initial Production
MATDEV	Materiel Developer
MCN	Management Control Number
MMIS	Modification Management Information System

NIIN	National Item Identification Number
NMC	Not Mission Capable
NSLIN	Nonstandard Line Item Number
NSN	National Stock Number
O&M	Operations and Maintenance
ODS	Operation Desert Storm
ORG WON	Organizational Work Order Number
OSD	Office of the Secretary of Defense
OSMIS	Operating and Support Management Information System
PBUSE	Property Book Unit Supply–Enhanced
PEO	Program Executive Officer
PM	Program Manager
PMCS	Preventive Maintenance Checks and Services
PRON	Procurement Request Order Number
RFP	Request for Proposals
RIDB	Readiness Integrated Database
RRAD	Red River Army Depot
SAFM-CE	Assistant Secretary of the Army, Financial Management and Comptroller-Cost and Economics
SALE	Single Army Logistics Enterprise
SAMS-E	Standard Army Maintenance System-Enhanced
SDS	Standard Depot System
SLAMIS	SSN-LIN Automated Management and Integrating System
SSN	Standard Study Number
STAMIS	Standard Army Management Information Systems
TAMMS	The Army Maintenance Management System

TEDB	TAMMS Equipment Database
TLCSM	Total Life Cycle Systems Management
TOC	Total Operating Cost
TPER	Theater Provided Equipment Refurbishment
UIC	Unit Identifier Code
UII	Unique Item Identifier
ULLS-G	Unit Level Logistics System-Ground

1. Background and Research Approach

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Life Cycle Sustainment Data Gaps in Standard Army Management Information Systems: Needs, Gaps, and Opportunities

Sponsor: HQDA G-4

In 2003 the Department of Defense (DoD) revised its acquisition policy to include the Total Life Cycle Systems Management (TLCSM) directive, which calls for "cradle-to-grave" management of weapon and materiel systems. TLCSM was specifically defined as "the implementation, management, and oversight, by the designated Program Manager, of all activities associated with the acquisition, development, production, fielding, sustainment, and disposal of a DOD weapon system across its life cycle" (Office of the Secretary of Defense, 2003). A principal motivation for the policy revision was to ensure greater attention to system sustainment—in particular, operations and support, which have been estimated to consume 70 to 80 percent of a weapon's total ownership cost (Andrew et al., 2003; Redman, 2009).

In line with the revised DoD policy, the Army made a substantial organizational change to move toward TLCSM. The Assistant Secretary of the Army (Acquisition, Logistics, and Technology) (ASA[ALT]) and the Army Materiel Command (AMC) launched the Army's Life Cycle Management (LCM) initiative in 2004 to "enhance the input of logisticians into acquisition processes pertaining to current and future sustainment and readiness, reduce costs, improve quality, get products to the Soldier faster, and implement a more holistic approach to product development and system support" (HQDA Army Posture Statement, 2008). Central to the initiative was the creation of Life Cycle Management Commands (LCMCs), which aligned AMC Major Subordinate Commands with Program Executive Officers (PEOs) in the ALT community to give AMC logisticians more input into acquisition processes (HQDA, 2004).

The Army has also made significant information systems changes in support of TLCSM. In 2006 the AMC Logistics Support Activity (LOGSA) fielded the Logistics Information Warehouse (LIW), which provides a common point of entry to the Logistics Integrated Database (LIDB), the Integrated Logistics Analysis Program (ILAP), WebLOG tools, and other databases. LOGSA continues to expand and improve the content of LIW. Similarly, the Assistant Secretary of the Army, Financial Management and Comptroller-Cost and Economics (SAFM-CE) and CALIBRE Systems continue to add new reports and capabilities to the Operating and Support Management Information System (OSMIS).

Still, additional steps may be needed to ensure that Army information systems provide managers and analysts with access to high-quality, comprehensive life cycle sustainment (LCS) data—i.e., information about the operations, support, and/or disposal of Army equipment. Recent reports have described cases of crucial LCM decisions and supporting analyses being hindered by LCS data problems.[1] For instance, the Army Audit Agency (2008:16) noted that, due to a lack of accurate data on contractor resets, "Army leadership and Congress could not rely on the reported reset status of wheeled and tracked vehicles for decision-making purposes."[2] Additionally, in a study of program management in the U.S. military, Garrett and Rendon (2007:394) concluded, "We currently are limited in our understanding of life-cycle costs for our legacy systems due to the lack of reliable information databases. Without that knowledge, we are limited in estimating the impact of TOC [Total Operating Cost] reduction efforts on those life-cycle costs." Similarly, as McCoy (2009:41) pointed out,

> A critical component of effective life-cycle systems management is knowing how much readiness each additional dollar buys. In an ideal situation, fleet managers have adequate information to analyze the overall costs of sustainment alternatives effectively and select an option that ensures the weapon system will provide the lowest total cost of ownership consistent with an acceptable level of availability . . . However, the information required to perform this kind of analysis is not available in the current environment.

General Dunwoody (2009:4) highlighted the value of such data when she stated that "renewing our focus on sustaining equipment through every phase of the life-cycle process" calls for "a secure stream of readily accessible and accountable information." Thus, it is important to conduct a comprehensive review of Army LCS data, determining data needs, gaps, and opportunities for addressing those gaps.

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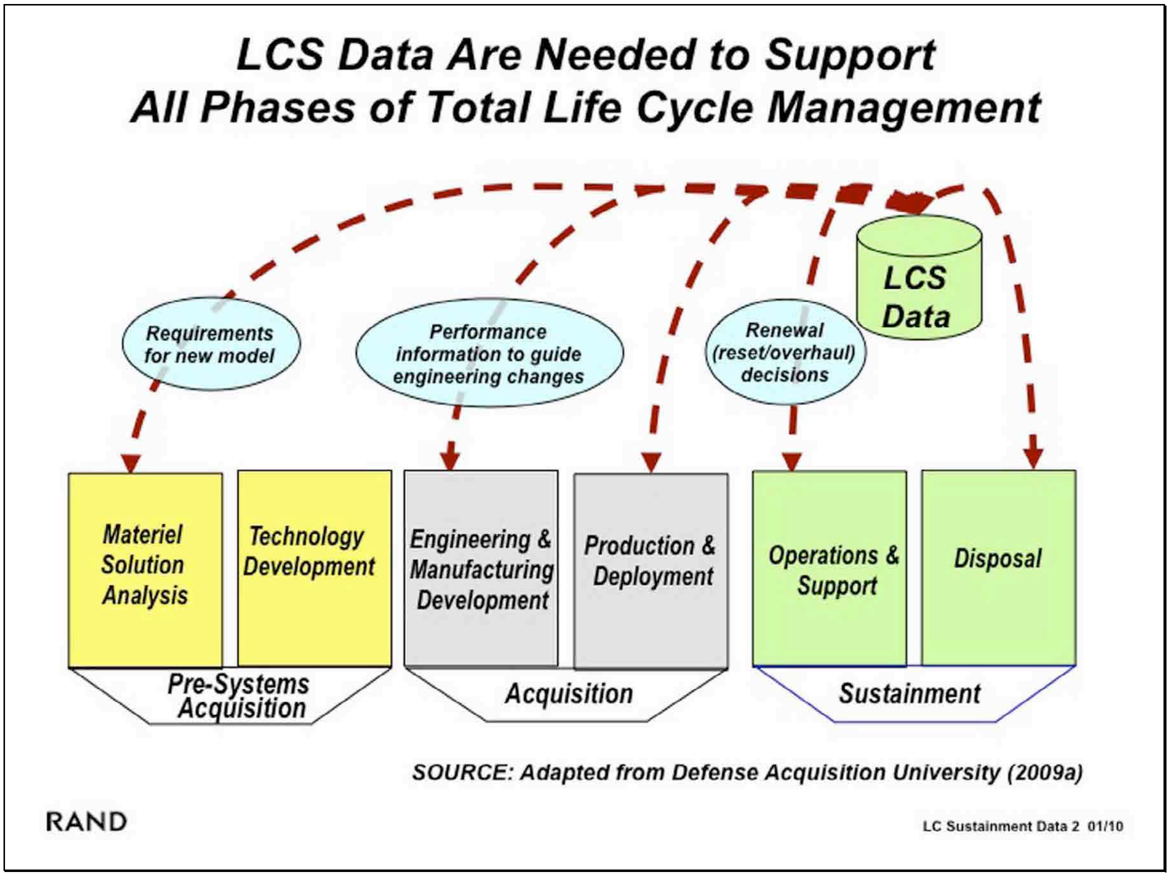
[1] Please see Appendix A for a list of reports.

[2] Specifically, the accuracy problem made it difficult to determine the number of vehicles available to distribute to units and how much to budget for reset in the next planning cycle.

The Director of the Resource Integration Directorate in the office of the Deputy Chief of Staff, G-4, Headquarters Department of the Army (DA G-4) sponsored a study to assess the LCS data currently available in Standard Army Management Information Systems (STAMIS). Specifically, we examined the extent to which STAMIS capture information needed for critical life cycle management decisions and analyses.



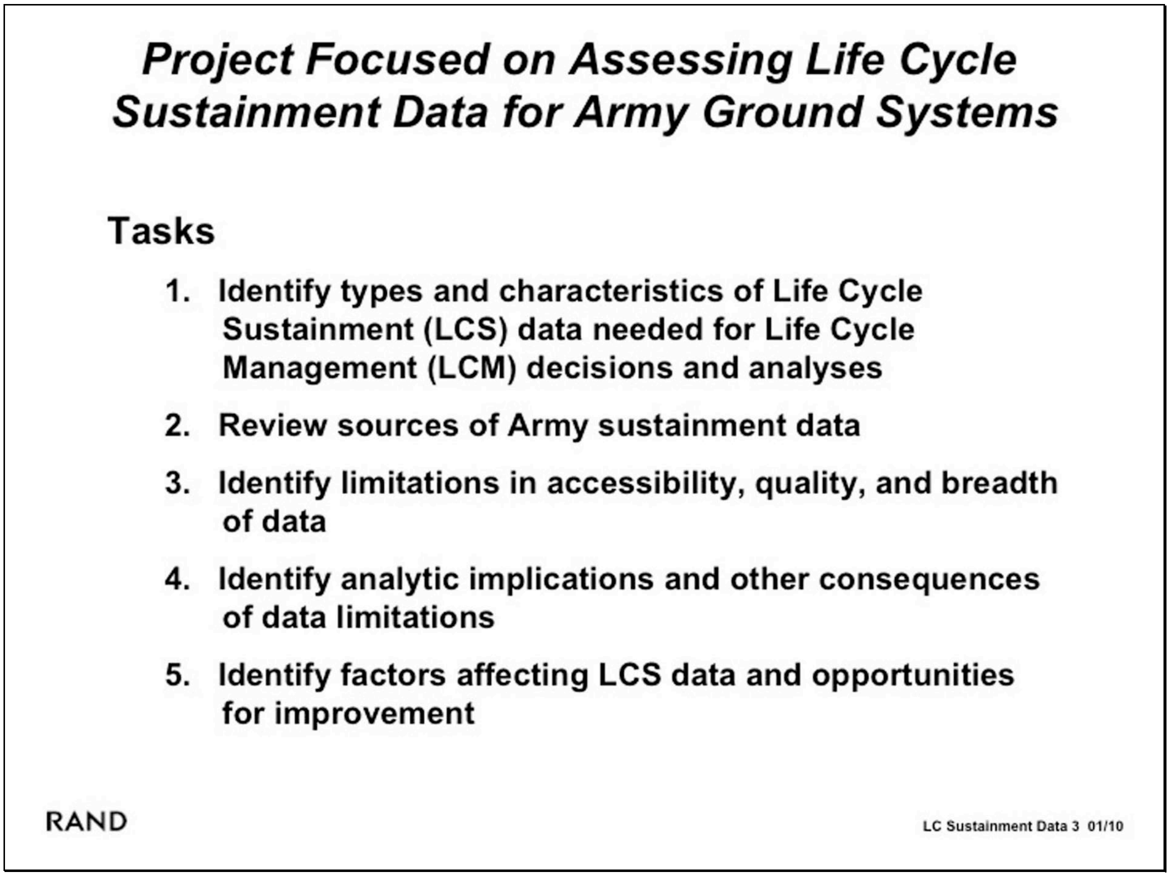
The above diagram, which is adapted from the DoD Lifecycle Framework (Defense Acquisition University, 2009a) and LOGSA Lifecycle Logistics Chart (Defense Acquisition University, 2009b), shows each phase of LCM. As the dotted arrows indicate, LCS data may serve as inputs to decisions and analyses in the Pre-Systems Acquisition, Acquisition, and Sustainment phases of LCM.

Pre-Systems Acquisition includes Materiel Solution Analysis (assessing potential materiel solutions to a capability gap) and Technology Development (determining appropriate technologies to be integrated into the proposed materiel solution) (DoD Instruction 5000.02, 2008:15-16).

Acquisition includes Engineering and Manufacturing Development (developing a system and a manufacturing process for the system) and Production and Deployment (achieving the desired operational capability through low-rate initial production (LRIP) followed by full-rate production, if the LRIP receives a favorable evaluation (DoD Instruction 5000.02, 2008:26).

Sustainment includes Operations and Support (planning and managing the operational readiness and maintenance of a system) and Disposal (planning and managing the demilitarization and removal of a system from service at the end of its useful life) (DoD Instruction 5000.02).[3]

[3] The Defense Acquisition Guide Lifecycle Framework (Defense Acquisition University, 2009a) treats disposal as part of operations and support; however, the "LOGSA Life Cycle Logistics Chart" (Defense Acquisition University, 2009b) distinguishes the two, as do other descriptions of life cycle management in the private and public sector (NASA, 2008). Here we distinguish the two elements of sustainment.



Our assessment focused on LCS data for Army ground vehicles and included five tasks: (1) identifying a set of key life cycle management decisions, likely analyses needed for those decisions, and the data elements that, ideally, should be available as inputs to such analyses; (2) examining existing LCS data sources to determine the types and characteristics of data captured; (3) identifying limitations in the available LCS data; (4) considering the implications of those limitations; and (5) identifying possible factors affecting LCS data and opportunities for improvement.

We Conducted Assessments Using Three Sources of Information

- Literature review
  - Articles on military and commercial LCS data and their uses
  - Standard Army Management Information Systems (STAMIS) briefings and manuals
- Interviews with SMEs familiar with Army LCS data and data sources
  - TACOM LCMC; CECOM LCMC; ASA[ALT]; LOGSA; HQDA G-4; CALIBRE; PM Stryker; RAND Arroyo Center; CECOM LCMC; HQDA G-4; ASA(ALT); FORSCOM G-4; CCAD; PM GCSS-A
- Hands-on examination of Army LCS database extracts

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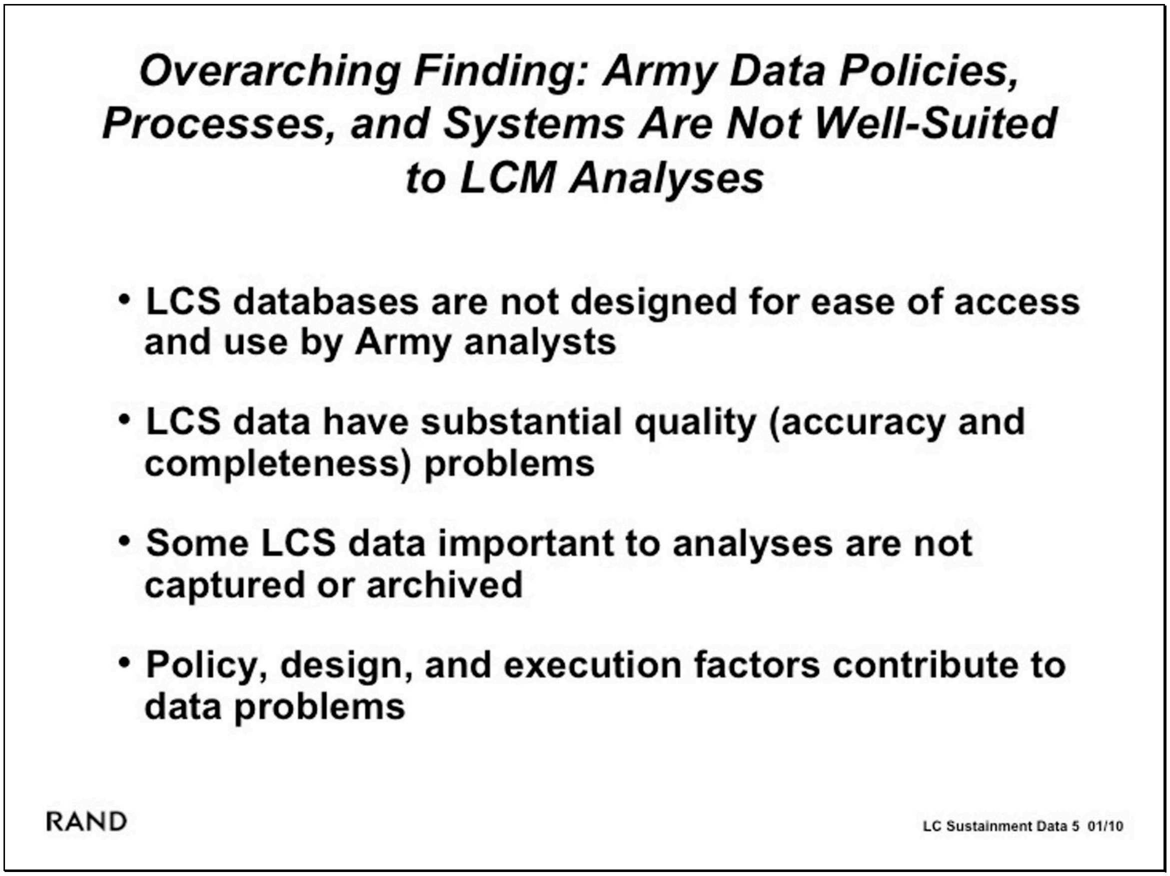
LC Sustainment Data 4 01/10

Our research approach included three components. The first component was a review of articles on military and commercial life cycle management decisions and analyses, focusing on the types of LCS data they tend to incorporate. The second component consisted of interviews with personnel who regularly access, use, or manage Army LCS data. Specifically, we conducted group interviews with 6 managers and analysts in the TACOM Cost and Systems Analysis department, 2 managers at the TACOM ILSC, 5 managers at CECOM's Enterprise Soldier Aviation (ESA) directorate, 5 managers at CECOM's Logistics and Readiness Center, 5 managers at ASA[ALT] Soldier and Maneuver Systems, 2 managers at LOGSA, and 4 managers at HQDA G-43. We also conducted individual interviews (1 each) with managers at TACOM ILSC, CALIBRE, PM Stryker, RAND Arroyo Center, HQDA G-4, FORSCOM G-4, Corpus Christi Army Depot, and PM GCSS-A. Appendix B lists the semi-structured interview questions.

For the third component of the research approach, the research team accessed standard Army information systems, documented our experiences in accessing and retrieving LCS data from those sources, and then reviewed and analyzed the database extracts. Appendix C lists the information systems discussed in this study.



The above slide provides a brief summary of key study findings, which the next section discusses in detail. Overall, the findings suggest that Army data policies, processes, and systems do not effectively provide the LCS data needed to support LCM analyses. A number of information system features hinder access to and the use of STAMIS LCS data for analysis purposes. Additionally, STAMIS LCS data tend to have substantial quality problems. Also, some LCS data—especially some types of maintenance actions—that are important to analyses either (a) are not captured at all by STAMIS or (b) are captured but not archived. Reasons for these data problems include limitations in Army maintenance data policies, current information system designs, and practices of units and organizations responsible for executing Army data policies.

2. Findings

We Considered Potential Data Needs for a Set of Key LCM Decisions and Supporting Analyses

- Acquisition strategy
  - Assess remaining life of current systems
- Upgrade planning (component or end item)
  - Assess inherent failure rates and profiles
- Renewal planning
  - Assess failure rates, costs, and readiness over time
- Scheduled service updates
  - Assess failure rates and profiles
- Maintenance workforce size and skill needs
  - Calculate workload over time
- Budgeting
  - Calculate system O&M costs
- New system design needs
  - Assess usage, maintenance patterns, design issues for current systems
- System performance with respect to KPPs
  - Assess readiness and operational capability

Promoting reliability and availability

Resource / budget planning

Materiel development

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LC Sustainment Data 6 01/10

Data Needs for Life Cycle Management Decisions

In evaluating Army LCS data, we began by considering LCM decision areas, analyses that support decisions in those categories, and data elements needed for those analyses. Key Army LCM decision areas tend to fall into one or more of three categories: (1) promoting equipment reliability and availability, (2) determining budget/resource needs, and (3) developing materiel. Early in a system's life cycle, critical decision areas that fall in the first two categories include acquisition strategy development, upgrade planning, and renewal planning.[4] An acquisition strategy refers to a framework for planning, directing, contracting, and managing a system to achieve program objectives within the resource constraints imposed (Defense Acquisition University, 2009c). An example of an LCM analysis that may inform acquisition strategy decisions is an assessment of the remaining life of current systems; systems with little remaining life are likely to call for replacement or recapitalization earlier than other systems.

Just as acquisition strategies are needed for new systems, upgrade plans are needed for end item or components remaining in use. Upgrade planning may include decisions about which systems/components need modernization, how many will be upgraded, and the upgrade and fielding schedules. Assessments of failure rates and profiles can inform such plans. As suggested by Dumond, Eden, McIver, and Shulman (1994:28), data collection and analyses of performance and failure patterns in newly fielded as well as mature systems can help detect and isolate design deficiencies that call for engineering changes.

Another decision area that has become particularly prominent during Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) is renewal planning, currently one of the Army's top priorities (GEN Chiarelli, 2009). Here we use the term *renewal* to refer to reset, refurbishment, overhaul, upgrade, and recapitalization processes that restore equipment damaged during combat. (Each of these renewal processes has a different scope of work and level of funding; recap has the most extensive scope, followed by upgrade and

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[4] Because acquisition, upgrade, and renewal efforts may be intended, in part, to increase equipment reliability and availability, and because such decisions affect (and are affected by) budgets, they fall in the categories of promoting reliability/availability and resource/budget planning. Consistent with this categorization, the Defense Acquisition Guidebook (Defense Acquisition University, 2009a) notes that life cycle sustainment planning (to maintain reliability) and resource management are both considerations in the selection of an acquisition strategy.

overhaul, then reset and refurbishment [Boucher, 2007].[5]) Renewal decisions may concern the type of renewal needed for a system, when and where such processes should occur, the portion of the fleet to be renewed, and how much to budget for renewal. Analyses of the impact of age, prior renewal, OPTEMPO, location, and other predictors on failure rates, sustainment costs, and readiness may inform such decisions.

A fourth LCM decision area, which is in the category of promoting reliability and availability, is scheduled service updates—that is, identifying necessary changes in preventive maintenance checks and services (PMCS). The prescribed set of services in the Army's quarterly, semi-annual, and annual PMCS schedules need to be updated as vehicles are modified or used under different conditions. A deployed field maintenance company recently reported that performing annual services twice as often (semi-annually) was more efficient and effective in Iraq than performing the prescribed quarterly and semi-annual services, given the high OPTEMPOs and extreme temperatures (King, 2009). Failure rates and profiles need to be analyzed systematically to assess PMCS effectiveness and determine when such changes are warranted on a large scale. As LaFergola (2010) observed in his article on commercial lift truck fleet management, data on maintenance performed helps "facility managers recognize circumstances in which unexpected maintenance was required that may go beyond the [current scheduled maintenance program]."[6]

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[5] Recap includes rebuild (returning items to "like-new"—zero mile—condition) plus upgrade (enhanced capabilities); overhaul is strictly rebuild (return to like-new condition) without upgrade; and reset returns equipment to its predeployment "10/20 standard" condition (HQDA G-4, DALO-MNN, 2008:26; Boucher, 2007). In theater this return to 10/20 condition is known as refurbishment—more specifically, Theater Provided Equipment Refurbishment.

[6] PMCS revision may be appropriate when analysts find a trend such as the higher rate of M2 Bradley transmission failures that occurred in Iraq. Boyd (2005:21) recalled that M2 Bradley transmission failures frequently occurred in Iraq due to extra weight (about 5,000 pounds of reactive armor) and higher mileage. As he observed, "Failure trends such as this highlight the importance of PMCS and proper scheduled maintenance."

A key LCM decision area in the category of resource/budget planning involves maintenance workforce planning—that is, determining who will maintain equipment (organic versus contract personnel) and how many maintainers are needed. As a recent U.S. Government Accountability Office (GAO) study of depot maintenance planning pointed out, planning for future maintenance requirements calls for "timely and reliable information from their major commands on both the amounts and types of workloads they should expect to receive in future years" (Solis, 2009:4).

Budget preparation is also an integral part of life cycle planning. To support budget requests to Congress and facilitate budget execution (management of awarded funds), annual operations and maintenance (O&M) budget forecasts are needed, as well as estimates of O&M costs during the life of a weapon system. Such analyses may include comparing the costs and benefits of contractor versus organic logistics support (Warren, 2002a). Additionally, to estimate the cost of a new system, analysts "begin with the costs of earlier systems of a similar nature, that is, analogous systems. The 'cleaner' the cost database of the predecessor system(s), the higher [will be] the confidence in cost estimates for the new system" (Garrett and Rendon, 2007:202).

A critical LCM decision area related to materiel development is new system design needs (assessing how well existing systems are functioning under current operating conditions). Repair data for current equipment may reveal design flaws or vulnerabilities that need to be addressed in new system designs.

Another materiel development decision entails determining whether a system under development has sufficient performance with respect to key performance parameters (KPPs) to proceed with fielding. KPPs are attributes or characteristics of a system considered most essential for an effective military capability (Naegle, 2005). When threshold or objective KPPs for a system are not met, the acquisition program for that system may be reevaluated or terminated.

Table 2.1 includes examples of key decisions, and associated LCS data needs, that interviewees in this study mentioned.

Table 2.1
Interviewee Statements: Decisions Requiring LCS Data

Interviewee	Statement
ASA[ALT] manager	"Engines might be the number one cost driver on a particular vehicle, and the manufacturer may not be desiring to continue to produce that engine because it's inefficient or uneconomical to produce, or the technology may be old . . . There's logistics information that supports the argument for investing in upgrades."
TACOM Cost and Systems Analysis manager	"At different stages of the life of a weapon system, there's a decision about whether to continue on or stop spending money. At those stages, you have a decision maker at the OSD level, Department of the Army level, or at the command level at TACOM, depending on the dollar value of the program. The decision maker wants to know 'How much is it going to cost? What capability is it going to provide me?' We use sustainment data in developing these life cycle cost estimates." "We also use sustainment data in providing decision makers with alternative courses of action. These may include looking at alternatives for reducing the cost of sustainment—buying parts for a system . . . The economic analysis looks at the costs associated with either increasing the reliability of a part or reducing the cost of a part and compares the reduction in the actual operating costs."
CECOM ESA manager	"When the contractor is developing a weapon system for us, they'll base estimates on analogy—i.e., 'it was this much for a similar system.' They [use] good engineering estimates, but they are not collected from the field. It would be nice to get data back from the field."

Drawing from documents on commercial and military LCM best practices (such as General Administration of State of Washington, 2006; Office of the Secretary of Defense, Cost Analysis Improvement Group, 2007; Sowerby and Lauria, 2007; Wyrick and Storhaug, 2003), the research team identified a set of prescribed LCS data elements for LCM analyses. The set includes:

- Vehicle demographics—information that uniquely identifies an item or describes its physical attributes, owner, or location.

- Operations data—information readiness and usage of an item.
- Maintenance and disposal data—information about maintenance actions and about the removal of assets from the fleet.

For each of the focal decision areas, our research team considered which data elements contribute to rigorous supporting analyses, including well-specified statistical models.

LCM Decisions Require Data Elements in the Categories of System Demographics, Operations, Maintenance, and Disposal

Data Element		Acquisition strategy: Assess remaining life of current systems	Upgrade planning: Assess failure rates & profiles (end item and component)	Renewal planning: Assess failure rates, costs, & readiness over time	Scheduled service updates: Assess failure rates & profiles
Demographics	Serial Number	X	X	X	X
	Model	X	X	X	X
	Age (Manufacture Date)	X	X	X	X
	Weight/cube/cost	X (cost)	X (cost)		
	Unit				X
	Location	X	X	X	X
Oper-ations	Readiness levels & dates	X	X	X	X
	Usage (miles, hours, rounds fired, fuel consumed) & dates	X	X	X	X
Maintenance/ Disposal	Configuration mgmt.	X	X	X	X
	Maintenance type (sch/ unsch) & echelon (field, sustainment, renewal) & dates	X	X	X	X
	Parts used & cost	X	X	X	X
	Labor hours & cost	X	X	X	X
	Maintenance capacity			X	
	Disposal	X			

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LC Sustainment Data 7 01/10

The table in this slide has data elements listed in rows; decisions and supporting analyses listed in columns; and an X indicating each data element (row) needed for a given analysis (column).

While not preferred, it is certainly possible to do such analyses with fewer data elements than those marked with an X. Indeed, prior studies of Army fleets have often proceeded without serial-level data—i.e., datasets that tie age, usage, location, and other variables to individual vehicle serial numbers; instead, they used data at a higher level of analysis (Chappell et al., 2007; Congressional Budget Office, 2007). However, the use of aggregate data in such studies can obscure patterns that would otherwise be detected with individual-level data. Consistent with this point, in a study of Canadian Air Force (CAF) equipment performance, Chouinard (1997:40) noted that aggregate data in the CAF's Aircraft Maintenance Management Information System (AMMIS) were not ideal for reliability studies:

> It is important to note that equipment failure data collected under the AMMIS do not provide all the necessary details for traditional failure data analysis. In particular, the data collected for any particular type of equipment are aggregated by month across the entire fleet of aircraft on which the equipment is installed. These aggregate data are important for fleet management, but they obscure information about individual failure events which could be used for failure analysis.

Thus, it is important for LCS data elements to enable rigorous study methodologies with appropriate levels of analysis.

As the above table shows, decisions and analyses related to reliability and availability tend to call for most of the demographic, operations, and maintenance/disposal data elements. As mentioned earlier, renewal planning may be informed by an assessment of the impact of age, prior renewal, OPTEMPO, location, and other predictors on failure rates, sustainment costs, and readiness. Such analyses ideally include longitudinal demographic, operations, and maintenance/disposal data at the individual vehicle level. For each serial number, analysts need the corresponding year of manufacture, the equipment model, usage, and renewal dates and types to determine predictor variables in statistical models. For the same serial numbers, analysts need readiness and maintenance records to develop the statistical models. Such data elements and models may reveal which types of renewal tend to yield the most readiness and cost benefits, the systems for which effects are greatest, and the optimal timing of renewal.

LCM Decisions Require Data Elements in the Categories of System Demographics, Operations, Maintenance, and Disposal

		Maintenance workforce size & skill needs: Calculate workload	Budgeting: Calculate system O&M costs	New system design needs: Assess usage, maint patterns for current systems	System performance: Assess readiness & oper capability
Demographics	Serial Number	X	X	X	X
	Model	X	X	X	X
	Age (Manufacture Date)		X		
	Weight/cube/cost		X (cost)	X	
	Unit				X
	Location			X	X
Oper-ations	Readiness levels & dates		X	X	X
	Usage (miles, hours, rounds fired, fuel consumed) & dates		X	X	X
Maintenance/ Disposal	Configuration mgmt.	X	X	X	
	Maintenance type (sch/ unsch) & echelon (field, sustainment, renewal) & dates	X	X	X	
	Parts used & cost		X	X	
	Labor hours & cost	X	X	X	
	Maintenance capacity		X		
	Disposal				

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LC Sustainment Data 8 01/10

Decisions and analyses related to resource/budget planning and materiel development also call for many of the data elements listed. In order to identify critical requirements for new systems, analyses may consider how and where vehicles are currently being used, which systems are having readiness problems and/or incurring high maintenance costs because of such usage, and the subsystems that are particularly susceptible to failure under those conditions. Thus, readiness, usage, location, configuration, and maintenance data on current systems are among the likely inputs to analyses identifying new system design needs.

Also, to justify O&M budget decisions, it may be necessary to develop models that estimate maintenance costs for items based on age, usage, and configuration. Additionally, readiness data may contribute to an assessment of the benefits of maintenance expenditures, further informing O&M budget decisions.

We Identified Criteria for Evaluating LCS Data/Databases and Organized Them into Three Categories

Category	Assessment Criteria
Ease of Access and Use	• Are the data available on a STAMIS? • Is gaining approval for access burdensome? • Is the database well-documented and user-friendly? • Can the data be readily linked to other data?
Quality	• Are the data – accurate? – complete (e.g., portion of fleet covered)? precise (e.g., serial number level)? – up-to-date?
Historical span	• How many years of data are available?

Sources of types & categories: Jagadish et al. (2007)
http://www.eecs.umich.edu/db/usable/usability.pdf
Department of Transportation (2000)
http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPT_MIS/13580.html

RAND LC Sustainment Data 9 01/10

Assessment of Life Cycle Sustainment Data

The previous section described a set of critical LCM decision areas and outlined the data elements needed for analyses in those areas. In this section we present an assessment of the extent to which STAMIS provide those data.

Our evaluation of STAMIS LCS data was based on criteria in three categories: ease of access and use, quality, and historical span of the data. This slide shows the criteria corresponding to each category.

Similar criteria have been used in prior studies evaluating data and data sources. Jagadish and colleagues (2007) noted that the *usability* of a database, "the ability to get information into and out of the system easily and efficiently," is as important as the capability of the database. They suggested that usability includes such factors as the degree to which users have to "stitch information together to answer most of the real queries," whether "a system hinders users from querying the data in the way they want," and the difficulty of locating a particular piece of data.

Others have focused on data quality and access as evaluation criteria. The Intelligent Transportation Society (2000) emphasized that its Advanced Traveler Information Systems need to have high data quality (interpreted as the degree of accuracy, timeliness, breadth/depth of coverage, and detail) as well as sufficient access (availability to others). The organization's guidelines point out that either "good data with limited or no access or inadequate data with sufficient access" can be problematic (ITS, 2000).

Another consideration is the amount of historical data retained. Referring to studies about the relationship between age and human behavior, Singer and Willett (2003:9) noted that

> . . . too many empirical researchers seem willing to leap from cross-sectional data that describe differences among individuals of different ages to making generalizations about change over time.

They explained that the problem with such an approach is that individuals in different age groups belong to different cohorts that experienced different school curricula and life events:

> In statistical terms, cross-sectional studies confound age and cohort effects (and age and history effects) and are prone to selection bias (Singer and Willett, 2003:10).

By the same token, cross-sectional data are not ideal for studying vehicle performance over time. Comparing the performance of a 5-year-old vehicle and a separate 10-year-old vehicle is not equivalent to comparing the performance of a single vehicle at age 5 and age 10. In general, longitudinal data are preferred for assessing vehicle changes over time.

Interviewees and the Research Team Encountered Obstacles to the Access of LCS Data

- Not all data accessible via one portal (i.e., LIW)
- Account request forms (e.g., for LIW and OSMIS) ask which parts of the information system one will need to access
  - a "catch-22": difficult to know without already having an account
- Lengthy waits for approval in some cases and refusals in others despite clearance, CAC card, and need for access
- Even with an approved system account, some applications not accessible without a special approval from other organization
- Need to enter some databases every 30–60 days to retain access

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LC Sustainment Data 10 01/10

General Obstacles to Access and Use of LCS Data

Statements from interviewees and the research team's own experiences with gathering LCS data revealed a set of obstacles to data access. First, it is not always clear to analysts whether certain data exist or where to find them. While many databases are centrally located at the Logistics Information Warehouse, others are not. Army Electronic Product Support (AEPS), Army Workload Performance System (AWPS), Modification Management Information System (MMIS), and Operating and Support Management Information System (OSMIS) are not part of LIW, and each requires a separate application process for a system account.

In addition, access request forms for some systems (AWPS, OSMIS, and LIW) ask the applicant to specify those portions of the information system he/she will need to access.[7] However, it is difficult to know all that is available on an information system—and which portions will be relevant and useful to one's analyses—without having an account and access to all portions of the information system. A description from a manual, if available, is often not sufficient to determine the level of analysis of the data, the locations and equipment covered, and the data fields included in each portion of an information system. The "catch-22" is that, to get an account, one must specify the portions of the information system one will use, but one cannot determine what one will use unless one has an account.

In some cases, analysts are granted access to an information system only to find that some of the modules in that information system are not accessible without further approval processes. In the AWPS website, for instance, separate applications were needed to access the Depot Maintenance Operations Planning System (DMOPS) and Red River Army Depot (RRAD) AWPS, two of multiple databases listed in AWPS. Also, even if one obtains an account in AEPS, one will not automatically have access to the gun card firing data. Instead, the site states, "You do not have Authorized Access granted for this application. To obtain access, please contact one of the Application POCs [people on the 'AMC Gun Card Points of Contact' list]." Similarly, LIW has a link to the SSN-LIN Automated Management and Integrating System (SLAMIS), but one still needs a valid logon account with SLAMIS to use it.

Once access to an information system is granted, it can easily be lost. According to the LOGSA help desk, an LIW account will be frozen if it is not used for 30 days and deleted if it is not used for 90 days. An interviewee in the TACOM Cost and Systems Analysis department noted, "The databases we use have varying password requirements that at times make it difficult to retain

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[7] The System Access Request web page for LIW states that, for the broader "controlled access," "you will be given basic access and provided a list of controlled applications (reports to select from that are available according to your credentials). Your authorizing official will have to approve access to all groupings based on what is needed to do your duties."

access—requirements such as expiration dates [if the account is not used] for 30–60 days. A project may require use of a particular database for a short time; then its use may not be required for another six months. A person should not have to keep entering the database on a monthly basis just to retain membership for when it is needed."

Interviewees and the Research Team Encountered Obstacles to the Use of LCS Data

- **Delays and disruptions—particularly with large data pulls**
  - Lengthy run times
  - Frequent "time outs" (need to log in multiple times)
- **Documentation and user interface challenges**
  - Databases with overlapping functions
  - Missing labels (miles vs. kilometers) in LIDB
  - No detailed OSMIS manual—just high-level slide presentations
  - ILAP work orders still listed as GS-DOL and DS in Shop Operations module, even though maintenance is now field and sustainment
- **Flexibility issues**
  - Cannot select region (e.g., Iraq, Afghanistan) for consolidated property listing from PBUSE
  - Piecemeal data pulls
    - Usage by serial number pulled one month at a time in OSMIS, one year at a time in LIDB
    - In ILAP Shop Operations module, can pull completed work orders for a NIIN, but not for a list of NIINs or an FSC

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LC Sustainment Data 11 01/10

Just as there are obstacles to accessing information systems with LCS data, there are impediments to the use of those data. In LIW and Property Book Unit Supply–Enhanced (PBUSE), the run time for a report can range from minutes to hours, depending on the amount of data requested and the number of people using the system. Said a FORSCOM manager, "LIW, because of the way it operates, is time-consuming. It is lengthy in running the scrubs I want."

In addition, users often need to type on their keyboard or select menu items regularly to ensure that they are not logged off of a system due to inactivity. The AEPS website has a 30-minute timer that counts down when a user is not typing or selecting menu items. If the counter reaches zero, the session times out. As a second FORSCOM manager noted, "There's a time limit where you log on and the clock starts ticking. You can't just minimize it; you can't continue to do your work without requesting additional time. It's minor, but it's a nuisance." Similarly, ILAP times out after a few minutes without activity. Since downloading a large data file from ILAP can easily take 30 minutes or longer, the downloading process will stop—and the link to ILAP will close—unless the user presses a key every few minutes to show activity.

User interface features for some systems can make it difficult to determine which application to use. Some of the applications have overlapping functions, so it is not always clear which application is most appropriate for an analyst's purposes. Within LIW, work orders can be obtained from ILAP or from the SAMS Research–Work Order Detail report; Army asset on-hand quantities can be obtained from multiple LIDB reports (Army Assets, Total Property Book Assets) as well as PBUSE; serial number lists are available from LIDB Ground Equipment Tracker and Army Serial Number Tracker.

Other user interface issues hinder interpretation of LCS data. First, while LIW has detailed online documentation, OSMIS does not; only high-level slide presentations explaining OSMIS can be found at the website. Second, the LIDB Serial Number Usage Report does not indicate whether the odometer readings are in miles or kilometers. Third, the ILAP completed work order reports are called "DS Work Orders" and "GS-DOL Work Orders," labels that correspond to the Army's previous four-level maintenance structure,[8] even though the Army currently has a two-level (field and sustainment) maintenance structure, with field maintenance divided into organizational and support-level work orders. Because the work order report titles do not correspond to the Army's current maintenance structure, it may not be readily apparent to ILAP users what portion of all maintenance actions the reports are capturing.

Information system flexibility issues were also reported. In the PBUSE Consolidated Property Listing (which provides a listing of all assets required, authorized, on hand, and due in), one can limit the data pull to a specific Unit

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[8] The four-level maintenance structure included organization-level, direct support (DS), general support (GS), and depot. The Directorate of Logistics (DOL) has traditionally been a provider of maintenance above the DS level (McCurry, 1995). The transition from four-level to two-level maintenance is discussed in more detail later in this report.

Identifier Code (UIC) or a range of Line Item Numbers (LINs), but one cannot restrict the output to a geographic region, command, or division. While one report is running, a second one cannot be requested. If the user requests a large report by mistake, the request cannot be cancelled, and it may not be possible to submit another request for hours.

In other information systems, some data can only be obtained in a piecemeal fashion. In OSMIS, the Monthly Management Report (MMR) provides monthly usage and odometer readings from Unit Level Logistics System–Ground (ULLS-G) by serial number, but users can only request one month at a time when running the report. Users can request up to 12 months of data when running the LIW/LIDB Serial Number Usage Report. If users need 5 to 10 years of odometer readings for a longitudinal analysis, the report needs to be run 5 to 10 times. In the ILAP Maintenance (Shop Operations) module, one can request closed DS and GS-DOL work orders for a given National Item Identification Number (NIIN) but not for a list of NIINs. If one is familiar with the SQL programming language, it is possible to use the Dynamic Query module to request closed DS work orders—but not GS-DOL work orders—for a specific list of NIINs.

In summary, there are noteworthy impediments to the access and use of STAMIS LCS data. Data are located in multiple information systems with separate application processes, and such application processes can be lengthy, with legitimate applicants sometimes receiving partial access or being refused access. When granted access, database users tend to encounter delays and disruptions when running reports, ambiguous user interfaces and documentation, and database flexibility issues.

Demographic Data Tend to Be Poor-to-Medium Quality

Data Element	Data Source	Ease of Use/ Access*	Quality	History
Serial Number	ILAP LIDB PBUSE	H H M	L L L	—
NSN, LIN, NSLIN	LIDB PBUSE	H (M for NSLIN) M	M-H (L for NSLIN)	—
Age (Year of Manufacture)	LIDB/ TAMMS	H	L-M	—
Weight/Cube/Cost	FEDLOG	H	L /L / H	L
Unit	LIDB PBUSE	H M	M M	M L
Location	LIDB PBUSE	H L	M M	M L

*Rating based on access/use *for analysis purposes*

H = High M = Medium L = Low — NA

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LC Sustainment Data 12 01/10

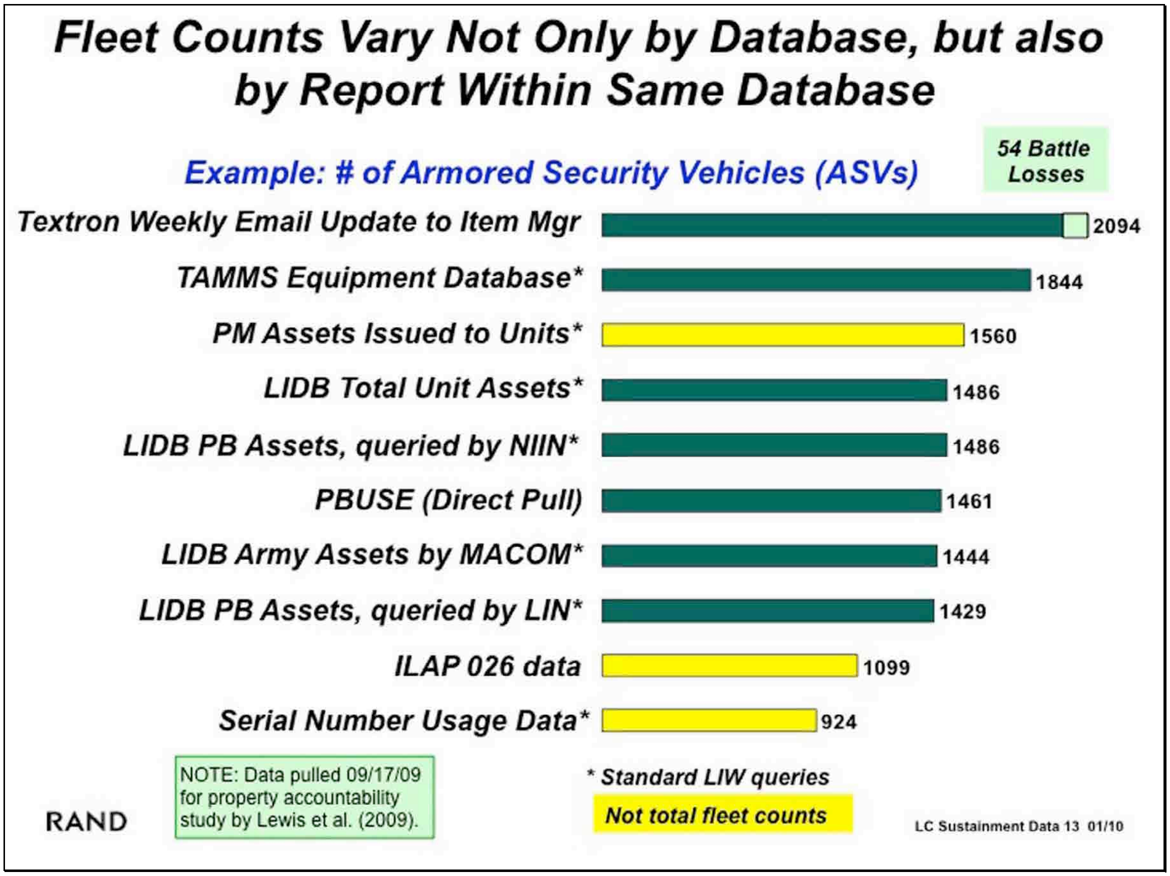
Assessment of Demographic Data on Army Equipment

The preceding section discussed general limitations to the access and use of LCS data in Army information systems. In this section we present findings from an assessment of the access/use, quality, and historical span of demographic LCS data elements.

In the above table, the first column contains the demographic data element that was rated; the second column contains sources of each element; and the third, fourth, and fifth columns contain the research team's ratings corresponding to each element and data source.[9]

[9] Appendix D contains a table that explains the basis for each medium (M) and low (L) rating.

As indicated by the ratings, most demographic data on Army equipment are reasonably accessible after one has an account in LIW, and except in the case of theater-provided equipment, LIDB provides historical unit and location data for more than a decade. However, demographic data—especially serial numbers, manufacture dates, and weight/volume (cube) measurements, tend to be low quality. Subsequent slides illustrate quality issues that correspond to some of the L ratings in the table.



Fleet Counts and Serial Numbers

A recent study of Army property accountability (Lewis et al., 2009) found that different Army information systems—and different reports within the same information system—yielded different on-hand counts for the same type of vehicle, even though the data were gathered on the same day. On September 17, 2009, the PBUSE Consolidated Property Listing showed that there were 1,460 Armored Security Vehicles (ASVs), while LIDB Property Book Assets showed that there were 1,486. The TAMMS Equipment Database, which (like LIDB Property Book Assets) is accessed via LIW, indicated that there were 1,844 ASVs. All these counts were hundreds of vehicles short of the ASV delivered fleet size of 2,094 reported by Textron, the manufacturer. Equipment on-hand counts in STAMIS are a reflection of the serial numbers provided by units. Serial numbers that are either not reported or not reported accurately contribute to inconsistent fleet counts.

A Variety of Serial Number Errors Are Common in STAMIS, Particularly Maintenance Systems

Error Description	Example	Source
User-created serial number	"SEE LIST" "N/A" "HOME STATION"	ILAP work order for M1A1
Registration number listed instead of serial number	NPOPD2 NPOPCU	ILAP work order for PLS M1075
Registration + full or partial serial number	3ADR3309R/MV033 MV046Y-3277R	ILAP work order for M3A2 ODS
Dashes or other symbols	34949–6608732 31/Q2113 3ADR3258R*2WO'S	PBUSE data on Fork Lift Trk (T48944) PBUSE data on M931A2 Trk TRAC ILAP data on M3A2 CFV
Shortened serial numbers	1FUJATCG14PM10159 1FUJATCG24PM10168 PM10161 PM10162	LIDB serial number usage report for M915A3 *172 serial numbers beginning with 1FUJATCG24 disappear from the reports in Aug 2007 but have recent manufacture dates & usage up to that point. A data cleanup error?

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LC Sustainment Data 14 01/10

Serial number errors include entering an alternative to the serial number such as "N/A" or the equipment registration number; combining the registration number and serial number; inserting dashes or other characters in the serial number; and shortening the serial number. These types of errors are found in extracts from LIDB and PBUSE but are especially common in maintenance data.

Serial Number Discrepancies Make It Difficult to Link Different Types of Data Corresponding to the Same Vehicle

Example of Serial Number Cleanup Needed for FLU 419 (LIN T34437):

We initially found 6,679 distinct serial numbers associated with LIN T34437 in PBUSE, RIDB, TEDB, Usage, and MMIS databases. After a preliminary "cleanup," there were 2,082 distinct serial numbers.

Below: Although identical 6-digit sequences appear within the serial numbers from each database, none of the original serial numbers can be matched without cleaning.

"Clean" Serial	Usage Serial	MMIS Serial	RIDB* Serial	PBUSE Serial	TEDB Serial
450072	HM450072	OHM450072	1FG9999HM450072	1FG999990HM450072	90HM450072
450148	97HM450148	7HM450148	HM450148	450148	1FG999997HM450148
450423	93HM450423	1FG993HM450423	450423	HM450423	1FG999993HM450423
451469	AM451469	KM451469	451469	IFG999990KM451469	90KM451469

****Some of the discrepancies are due to different databases having different serial number length restrictions: e.g., maintenance database cuts off length at 15 digits.***

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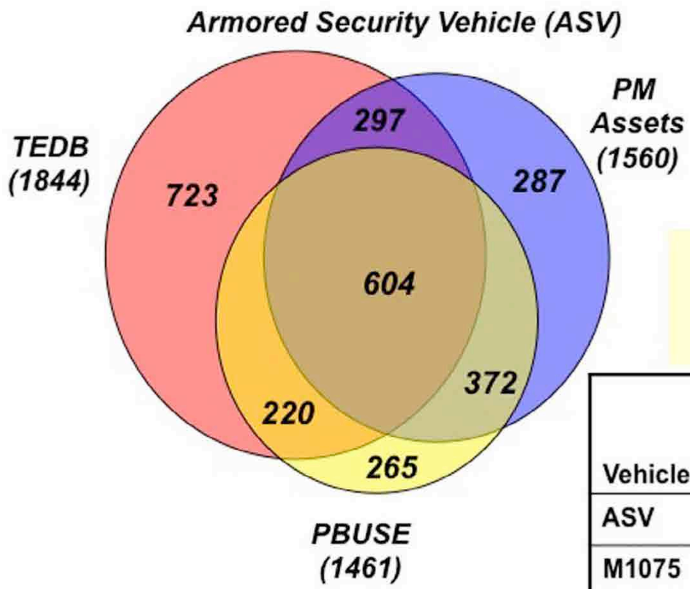
LC Sustainment Data 15 01/10

Because of such errors, different databases often have different versions of the same serial number. This slide shows four examples of serial numbers that have different forms in the LIDB Serial Number Usage Reports, MMIS, Readiness Integrated Database (RIDB), PBUSE, and TAMMS Equipment Database (TEDB). Some analyses call for linking manufacture dates, odometer readings, work orders, and other data by serial number; however, serial number discrepancies can hinder this process. However, automated linking cannot be done by analysts around the Army as analytic needs develop. Analysts typically need to "clean" the serial number data before linking serial-level data from different sources.

In this example, the total number of distinct FLU419 (LIN T34437 – Small Emplacement Excavator) serial numbers found in different sources appeared to be 6,679 before the serial numbers were cleaned. After cleanup, there was substantially greater overlap in the serial number lists from different sources; the number of distinct serial numbers went down to 2,082.

Serial Numbers Listings Vary Substantially Across Databases



M1075 & M931 have similar patterns, with <25% of serial numbers appearing in all 3 databases

Vehicle	# serial numbers in all 3 databases	# serial numbers in 2 databases	# serial numbers in 1 database
ASV	604	889	1,275
M1075	1,219	1,808	4,263
M931	2,106	3,521	6,177

RAND NOTE: Data pulled 09/17/09 for property accountability study by Lewis et al. (2009)

LC Sustainment Data 16 01/10

This Venn diagram, also from Lewis et al. (2009), further illustrates the impact of serial number discrepancies across data sources. Of the total set of ASV serial numbers listed in TEDB (N=1,844), the LIDB PM Assets database (N=1,560), and PBUSE (N=1,461) in September 2009, less than 25 percent (N=604 vehicles) appeared in all three databases.

The table to the right of the Venn diagram shows that the overlap in serial number lists from different databases was not only low for the ASV, but also for the PLS (palletized load system) M1075 and M931 truck. For the M1075, 4,263 serial numbers appeared in only one of the three databases (i.e., TEDB only, PBUSE only, or LIDB PM Assets only); 1,808 appeared in only two of the three databases (i.e., TEDB and PBUSE, TEDB and PM Assets, or PBUSE and PM Assets); 1,219 serial numbers (only 17 percent of the total number) appeared in all three databases.

Only Serial Numbers Appearing in TEDB Have Year-of-Manufacture (YOM) Data, and Many of the Dates are Questionable

- Serial numbers not in TEDB lack YOM data (e.g., 44% of ASV serial numbers and 56% of PLS M1075 serial numbers in PBUSE not in TEDB)
- Most serial numbers that are in TEDB have manufacture dates, but many dates do not correspond to the serial number sequence or variant

Examples:

M1A2 Abrams Tank

SERIAL NO.	REG NO.	YR MFG
LA27225M	JZ07NL	2006
LA27227M	JZ07RG	1995
LA27230M	JZ07RU	1969
LA27231M	JZ07RW	1969
LA27240M	JZ07NM	2007
LA27246M	JZ07NZ	2006
LA27247M	JZ07NW	2006
LA27252M	JZ07P1	2006
LA27255M	JZ07QR	2006
LA27256M	JZ07NT	2006
LA27257M	JZ07NN	2006
LA27258M	JZ07P3	2006
LA27259M	JZ07NK	2006
LA28202M	JZ07M2	1995
LA28204M	JZ07LY	1995
LA28205M	JZ07NH	2006

M2A2 ODS

NIIN	SERIAL NO.	REG NO.	YR MFG
014059886	2ADR3793R	MV06DP	1995
014059886	2ADR3793R	MV06DP	1995
014059886	2ADR3795R	MV06E0	1987
014059886	2ADR3798R	MV06EP	1987
014059886	2ADR3798R	MV06EP	1987
014059886	2ADR3799R	MV06EN	1987
014059886	2ADR3799R	MV06EN	1987
014059886	2ADR3800R	MV06DU	1987
014059886	2ADR3801R	MV06DT	1987
014059886	2ADR3802R	MV06F4	1987
014059886	2ADR3803R	MV06F3	1987

Dates precede Operation Desert Storm

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Dates do not correspond to serial number sequence

LC Sustainment Data 17 01/10

Because TEDB is the only standard Army database containing equipment manufacture dates by serial number, analysts generally lack age data for serial numbers that do not appear in TEDB. Of the 1,461 ASV serial numbers that appear in PBUSE, 824 are in TEDB; this means that at least 637 (or 44 percent) of those serial numbers lack age data in a central source.

About 96 percent of the serial numbers that *do* appear in TEDB have manufacture dates listed,[10] but the accuracy of those dates tends to be low. Despite serial numbers typically generated in manufacturing sequence order, many manufacture dates do not correspond to the serial number sequence;

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[10] This 96 percent figure is based on data pulled from ILAP table TEDB_SN_DETAILS for FSC 2350 (tracked combat, assault, and tactical vehicles) on March 30, 2010.

serial numbers that are very close in sequence (L27227M and L27230M) can have very different manufacture dates listed (1995 vs. 1969). Moreover, some manufacture dates listed for a variant are well before the date that the variant was first released—M2A2 ODS (Operation Desert Storm) vehicles with manufacture dates preceding Operation Desert Storm.

For Recapitalized Vehicles, Year of Manufacture (YOM) Sometimes Reflects the Recap Date and Sometimes Reflects Original Manufacture Date

HEMTT LHS Vehicles that have been through the Recapitalization, Repair, and Return program (designated by model ending in R1)

MODEL	SN	REGNO	OWNING UIC	YR MFG
M1120A2R1	2K1J20E1022490	NP1WQ5	WARLA0	1983
M1120A2R1	2K1J20F1025861	NP1UR9	WACKA0	2002
M1120A2R1	2K1J20G1020001	NP1UA1	WAYHAA	2002
M1120A2R1	2K1J22S1051193	NP1WQ3	WARLA0	1983
M1120A2R1	2K1J23G1028657	NP1WQ7	WARLG0	2007
M1120A2R1	2K1J23M1042103	NP1URB	WACKFL	2002
M1120A2R1	2K1J24D1020515	NP1UA3	WAYHAA	2002
M1120A2R1	2K1J25G1027736	NP1WQ2	WARLA0	1983
M1120A2R1	2K1J25J1033494	NP1WQG	WARLA0	1983
M1120A2R1	2K1J25J1035990	NP1WQU	WG81AA	1988
M1120A2R1	2K1J26H1031599	NP1WQC	WARLA0	1983
M1120A2R1	2K1J26K1036521	NP1WQE	WARLA0	1983
M1120A2R1	2K1J27K1039640	NP1WQD	WARLA0	1983
M1120A2R1	2K1J2XD1021197	NP1WQ4	WARLA0	1983
M1120A2R1	2K1J2XJ1033037	NP1WQ6	WARLA0	1983
M1120A2R1	33011	NP1WBG	WCBGA0	2002
M1120A2R1	333044	NP1WBK	WCBGA0	2002
M1120A2R1	333060	NP1WBH	WCBGA0	2002
M1120A2R1	34023	NP1WPA	WJMST0	2002
M1120A2R1	34103	NP0EPE	W2MKZB	1995
M1120A2R1	34331	NP0ERZ	W2MKZB	1995
M1120A2R1	34419	NP1WBJ	WCBGA0	2002
M1120A2R1	34904	NP0ET6	W2MKZB	1995

In OEM data provided by PM HTV, recap dates for M1120 range from 2000 to 2009.

Year of manufacture listed in TEDB is in the 2002–2007 time frame for some of the recapitalized M1120 vehicles and in the 1980s and 1990s for others.

Also, some dates do not correspond to original manufacture date or recap date.

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TEDB data as of 22 Jan 2010

LC Sustainment Data 18 01/10

When vehicles have been recapitalized, TEDB sometimes lists the recapitalization (recap) date instead of the original year of manufacture. The HEMTT LHS[11] vehicles shown above were all recapitalized over the past decade; TEDB lists the recap date for some and the original manufacture date for others. This inconsistent treatment of "YR MFG" makes it difficult to use the data to analyze the effects of age on equipment.

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[11] Heavy Expanded Mobility Tactical Truck Load Handling System.

A Nonstandard Line Item Number (NSLIN) May Not Be Precise Enough to Distinguish High- and Low-Priced Items in the SLAMIS Catalog

- If the MCN or NSN for a nonstandard item is not listed in a property book or other data source, the NSLIN will not be sufficient to determine a ballpark price

NSLIN	NSLIN Nomenclature	Model	Unit Price
FA207Q	MOTOROLA 2 WAY RADIO	MTX 800	$ 500
FA207Q	MOTOROLA 2 WAY RADIO	L04QKH9PW9AN	$ 6,500
FA207Q	MOTOROLA 2 WAY RADIO	COMMAND PLUS L1680A	$ 19,673

NSLIN	NSLIN Nomenclature	Model	Unit Price
RB7509	FIRING DEVICE	MRFD-3R GENERAL DYNAM	$ 6,800
RB7509	FIRING DEVICE	ED FIRESET SYSTEM SPECTRA PHYSICS LASER	$ 65,000

NSLIN	NSLIN Nomenclature	Model	Unit Price
YF2088	TRUCK TRACTOR	CHEVROLET 5700SFI	$ 9,079
YF2088	TRUCK TRACTOR	GU813 MACK	$250,000

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LC Sustainment Data 19 01/10

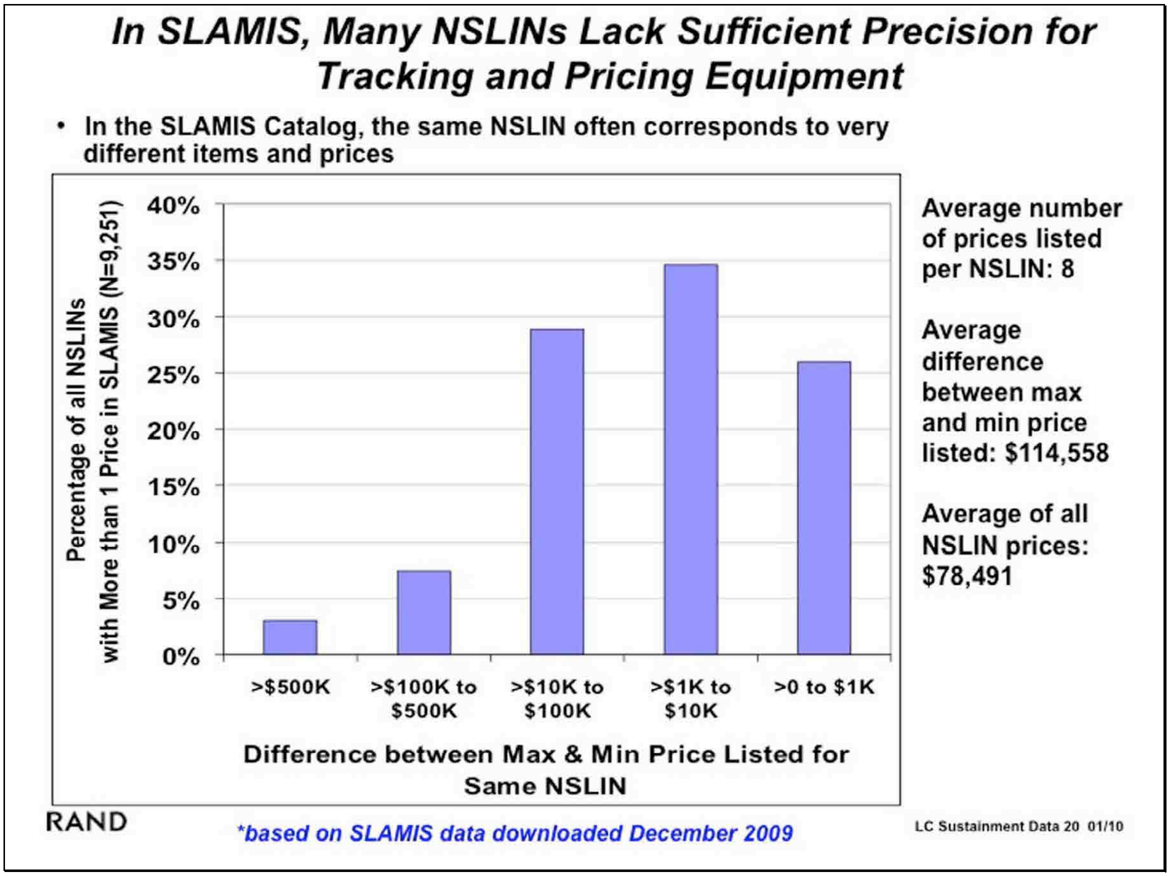
Nonstandard Line Item Numbers

Another demographic data element with a data quality issue is the Nonstandard Line Item Number (NSLIN). Traditionally, items in the federal supply system have been assigned a national stock number (NSN) and a line item number (LIN) for cataloging, requisitioning, and accountability. In some cases, however, the Army procures and uses items that do not yet have LINs, such as commercial off-the-shelf (COTS) equipment or items that are fielded before item managers type-classify them and enter them into the standard catalog (Dickson, 2006). Such items are assigned NSLINs instead of standard LINs, and they may have management control numbers (MCNs) instead of NSNs. While a standard LIN typically corresponds to a small set of similar items, an NSLIN can correspond to a wide variety of items, and this can present property accountability and equipment valuation problems. A

FORSCOM manager described several challenges related to NSLINs and SLAMIS as follows:

> [SLAMIS] was designed to allow us to identify and track all these NSLINs, but the problem is that you and I can go in and request LIN assignments for particular equipment. You might get a LIN assignment, and I might get [a different] LIN assignment for the same item. The database might treat it as 2 separate items. You can call [the equipment] ABC, and I can call it ABC1/2. The system may not realize it's the same item. [As a result], the same system can have many different NSLINs.
>
> Also, you will see a ton of equipment classified under the same NSLIN. If I have LIN FA2008, and if I go without knowing the stock number, I can't tell you what's out there. I need the stock number [NSN] or MCN. It's not clear why there are so many different items under the same NSLIN—but all having different NSNs. Those are some of the nuances that make it challenging.

The above slide contains examples of items with very different prices falling under the same NSLIN. If one wants to determine the fair market value of an item so as to determine the value of a loss (as prescribed by AR 735-5 (HQDA, 2005a), the NSLIN often will not be sufficient (Dickson, 2006).



The cases on the previous slide are not isolated examples; the above chart suggests that many NSLINs in SLAMIS correspond to items with very different prices. The average NSLIN price was $78,491 as of December 2009, and the average difference between the maximum and minimum price corresponding to the same NSLIN was $114,558. That is, the average range of prices corresponding to an NSLIN exceeds the average price of an NSLIN.

For the 9,251 NSLINs (out of 16,206) with at least 2 distinct prices, this bar chart shows the percentage of NSLINs that had narrow versus wide differences between their maximum and minimum prices. Together, the 3 bars on the left indicate that about 40 percent of the NSLINs had wide differences (ranging from $10,000 to more than $500,000).

Types and Quality of Usage Data in STAMIS Are Limited

Data Element (by serial no.)		Data Source	Ease of Use/ Access	Quality	History
	Readiness	RIDB	H	M	H
Usage	Mileage	LIDB OSMIS	H M	L L	H M
Usage	Operating Hours	—	None	—	—
Usage	Fuel Consumption	OSMIS	H	L	—
Usage	Rounds Fired	AEPS	L	L	?

H = High M = Medium L = Low — NA

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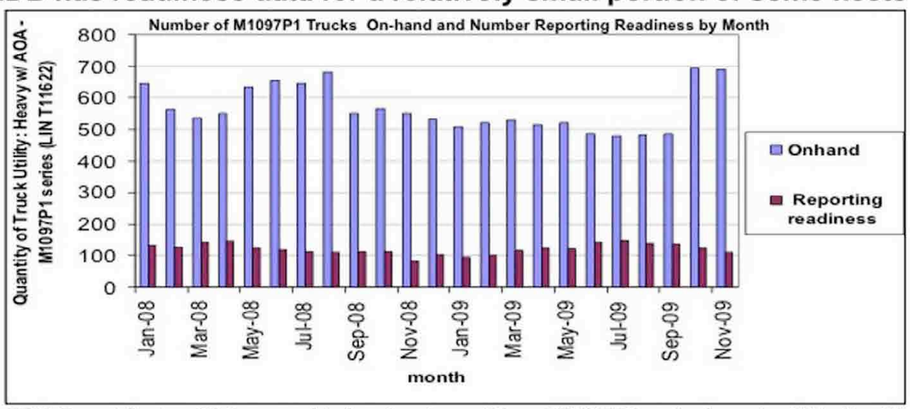
LC Sustainment Data 21 01/10

Assessment of Data on the Operation of Army Equipment

Like equipment demographic data in STAMIS, operations data have considerable limitations. In particular, data on rounds fired have access challenges, and data on miles driven have substantial quality issues. Ground systems' operating hours (including idling time) are not captured. Appendix D lists the bases for the M and L ratings in the above table, and subsequent slides in this section illustrate key readiness and usage quality issues.

Missing Data Reduce the Quality of Readiness Reports

- **RIDB feedback reporting statistics for 2009 show, on average, monthly readiness reports were submitted by 69% of FORSCOM units required to report (749 out of 1089 units),** with standard deviation of 2%
- **RIDB has 2008—but not 2009—data (as of Feb 2010) for some systems listed in MMDF "B Tables" of Readiness Reportable Items—e.g.,**
  - **M915 series truck tractors (LIN T61103)**
  - **130G Grader (LIN G74783)**
  - **Deuce Tractor (LIN T76541)**
- **RIDB has readiness data for a relatively small portion of some fleets**



AE2S Expert System History provided on-hand quantities of M1097P1 series from Jan 08 to Nov 09

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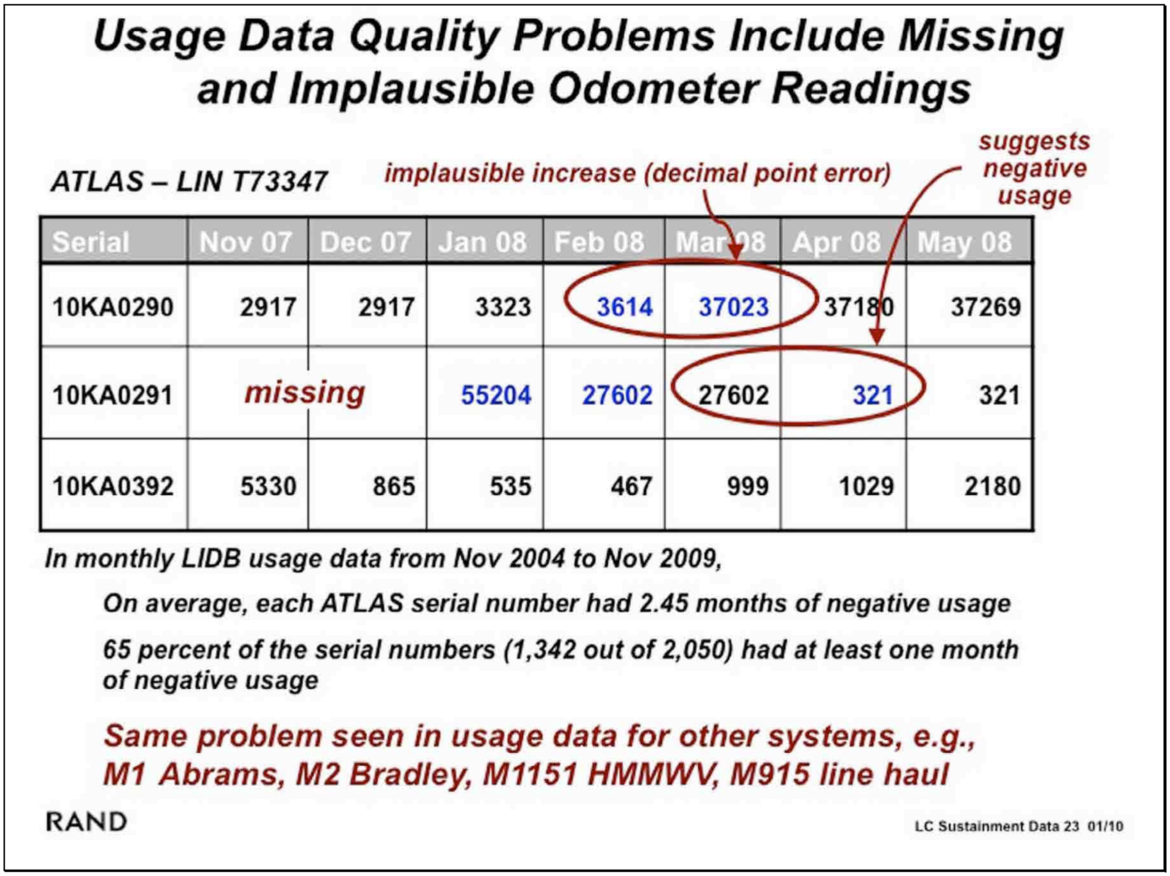
LC Sustainment Data 22 01/10

Readiness Data

Equipment readiness (percent fully mission capable) data are available in the LIW Readiness Integrated Database (RIDB). However, missing data tend to be a problem. Based on a RIDB Feedback Reporting Statistics report for 2009, about a third of FORSCOM units that are required to report readiness are not doing so. Those units that do report readiness do not necessarily report it for all of their vehicles. Consequently, readiness data only correspond to a small percentage of some fleets. A TACOM ILSC manager noted, "My [monthly] report says that there are 34,995 M2 machine guns in active use, and the readiness report [says] 9,995 in active use. So the readiness report is only picking up one-third of what's out there—again, it's because units aren't reporting." Consistent with his point, the bar chart here shows that RIDB had readiness data for about one-fifth of the HMMWV M1097P1 fleet during 2009.



Equipment Usage Data

Both missing and implausible odometer readings are prevalent in LIDB usage data. The Serial Number Usage Report provides monthly odometer readings by serial number from as early as 1996 (for those systems existing at that time) until the present. However, some odometer readings falsely indicate that vehicles have negative monthly usage (i.e., reading for month *n+1* less than reading for month *n*) or unreasonably high monthly usage. Additionally, missing odometer readings are common.

A Unit May Not Report Vehicle Usage (Odometer Readings) for Many Months

UNIT NO./NAME	UIC	FSC	NIIN	SERIAL NO	REG NO.	YR MF	8-Nov	8-Dec	9-Jan	9-Feb	9-Mar	9-Apr	9-May	9-Jun
0002 - IN BN A CO	WJTJA0	2350	14059886	2ADR0006	MV06FB	1995								
0002 - IN BN A CO	WJTJA0	2350	14059886	2ADR0163	MV06KY	1996				1697	2579	3055	3892	
0002 - IN BN A CO	WJTJA0	2350	14059886	2ADR0201	MV06M2	1996								
0002 - IN BN A CO	WJTJA0	2350	14059886	2ADR3591	MV02EC	1987				1045	1045	2127	2944	
0002 - IN BN A CO	WJTJA0	2350	14059886	2ADR3788	MV06EX	2009								
0002 - IN BN A CO	WJTJA0	2350	14059886	2ADR3989	MV0ZWG	1994								
0002 - IN BN A CO	WJTJA0	2350	14059886	2ADR4007	MV04DJ									
0002 - IN BN A CO	WJTJA0	2350	14059886	2ADR4021	MV01BJ	2009								
0002 - IN BN A CO	WJTJA0	2350	14059886	2ADR4022	MV02VE									
0002 - IN BN A CO	WJTJA0	2350	14059886	2ADR4030	MV01C4									
0002 - IN BN 2ND A CO LBE	WJTJAL	2350	14059886	2ADR0163	MV06KY	1996		1222						
0002 - IN BN 2ND A CO LBE	WJTJAL	2350	14059886	2ADR3163	MV02R8	1987		8865	8865	8865	8865	8865	8865	8865
0002 - IN BN 2ND A CO LBE	WJTJAL	2350	14059886	2ADR3591	MV02EC	1987		522						
0002 - IN BN 2ND A CO LBE	WJTJAL	2350	14059886	2ADR3646	MV02W1	1987		268	268	268	268			396
0002 - IN BN 2ND IN B CO LBE	WJTJBL	2350	12487619	2ADR3109	MV020V	1986		319						
0002 - IN BN 2ND IN B CO LBE	WJTJBL	2350	12487619	2ADR3354	MV02RU	1987		593	593	593	593	593	593	593
0002 - IN BN 2ND IN B CO LBE	WJTJBL	2350	14059886	2ADR3812	MV06EB	1987								
0002 - IN BN C CO	WJTJC0	2350	14059886	2ADR0101	MV06J4	1996			745	745	750			750
0002 - IN BN C CO	WJTJC0	2350	14059886	2ADR3110	MV0204	1986			86	224	364			585

Excerpt from LIDB Serial Number Usage Report for M2A2 ODS

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LC Sustainment Data 24 01/10

Particularly when they are deployed, units often do not report odometer readings for many months. In this example the deployed equipment items in an infantry company (UIC "WJTJA0") have almost no M2A2 ODS odometer readings between November 2008 and June 2009. Left-behind equipment (LBE) items in the rear detachment (with UIC "WJTJAL") have more readings, although there are still gaps.[12]

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[12] The monthly odometer readings for the rear detachment in this example generally do not change from month to month. One reason may be that the left-behind equipment for that unit was not used.

Implausible Usage Data Include Identical Monthly Odometer Readings for Multiple Vehicles in Different Units

UIC	FSC	NIIN	SERIAL N(	REG NO.	YR MFG	6-Nov	6-Dec	7-Jan	7-Feb	7-Mar	7-Apr
WAJVB0	2350	12487619	2AD20450	MV03WV	1990	18302	7396	7396	7473	41340	7476
WA4FA0	2350	12487619	2AD20475	MV03XL	1991	18302	6338	6353	6354	41340	6440
WAJVT0	2350	12487619	2AD20712	MV044K	1990	18302	4249	4489	4362	41340	4374
WA4FT0	2350	12487619	2AD20968	MV04K8	1990	18302	9450	9474	9490	41340	9490
WAJVT0	2350	12487619	2AD21090	MV04NU	1991	18302	8632	8633	8633	41340	8633
WA4FA0	2350	12487619	2AD21130	MV04Q0	1991	18302	7292	7294	7295	41340	7922
WAJVB0	2350	12487619	2AD21174	MV04RA	1991	18302	4896	4896	4896	41340	4943
WAJVA0	2350	12487619	2AD21264	MV04V5	1991	18302	5656	5656	5705	41340	5768
WA4FE0	2350	12487619	2AD21265	MV04V6	1991	18302	1143	4489	1246	41340	1246
WAJVA0	2350	12487619	2AD21272	MV04VD	1991	18302	3961	4489	4012	41340	4043
WAJVB0	2350	12487619	2AD21274	MV04VF	1991	18302	3532	4489	3609	41340	3634
WJL4T0	2350	12487619	2AD21275	MV04VG	1991	18302	612	4489	626	41340	626
WA4FA0	2350	12487619	2AD21276	MV04VH	1991	18302	9380	9385	9385	41340	9646
WA4FT0	2350	12487619	2AD21277	MV04VJ	1991	18302	8512	8512	8527	41340	8568
WA4FA0	2350	12487619	2AD21278	MV04VK	1991	18302	4399	4489	4411	41340	4560
WA4FA0	2350	12487619	2AD21279	MV04VL	1991	18302	7940	7944	7944	41340	8069
WAJVE0	2350	12487619	2AD21283	MV04VQ	1991	18302	2575	4489	2635	41340	2637
WA4FE0	2350	12487619	2AD21284	MV04VR	1991	89702	89702	89702	89702	89702	89703
WAJVB0	2350	12487619	2AD21285	MV04VS	1991	18302	8969	8969	9018	41340	9183
WAJVA0	2350	12487619	2AD21286	MV04VT	1991	18302	1022	4489	1140	41340	1184
WAH8AA	2350	12487619	2AD21287	MV04VU	1991	18302	4489	4489	772	41340	774
WAJVA0	2350	12487619	2AD21290	MV04VX	1991	18302	6893	6934	6957	41340	6974
WA4FE0	2350	12487619	2AD21293	MV04W0	1991	18302	1104	4489	1327	41340	1327

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LC Sustainment Data 25 01/10

In Serial Number Usage reports through 2007, one finds intermittent columns of identical odometer readings—i.e., cases of multiple vehicles in different units having the same odometer reading. This pattern could reflect an error in the LIW programs that process the odometer data. The research team did not find this pattern in the post-2007 data. However, analysts using historical odometer readings are still likely to encounter data with this quality problem.

Information about another type of usage, fuel consumption, can be found in OSMIS, but this is reportedly a rough estimate. A TACOM Cost and Systems Analysis interviewee stated that OSMIS fuel consumption figures are “not truly representative of actual usage.” He remarked that “This is something people here [at TACOM] have struggled with over the years: We don’t know how much we are using [or] where.”

When our research team sent OSMIS help staff (at Calibre) questions about the fuel consumption calculation, the staff responded that fuel consumption per vehicle type is “based on fuel consumption rate [multiplied by] miles driven” by such vehicles. They also stated that the fuel consumption rate for a given system is based on “information from program managers, manufacturers, actual data collection at the unit level, Army publications, etc.” The fuel consumption rates (gallons per mile) are not easy to find (found in OSMIS Excel downloads); are not updated regularly (April 2009 report was available as of March 2010); and are by system (LIN or MDS), rather than by serial number. There is no information about the extent to which the rates are based on actual consumption versus manufacturer estimates or how consumption varies by terrain or location.[13]

[13] There is a separate fuel report that can be accessed in the “Weapon System Data” module of OSMIS. That report provides fuel cost per mile for a given type of vehicle, and OSMIS support staff indicated that it is derived by dividing vehicle activity (miles driven) by fuel consumption (gallons per mile), multiplying the result by fuel cost, and adding a 0.02 percent surcharge to account for other fluids used by vehicles. This additional fuel report does not include fuel consumption (gallons per mile), although the figure can be derived from the information present. Like the fuel consumption spreadsheet, the fuel report data are by vehicle type (LIN or MDS), rather than by serial number, and there is no information about the extent to which the cost per mile figures are derived from actual consumption versus manufacturer estimates. As of March 2010, the fuel report provided figures from FY95 through FY08.

STAMIS Lack Key Renewal and Disposal Data by Serial Number

Data Element (by serial no.)		Data Source	Ease of Use/ Access	Quality	History
Field-Level Maint	Repair time & dates	ILAP	M	L	M
	Cost: parts and labor	ILAP	M	L	M
Sustainment-level Maintenance	GS repair time & dates	ILAP	M	M	M
	GS cost: parts & labor	ILAP	M	M	M
	Renewal time, dates, cost (parts & labor)	AWPS & SDS	M	L	M
	Configuration Mgmt.	MMIS	H	M	H
Disposal	Costs	None	—	—	—
	Est. Cost to Replace	FEDLOG	H	M	—
	Salvage Value	None	—	—	—
	Validated Losses	AEL Tracker	H	L	L

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LC Sustainment Data 26 01/10

Assessment of Data on Maintenance and Disposal of Army Equipment

Our review of equipment maintenance and disposal data in Army STAMIS suggests that maintenance data are moderately accessible; are low-to-medium quality; and have moderate historical span. There is little financial information about disposal of Army equipment. Disposal data that are available tend to be easy to access but have low quality and historical span.

Appendix D lists the basis for each M and L rating, and subsequent slides in this section illustrate key maintenance and disposal data quality issues.

Most Field Maintenance Data Not Yet Captured by STAMIS

- **Interviews with maintenance personnel at Fort Campbell indicate work orders are seldom opened for scheduled field-level maintenance**
- **Interview with ILAP subject matter expert at Calibre indicates**
  - **SAMS-E use has not yet switched to two-level maintenance**
  - **Organizational maintenance data capture only includes deadlining repairs**
    - **EDA contains deadlining organizational repairs**
    - **Some deadlining organizational repairs (those evacuated to a shop) appear in DS and GS-DOL work orders**
  - **Key obstacle to capturing all scheduled and unscheduled maintenance: SAMS-E box needs to allow multiple work orders to be open for same piece of equipment at the same time**

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LC Sustainment Data 27 01/10

Transitioning from Four-Level to Two-Level Maintenance

As mentioned earlier, the Army maintenance system has been changing from a four-level to a two-level structure. As described by General Stevenson (2002:6), the four-level structure consisted of

- unit/organizational level maintenance (in which equipment was repaired and returned to the user);
- direct support (DS) maintenance (mostly repair and return to the user, but some repair and return to supply);
- general support (GS) maintenance (mostly repair and return to supply; some repair and return to user); and
- depot maintenance (repair and return to supply).

The two-level structure, which was initiated to reduce logistics footprint and increase efficiency, consists of field maintenance ("on-system maintenance" that combines organizational and DS repairs) and sustainment maintenance ("off-system maintenance" that combines GS and depot maintenance) (Stevenson, 2002:6). Field maintenance includes organizational and support-level work orders.

As noted earlier, an ILAP subject matter expert indicated that SAMS-E use has not yet transitioned from four-level to two-level maintenance. Additional information about the transition status appears in a PM LIS briefing (2009:9):

> Today SAMS-E provides limited support to a full integration to Two-Level Maintenance because of the way it is programmed; however, these limits are set and perpetuated by a current mix of legacy and SAMS-E systems in the field, thus generating a requirement to continue to report the equipment readiness to LIW in the traditional way and format. Units are still expected to report Direct Support and Organizational data separately while the Army is directed to operate and practice only Field and Sustainment Maintenance.

Thus, given that there is currently a two-level maintenance system but four-level maintenance reporting and data capture, we refer to field/sustainment as well as organizational, DS, and GS-DOL maintenance in the paragraphs that follow.

Field-Level Maintenance Data

A key gap in maintenance data is that there are few records of scheduled field maintenance. A RAND researcher who interviewed maintenance personnel at Fort Campbell stated, "Maintainers at Campbell say it would be very unusual for any shop to open a work order for scheduled [field-level] maintenance" (Lackey, 2010).

Another field-level maintenance data gap in STAMIS is a lack of records of nondeadlining organizational maintenance. The Equipment Downtime Analyzer (EDA) captures deadlining organizational repairs (Peltz, Robbins, Boren, and Wolff, 2002; Girardini, Lackey, and Peltz, 2007).

GS-DOL Data Quality (Archived in ILAP) Has Been Improving

Missing data percentages have decreased from 2000 to 2009

GS-DOL completed work order data for the five ground system FSCs with the most work orders: 2320, 2330, 2350, 2310, 2420

Year	# WOs	Percent Serial Numbers Missing	Percent Fault Data Missing	Percent Cost Data Missing
2000	7,698	63.03	6.95	37.11
2001	45,421	65.68	9.2	64.04
2002	57,396	40.73	19.51	37.35
2003	65,305	36.64	4.26	22.59
2004	73,840	26.04	0.02	8.75
2005	102,893	36.67	0.06	5.35
2006	65,038	18.03	0.17	4.14
2007	168,317	4.14	1.46	5.58
2008	119,305	1.13	1.15	4.98
2009	159,121	0.05	0.91	7.07

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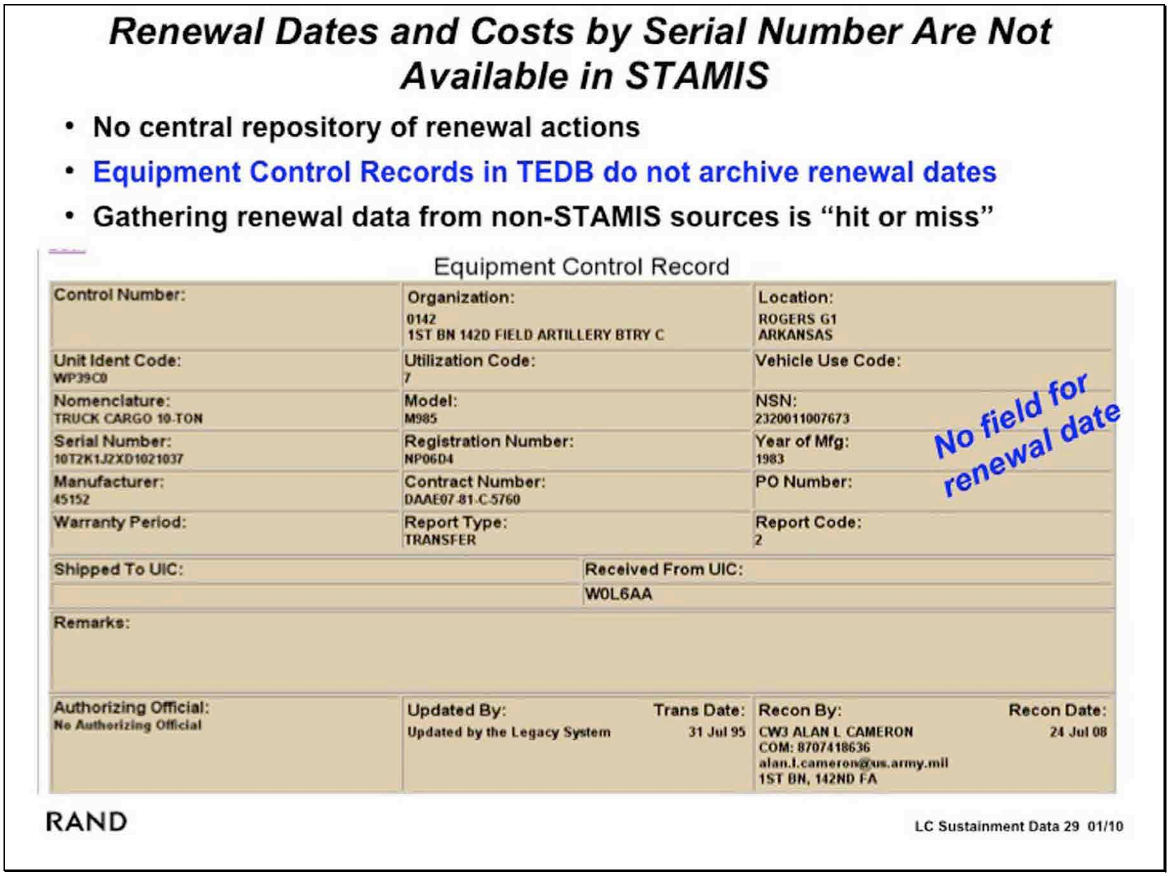
LC Sustainment Data 28 01/10

Sustainment-Level Maintenance Data

The quality of sustainment-level maintenance data has improved markedly. Almost all GS-DOL work orders currently include serial numbers and descriptions about the fault that led to the repair, and only 7 percent are missing data on labor and parts costs. Work orders from earlier years are missing considerably greater percentages of serial numbers, fault information, and costs.



Additionally, Army STAMIS generally do not contain data on equipment renewal by serial number. AWPS and SDS contain data on aggregate data on depot maintenance. These include the quantity of items inducted with a given Procurement Request Order Number (PRON) and NSN; the quantity completed; their average repair cycle time; and their total labor, material, and other costs. Such data are used for workload planning, determining manpower requirements, and justifying budget requests (Warren, 2002b). However, they are not sufficient for linking the renewal history of vehicles to the performance and subsequent sustainment costs of those vehicles or for determining the optimal timing of renewal in the life of a system.

Although depots are expected to send renewal dates by serial number to LOGSA via DA Form 2408-9, a LOGSA interviewee indicated that depots seldom send this information. In addition, when such data do reach LOGSA, they do not appear in the Equipment Control Record (ECR). As shown in the above slide, the ECR has no field showing the renewal date. LOGSA stores any renewal data it receives (via Form 2408-9) in a Recap-Rebuild-Overhaul table that is accessible to LOGSA but not others. LOGSA sent the table to our research team, and most entries were overhauls that occurred prior to 1998.

So Far, the New Army Equipment Loss (AEL) Tracker Database Has Quality Limitations but Good Historical Span

Data Element	% Missing (quality)	Time Period (breadth)
Loss date	0% missing (good quality)	09MAY85 - 16DEC09
Validation date	99.99% (poor quality)	—
Incident type	84%	—
Incident date	99%	14JUN99 - 29SEP09
Incident location	99%	—
Disposition date	98%	01OCT01 - 01AUG09
Disposition category	96%	—
Attrition date	83%	26DEC01 - 06OCT09

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LC Sustainment Data 30 01/10

Disposal Data

According to interviewees from the TACOM Cost and Systems Analysis department, there is a lack of data related to the demilitarization of equipment in the disposal process. As one such analyst noted,

> A missed data collection effort is demilitarization. When you dispose of a vehicle, there are certain parts that you have to break down in certain ways. [There are] environmental costs, transportation costs—a whole process that occurs when a vehicle is demilitarized. To my knowledge, there isn't a data source for actual demilitarization costs . . . and those can be significant costs. There are agencies (like the Army Environmental Agency) that will develop environmental estimates for programs, but the estimates represent mostly rough-order-of-magnitude estimates based on expert opinion.

In general, Army STAMIS contain little information about equipment disposal. Salvage values and disposal cost data are not available. However, LOGSA did recently add the Army Equipment Loss (AEL) Tracker to LIW.

The AEL Tracker contained 27,043 records as of January 4, 2010. As shown in the above slide, each record had the date of the loss but typically did not have additional information about the loss. For instance, 26,038 records (96 percent of the total) did not have the disposition category ("DRMO," "Dispose in Place," "Pending Legal Determination," "Center for Military History") listed, and 99 percent did not state the location of the incident that led to the loss. Although 22,748 records (84 percent of the total) listed the incident type, for 21,361 of those records the incident type was "21," which translates to "Other–Tell LOGSA to add new type incident." The quality of AEL Tracker data may soon improve, however. Materiel managers are in the process of gaining special System Access Request permissions to update AEL Tracker information. Once they are able to update the database, more detailed equipment loss data may be available.

Key LCM Decisions Are Hindered by Data-Quality Issues

	Data Element	Acquisition strategy: Assess remaining life of current systems	Upgrade planning: Assess failure rates & profiles (end item and component)	Renewal planning: Assess failure rates, costs, & readiness over time	Scheduled service updates: Assess failure rates & profiles
Demographics	Serial Number	X	X	X	X
	Model	X	X	X	X
	Age (Manufacture Date)	X	X	X	X
	Weight/cube/cost	X (cost)	X (cost)		
	Unit				X
	Location	X	X	X	X
Oper-ations	Readiness levels & dates	X	X	X	X
	Usage (miles, hours, rounds fired, fuel consumed) & dates	X	X	X	X
Maintenance/ Disposal	Configuration mgmt.	X	X	X	X
	Maintenance type (sch/unsch) & echelon (field, sustainment, renewal) & dates	X	X	X	X
	Parts used & cost	X	X	X	X
	Labor hours & cost	X	X	X	X
	Maintenance capacity			X	
	Disposal	X			

RAND LC Sustainment Data 31 01/10

Impact of Data Limitations

After evaluating LCS data elements available in Army STAMIS, we returned to the tables (found earlier in this document) that identify (with an X) each data element needed for analyses supporting key LCM decisions. We then shaded cells of the needed data elements based on their quality ratings: green for high, yellow for medium, or red for low. Most cells in the above table were shaded red or yellow, an indication that existing data are not sufficient for effective analyses, and empirically well-supported decisions, in the areas of acquisition strategy, upgrade planning, renewal planning, and scheduled service updates.

Key LCM Decisions Are Hindered by Data Quality Issues

		Maintenance workforce size & skill needs: Calculate workload	Budgeting: Calculate system O&M costs	New system design needs: Assess usage & maint patterns for current systems	System performance: Assess readiness & oper capability
Demographics	Serial Number	X	X	X	X
	Model	X	X	X	X
	Age (Manufacture Date)		X		
	Weight/cube/cost		X (cost)	X	
	Unit				X
	Location			X	X
Oper-ations	Readiness & dates		X	X	X
	Usage (miles, hours, rounds fired, fuel consumed) & dates		X	X	X
Maintenance/ Disposal	Configuration mgmt.	X	X	X	
	Maintenance type (sch/ unsch) & echelon (field, sustainment, renewal) & dates	X	X	X	
	Parts used & cost		X	X	
	Labor hours & cost	X	X	X	
	Maintenance capacity		X		
	Disposal				

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LC Sustainment Data 32 01/10

Similarly, in the above table, which identified decision elements needed for four resource/budget planning and materiel development decisions, most cells were either yellow (medium quality) or red (low quality). That is, existing data also do not facilitate decisions and analyses related to maintenance workforce planning, budgeting, new system design, and system performance.

Interviews Provided Examples of Insufficient LCS Data Impeding LCM Analyses

- **Decision:** ***Determining new system design and acquisition requirements to ensure supportability***
  - **Analyses:** Drivers of scheduled and unscheduled maintenance time
  - **LCS data problem:** Lack of work orders with labor hours for field-level scheduled maintenance
- **Decision:** ***Whether to upgrade a component (e.g., wiring harness)***
  - **Analyses:** Assess part reliability, costs, primary reasons for failure
  - **LCS data problem:** Work order data gaps – i.e., part repair/ replacement by vehicle serial number and reason for demand
- **Decision:** ***Resource needs for fleet replacement & recapitalization***
  - **Analyses:** Analyses of vehicle aging effects, recapitalization cost-per-vehicle trends
  - **LCS data problem**: Missing historical repair/replacement of vehicle components, renewal dates, and types; missing vehicle-level recapitalization costs

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LC Sustainment Data 33 01/10

Interviewees described the effects of LCS data gaps on critical analyses and decisions. A LOGSA manager (Table 2.2(a)) discussed how maintenance data shortcomings, including insufficient scheduled maintenance data, impact decisions and plans related to the design and acquisition of new systems.

Another interviewee (from TACOM Cost and Systems Analysis department) noted that a lack of information about the reasons for part demands—whether a part failed because of an accident for instance—makes it difficult to support decisions about whether or not to upgrade parts. The LOGSA manager made a similar observation (Table 2.2(b)).

Additionally, a TACOM Cost and Systems manager described several impediments to determining resource needs for replacement and recapitalization of vehicles in Army fleets. He noted that an obstacle to assessing aging effects (when replacement and/or recapitalization is needed) is the lack of historical data on the replacement of vehicle components (Table 2.2(c)). He also noted that an obstacle to tracking recapitalization costs per vehicle is the lack of vehicle-level renewal data (Table 2.2(d)).

A manager at HQDA G-4 pointed out that, in general, frequent questions about the integrity of the data lead analysts in his organization to spend extra time "revisiting grounds to validate the data." There is also "a constant fear" that erroneous data will be presented to leadership (Table 2.2(e)).

Table 2.2
Interviewee Statements: Effects of LCS Data Gaps

Interviewee		Statement
(a)	LOGSA manager	"Legacy data from a previous system is the best thing to have. You want to know what were the maintenance drivers. For example, how many maintainers did we have for a fleet of 50 vehicles? What did they spend time on—oil changes? Why were oil changes taking all their time? Whatever these maintenance folks are doing, we need to look at how to reduce their time on the next vehicle. Having data on a predecessor system during acquisition is very important."
(b)	LOGSA manager	"There was a wiring harness on one ground vehicle that was very expensive and very time-consuming to replace. When the turret opening came down a certain way, it would pinch the wiring harness. Wiring harnesses were failing because a clip was broken. The vehicle was [ostensibly] down because of this wiring harness, but it really did not have to do with the wiring harness; it was because the clip was loose. So how do you get accurate information about the cause of the failure?"
(c)	TACOM Cost and Systems Analysis manager	"One of the things we've wanted to look at but haven't been able to track is costs with age. You may have a vehicle that is a composite of an engine 5 years old, a suspension 15 years old. . . . So when people want to look at, over time, what age does to sustainment costs of the Army—well, what age are you talking about?"
(d)	TACOM Cost and Systems Analysis manager	"Leadership came to us and asked us to track the improvement in unit [recap] cost over time, since the initial unit cost exceeded the [target]. There wasn't a reporting system we could readily go to within the depots to be able to identify the labor and material required to do the work on one vehicle. They knew how much money they spent per month and how many vehicles they had recapitalized in the month—but did not have the data at the vehicle level, which made it challenging to see the unit cost improvement over time. The information systems that were at the depot . . . we couldn't get access, and once we got access, we found significant [data] shortfalls. [To get access] it took the CG [Commanding General] going to the depots to say, 'Let my cost guys in, and give them access to your cost and labor data.'"
(e)	HQDA G-4 manager	"If we rely on data that later proves to be inaccurate and provide it to a 3-star or CSA [Chief of Staff of the Army] level or Congress, then . . . when the data go out it's hard to reel back in. Hard to go back and reverse something if the data were in error."

Lack of STAMIS Reset, Recap, and Overhaul Data Impedes Assessment of Army Equipment Renewal Program

RAND team faced significant obstacles in recent effort to gather renewal data

- Needed renewal (reset/recap/overhaul/refurb) dates by serial number
- Data-gathering process required multiple phone calls and emails to scattered non-STAMIS sources
  - Some PMs keep their own databases with renewal data by serial number and provided the data they had available
  - Other PMs needed to send special requests for data to contractors and depots
  - Reset, recapitalization, and theater provided equipment refurbishment (TPER) data each came from different POCs
  - Data from different sources had different fields (content and formats)
    - Renewal cost by serial number available for CE/MHE but not tactical vehicles
    - Different dates encountered in different datasets: “acceptance date”; “start date” and “end date”; “date returned”; “DD250/ship date”
- Renewal data for some systems were not provided (or do not exist)

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LC Sustainment Data 34 01/10

RAND researchers conducting a study to assess equipment renewal effects also found that insufficient STAMIS data on reset, recapitalization, overhaul, and refurbishment was a significant impediment, greatly increasing the time needed to conduct analysis, the resources needed, and sometimes limiting the analytic techniques that could be employed. As outlined in the above slide, the study called for renewal history (renewal dates) by serial number for multiple types of vehicles, including tactical vehicles, force projection vehicles, and combat vehicles. Because there was not a STAMIS source of such serial-level data, the research team attempted to gather the data from non-STAMIS sources.

Gathering these non-STAMIS data entailed emailing and calling multiple program managers (PMs) and other contacts at TACOM to request data for different types of vehicles. The team contacted managers at PM Bradley regarding Bradley Fighting Vehicle data; PM Heavy Tactical Vehicles (HTV) regarding HTV data; and PM Force Projection regarding combat engineer/material handling equipment (CE/MHE) data. In some cases, different managers in the same PM office (PM HTV) were responsible for overseeing reset, recapitalization, and theater-provided equipment refurbishment of a given type of vehicle. The team needed to send emails and make phone calls to many of these managers to describe the study, explain the need for the data, and follow up on data requests.

PMs are frequently approached with requests for renewal data. Each request requires the PM to verify the identity and authorized need of each requestor, determine the time span and data fields needed, and then prepare and send files to meet those needs. Given the many responsibilities of PMs and their varying approaches to tracking renewals, it can be difficult to respond to such requests. Some managers were able to provide the data promptly (within a week), and others sent the data after a few months. The data received varied in content (different types of dates listed) and format (PDF files, single Excel spreadsheet, multiple Excel spreadsheets). For some systems, renewal data were not provided. These problems limited the number of systems for which renewal effects could be assessed. Ensuring that STAMIS archive such data will reduce the burden on PMs and facilitate assessment of renewal program value.

Army Policy Is Not Well-Aligned with Data Needs for LCS Analyses and Decisions

- Policy of depending on units for manual input and data quality
  - "Units perform quarterly reconciliations between equipment data shown in units' ULLS-G equipment data file and equipment data shown on unit property books to ensure data synchronization and accuracy." (DA PAM 750-8:133)
- Policy only requires organizational work orders for NMC repairs (DA PAM 750-8:35)
- No policy for STAMIS to get and archive renewal data (dates, types, costs) by serial number
  - Policy refers to AMC archive: "Historical information on depot maintenance operations will be archived by AMC and provided on demand to appropriate users." (AR 750-1: 16)
- Dependence on PMs to ensure renewal data are gathered and analyzed
  - Materiel Developers (MATDEVs) will "Ensure that data collected from all levels of maintenance are analyzed and used for reliability improvement and updating logistical and manpower data bases used in determining Army force structure maintenance requirements…." (AR 750-1:7)
  - "MATDEVs will track efficiency programs (for example, Recapitalization) to validate cost avoidance." (AR 750-1:77)
  - "the MATDEV will . . . acquire all logistics data relevant to the materiel system"

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LC Sustainment Data 35 01/10

Factors Contributing to Data Issues

A review of relevant literature and interview statements suggests that three sets of factors contribute to the aforementioned data issues and their effects: (1) policy factors (limitations of existing Army maintenance policies); (2) design factors (information system design features); and (3) execution factors (how Army doctrine and policy are carried out by personnel).

Policy Factors

The primary Army policy documents related to maintenance and usage data are DA PAM 750-8, *The Army Maintenance Management System (TAMMS) Users Manual* (HQDA, 2005b), and AR 750-1, *Army Materiel Maintenance Policy* (HQDA, 2007a). Portions of both are not conducive to driving the capture and archiving of accessible, high-quality, longitudinal LCS data in STAMIS. DA PAM 750-8 places the burden on units to keep track of instructions for manually entering equipment maintenance and usage information either via the Army Materiel Status System (AMSS) end-of-period report process, electronic forms, or paper forms; it also relies heavily on units to review reports and identify/correct inaccuracies.

Additionally, DA PAM 750-8 specifies that an organizational work order number (ORG WON) is assigned to track (a) inoperative, not mission capable (NMC) equipment that is repaired by the unit; and (b) any equipment sent to a support maintenance activity for repair. Consequently, when units repair nondeadlined (still operating) items, records of such repairs do not reach ILAP.

Gaps in AR 750-1 may be contributing to the lack of a STAMIS source of renewal data by serial number. Although the policy refers to gathering and archiving depot maintenance data, it does not specify that the data should be at the serial level. Moreover, by stating that AMC should provide depot maintenance information "on demand to appropriate users," the policy does not ensure accessibility of the data via STAMIS.

The role of the Materiel Developers (MATDEVs)—principally, the Army Program Executive Offices (PEOs) and Program Managers (PMs)—figures prominently in AR 750-1. Among the designated MATDEV responsibilities is ensuring that renewal data are gathered and analyzed so that total ownership cost can be reduced throughout a weapon system's life cycle. For programs such as recapitalization, the MATDEV is expected to have a "detailed evaluation plan covering data collection plan measures of success." Interviewees expressed concerns about this reliance on MATDEVs, noting that PMs are still more focused on acquisition than on sustainment because they are (1) typically in their positions for only three years; (2) still have more control over acquisition funds than sustainment funds; and (3) are pushed to get new systems fielded quickly.

Along the same lines, a recent GAO report (Solis, 2009:15) suggests that PMs may not be devoting sufficient attention to equipment sustainment. In particular, PMs have not been involving depot officials in "the sustainment portion of the life cycle management planning process for new and modified systems” because there is no formal requirement for PMs to do so.

Design and Execution Factors Contribute to Data Issues

- Design Factors
  - Too much manual input
    - Age, usage, renewal data
  - Limited error- and mistake-proofing (screening and rejecting) of inaccurate/invalid inputs to databases
  - Some data capture not properly designed into systems
    - Each Equipment Control Record overwrites the previous one in TEDB
    - Serial number field in maintenance systems limited to 15 digits
- Execution Factors
  - Perception that data reporting is not needed while deployed
    - Lack of enforcement of data reporting requirements
  - Insufficient securing of access to contractor data
  - Serial numbers change with recapitalization even though DA PAM 750-8 states they should not

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LC Sustainment Data 36 01/10

Design Factors

In addition to policy factors, design factors may be contributing to LCS data problems. Due to system changes over the past several years, units can now input manufacture dates, odometer readings, and maintenance data (including renewal dates) via electronic forms rather than hard copies (DA Form 2408-9 on LIW and the Unit Level Logistics System-Ground (ULLS-G)/Army Materiel Status System (AMSS) monthly reports). (Some units do not have ULLS-G or LIW access, so hard copies of forms such as the “Installation Materiel Status Report” are still accepted.) Even with electronic forms, however, data are entered manually and are subject to keystroke errors, logic errors (misinterpreting a question asked), or similar problems. An unofficial UIC—one created for local use rather than one recognized by the Army Status of Resource and Training System (ASORTS) or the wrong reporting date can lead to a flawed report, which AMSS treats as a missing report (LOGSA, 2007).

Also, opening an AMSS report in Word or Excel, instead of Notepad, generates characters in the file that skew the data submitted to LOGSA (Williams, 2009).

The research team noted several opportunities for keystroke and logic errors in electronic DA Form 2408-9. Specifically, the user needs to remember to select "overhaul" from the report code menu if the form is being used to submit overhaul data, and the user then needs to enter overhaul year in the "Year of Manufacture" field using a special format (1H05=first overhaul performed in 2005). Users could also potentially select incorrect items such as the utilization code from several other menus. Although ULLS-G/AMSS is normally used to report both readiness and usage data, DA Form 2408-9 has a field for "Usage Miles"; the user is supposed to enter the current odometer reading in that field but could inadvertently enter miles traveled (usage) since the last reading.

Commercial information systems often use two approaches for improving the quality of manually entered data: (1) error-proofing (preventing an error); and (2) mistake-proofing (detecting and correcting an error). In electronic DA Form 2408-9, we found some error proofing: warning messages that indicated when an invalid UIC, NSN, or serial number was entered. Invalid dates and odometer readings are not rejected, however. A recent LOGSA briefing (Williams, 2009) cautioned that entering the tenths digit on an odometer reading—3000.5 instead of 3000 or 3001—in ULLS-G will skew the usage report. Along the same lines, a LOGSA interviewee noted that "there are no up-front edits in PBUSE, so a PBO [property book officer] can put in anything he wants to—duplicate serial numbers, duplicate registration numbers. . . "

Another information system feature contributing to data issues is that some data capture is not designed into systems. New data submitted on DA Form 2408-9 can overwrite existing data on the TEDB Equipment Control Record. As a result, some vehicle ECRs list recapitalization dates as the year of manufacture. Also, a LOGSA manager noted that maintenance and supply systems do not interface and have discrepancies in their data fields—the serial number field is 20 characters in PBUSE and LIW but is only 15 characters in maintenance systems. Some serial numbers exceed 15 characters and are cut short in maintenance databases due to the field length restriction.

Execution Factors

Poor execution of current Army policies contributes to LCS data problems as well. Although Army policy—specifically, DA PAM 750-1 (HQDA, 2007b:19)—states that readiness reports "will be completed during both peacetime and military operations," interviewees pointed out that deployed units tend to perceive such reports as optional (Table 2.3(a)). Interviewees also suggested that lack of enforcement of the policy leads to missing usage and readiness reports from deployed units (Table 2.3(b)).

They also noted that the readiness reporting policy is not well-executed, and interviewees stated (Table 2.3(c)) that policies related to contractor maintenance data are not being fully observed. Such policies require contractors performing Army equipment maintenance to "report weekly open and closed work order production . . . information to LOGSA" (AR 750-1, HQDA, 2007a:43) and require that contracts "include provisions for the collection of work order . . . data from the contractor" (AR 750-1, HQDA, 2007a:44).

When examining recapitalization data provided by Program Managers, we found that another policy is not being observed regularly:

> Serial numbers that have been assigned to an item are not changed during its life cycle, regardless of changes in configuration. The exception to this rule is for the correction of errors resulting in duplication of numbers (DA PAM 750-8, HQDA, 2005b:134).

Despite this policy, recapitalized vehicles are often assigned new serial numbers. Because STAMIS do not contain such old-to-new serial number translations, it is difficult to assess the effect of recapitalization on vehicles—in order to track their failure rates before and after recapitalization—without having PM spreadsheets that show the correspondence between old and new serial numbers.

Table 2.3
Interviewee Statements: Reasons for LCS Data Problems

Interviewee		Statement
(a)	HQDA G-4 manager	"When you have units stateside, they provide data; when you have deployed units, it's harder to get the reports . . . You have a lot of commanders in the Army who were in Desert Shield. We waived reporting requirements during that time. Now it's a protracted conflict, and Congress is asking questions about the impact on equipment of prolonged conflict. But [units] don't understand downstream that there is a real-time requirement for information."
(b)	TACOM ILSC manager	"In peacetime, reporting is more accurate; in a deployed environment, it's less accurate. What are you going to do—call [a general] and chew him out because 82nd Airborne didn't report? How do you enforce it?"
(c)	ASA[ALT] manager	"CLS [Contractor Logistics Support] creates burdens on the process because the visibility—to the same level that [HQDA G-4] may desire to have (and that they do have on other programs) is not resident on the Stryker program. It's data that the G-4 is getting more visibility on, but since they don't control the databases, they don't necessarily have the same flexibility to manipulate the data as they need to answer particular questions."

Impact of GCSS-A and LMP on Data Access and Quality Not Yet Clear

- GCSS-A – Tactical-level integrated logistics system architecture
  - Purpose: To integrate supply, maintenance, property, ammunition, and finance data in a single database accessible to all authorized users; will replace legacy STAMIS
  - Concerns raised:
    - Will business rules and processes support enterprise requirements?
    - Will data quality issues in STAMIS carry over?
      - Disposal cost capture unclear
      - Initial data cleansing may not be sufficient
- LMP – National-level integrated logistics system architecture
  - Purpose: To modernize wholesale materiel and maintenance systems, (1) Commodity Command Standard System (CCSS) and (2) Standard Depot System (SDS)—the data source for AWPS
  - Concerns raised:
    - Depot maintenance data not at serial number level
      - does not address need for renewal data archiving
    - Disruptive transition so far

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LC Sustainment Data 37 01/10

Potential Impact of STAMIS Changes in Progress

Over the past decade, several programs were initiated to change STAMIS structure and content. The Global Combat Support System-Army (GCSS-A) is an automated logistics system that uses the SAP Defense Forces and Public Security (DFPS) software platform to provide Enterprise Resource Planning (ERP). It is designed to integrate tactical logistics data and functions as related to supply, maintenance, property, ammunition, and finance that presently reside in multiple STAMIS (PBUSE and SAMS-E). GCSS-A is still undergoing operational assessment and has not yet been fielded.

The Logistics Modernization Program (LMP) focuses on national-level (wholesale) logistics, integrating inventory management and depot operations data that currently reside in several legacy STAMIS: Commodity Command Standard System (CCSS) and Standard Depot System (SDS). Like GCSS-A, LMP leverages SAP software. LMP and GCSS-A will be key components of the

Single Army Logistics Enterprise (SALE), a network of automated logistics information systems linked to provide end-to-end visibility of national and tactical Army logistics (Anderson, 2009).

Subject matter experts (Egan, 2009) indicate that GCSS-A and LMP have the potential to address some of the data issues discussed in this document. First, as part of SALE, they may contribute to better asset visibility, including more accurate information about fleet sizes and equipment on-hand quantities in units or regions. Second, with newer computers and software replacing outdated ones, run times for operations and maintenance reports may be faster. Third, with more centralized databases, LCS data accessibility is likely to improve.

However, interviewees raised several concerns that suggest SALE should not be seen as a cure-all for LCS data issues. The primary caveats are outlined below.

GCSS-A Concerns

An HQDA G-4 manager noted that, for an ERP, it is important to define the enterprise and then set up business rules for enterprise requirements, but existing policies were developed with a narrower, tactical focus rather than a broader, strategic focus. His point echoes that of an earlier GAO report (Williams, Rhodes, and Solis, 2007), which concluded that the Army did not have an enterprise view when determining changes needed in its business processes. Specifically, the authors stated (p. 6) that

> the Army's existing strategy perpetuates some of the cumbersome and ineffective business processes that are currently used in its existing legacy system environment. The benefits of an ERP solution include streamlining of business processes and elimination of data redundancy.

While GCSS-A promises to capture needed field-level maintenance data that are currently missing or low quality, doing so will require changes in maintenance reporting practices.

At present, it is not possible to evaluate GCSS-A data quality in an operational environment. An interviewee questioned whether the planned data cleansing, which is to precede the transfer of data from legacy systems to

GCSS-A, will be sufficient—or whether repeated data cleansings will be needed. Business process changes, such as less manual data entry, may reduce the need for subsequent data cleansings.

LMP Concerns

Interviewee statements also revealed LMP limitations with respect to LCS data. According to a CECOM manager familiar with LMP, the system does not track depot maintenance by end item serial number, and the system therefore does not address the need for serial-level renewal data. Also, because the transition to LMP has been difficult, many have not yet experienced the intended benefits of the system. Examples of implementation difficulties appear in Table 2.4.

The Army is working to apply lessons learned in LMP implementation to date and a recent GAO report (Solis, Khan, and Barkakati, 2009:7) concluded that the Army has begun to implement most GAO recommendations related to LMP. Still, as with GCSS-A, the ultimate impact of LMP on LCS data cannot yet be determined.

Table 2.4
Interviewee Statements: Experiences with LMP

Interviewee	Statement
CCAD manager	"We're okay—producing. It had an impact on productivity; we saw productivity dip. We had to change our whole business process. LMP doesn't calculate revenue from a part until it hits the floor. It won't hit the assembly phase for 200 days, so LMP won't recognize the revenue. We had revenue below targets and took a beating at AMC; they didn't understand how LMP was changing the calculation."
CECOM manager	"We need to do a great job of data cleansing because, once it's in there, [LMP] is unforgiving."
CECOM manager	"LMP started in July 2003, and now it's 2010 and we still haven't fielded it to TACOM because of all the issues up until now. They were supposed to start with the other LCMCs a year and a half afterwards, but nobody else would take it. There have been thousands of change requests—problems people need resolved. They've resolved a lot, but we keep adding [new change requests] to it."

Item Unique Identification (IUID) May Help Improve Data Quality, but Impact May Depend on Implementation Resources and Scope

- **IUID – marking items with unique item identifiers in machine-readable code**
- **Purposes** (DoD 5000.02, 2008:79; HQDA Implementation Plan for Serialized Item Management (SIM), 2008)
  – Link pedigree, usage, maintenance, warranty, status, and configuration data to equipment
  – Enhance LCM
  – Provide more accurate asset valuation
- **Concerns:**
  – IUID is an unfunded OSD requirement
  – Potential for variation in implementation
    - PM has ultimate decisionmaking authority over which items are selected for IUID, in accordance with HQDA and DoD guidance (items >$5,000, serially tracked, or deemed necessary by the PM)
    - Legacy MIS will be "modernized on a case-by-case basis"
    - Distribution of scanners is to be determined

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LC Sustainment Data 38 01/10

Another major data initiative in the DoD and the Army is Item Unique Identification (IUID), a program to mark items with unique item identifiers (UIIs), machine-readable codes that distinguish each item from other items and do not change during the life of an item (Deputy Assistant Secretary of the Army, Acquisition Policy and Logistics (SAAL-ZL), 2009). The IUID implementation plan (SAAL-ZL, 2009) specifies that the UII "shall be used globally as the common data key in financial, property accountability, acquisition, supply, maintenance, and logistics automated information systems (AIS)." Goals of the program include more precise data capture, increased asset visibility, improved management of historical data, a better ability to determine property values in financial audits, and better logistics support. The plan also specifies that all Class VII items (major end items) should be marked by December 2010 (SAAL-ZL, 2009:16).

The extent to which these goals are achieved, however, depends on implementation resources and scope. A LOGSA IUID subject matter expert pointed out that IUID is an unfunded OSD requirement. Also, a PM Stryker manager noted, "IUID is being mandated across DoD, but funding implementation is being left up to the PMs. For it to be successful, all the systems need to be able to pass information from point to point." The HQDA and DoD guidance states that items selected for IUID should be those that are

- greater than $5,000;
- serially tracked; or
- deemed necessary by the PM.

The Army IUID strategy document (SAAL-ZL, 2008:9) states that the "PM is the ultimate decision making authority regarding which items are marked consistent with DoD, HQDA, and PEO guidance."

3. Overall Findings and Recommendations

Summary of Principal Information System Gaps and Contributing Factors

- **LCS databases are not designed for ease of access and use by Army analysts**
  - **Multiple, sometimes lengthy approval processes**
  - **Insufficient flexibility**
  - **Data visibility hampered by dispersion in multiple systems and by partitioning within systems**
- **LCS data have substantial quality (accuracy and completeness) problems**
  - **Serial number discrepancies**
  - **Inconsistent age data**
  - **Poor usage data capture**
- **Some LCS data important to analyses are not captured or archived sufficiently**
  - **Most unit maintenance and scheduled maintenance actions**
  - **Renewal actions**
- **Policy, design, and execution factors contribute to data problems**
  - **Policies do not require work orders for all organizational maintenance; do not require STAMIS archiving of renewal data; rely on units to check data quality**
  - **Systems still depend on manual input and have limited error- and mistake-proofing**
  - **Lack of emphasis on and enforcement of data reporting by units and depots**

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LC Sustainment Data 39 01/10

The slide above outlines the STAMIS LCS data limitations and contributing factors described in the previous section of this document. First, Army analysts' access and use of LCS data are hindered by lengthy approval processes for accounts on information systems; insufficient flexibility of the systems; and the dispersion of data in multiple systems as well as restrictions that allow users to access only a portion of the data in such systems. Second, there are substantial data quality issues, particularly

- serial number errors and discrepancies across data sources;

- inaccurate manufacture dates (or inconsistent treatment of age—sometimes based on year of recapitalization and sometimes based on manufacture date); and
- many missing and implausible odometer readings.

Third, STAMIS are not capturing

- most organizational-level maintenance (i.e., only capturing NMC repairs at the organizational-level); and
- most reset, refurbishment, recapitalization, and overhaul actions by end item serial number.

Finally, multiple policy, design, and execution factors may be contributing to these problems as listed in the above summary.

Recommendation: Take Actions to Improve Access, Ease of Use, and Quality of LCS Data

- **Improve access and ease of use of LCS data for analysts**
  - **Single, secure source of data**
  - **One-time approval process**
  - **Increase transparency and flexibility of database applications**
- **Error-proofing and mistake-proofing to improve quality of LCS data**
  - **Single data entry, automated when possible, for serial numbers and manufacture dates**
  - **Embedded data-harvesting instruments**
  - **Immediate rejection of data-entry errors in electronic forms**

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LC Sustainment Data 40 01/10

A number of opportunities exist for improving the ease-of-access/use, quality, and historical span (archiving) of Army LCS data. To increase Army analysts' awareness of—and access to—STAMIS LCS data, greater centralization of the data is needed. Further expansion of LIW to include AWPS, SDS, MMIS, and AEPS data would help accomplish this. Also, to reduce the number of lengthy application and approval processes needed for data access, the Army could consider establishing a list of authorized users for unclassified systems. The account approval process could consist of verifying that an applicant is on such a list. Additionally, information system users on the list could automatically be granted full access to all unclassified STAMIS data in an information system rather than partial access (i.e., being limited to specific modules).

To increase the usability of LCS data sources, several information system design changes may be helpful. In particular, users should have the option of extracting multiple years of data, rather than being limited to one month or one year at a time. Along the same lines, query options should be increased. The flexibility to specify the geographic region, level of analysis (serial, unit, or higher), and number of variants (one NIIN versus all NIINs with the same FSC) will allow data to more easily serve a wider variety of analytical purposes. Additionally, greater information system flexibility will reduce the burden on the user, such as the need to run a report repeatedly and write programs to link piecemeal data, which should increase the number of users with the time and capabilities to use the data. LIDB offers many options for extracting data, but other systems (ILAP, OSMIS, PBUSE) are less flexible. Other possible steps toward improved usability include improving navigation tools and reconsidering the arrangement of modules in LIW, and improving user support in OSMIS (by developing a detailed OSMIS manual, for instance). Such actions are likely to increase database transparency to Army analysts.

To improve data quality, it is important to increase error-proofing and mistake-proofing. A critical error-proofing step is reducing manual input of data. A one-time input of a vehicle's serial number and manufacture date, with the single input populating the serial number field in multiple systems, would reduce the opportunity for data entry errors. This single data entry could occur when the Army first receives a vehicle from a manufacturer. Then all vehicles would have only one number listed in PBUSE, and that number would drive the serial numbers in usage, readiness, and maintenance systems.

In addition, embedding data-harvesting instruments in new vehicles—smart cards attached to vehicle onboard diagnostic ports—would improve the capture and quality of vehicle usage and performance data. As one HQDA G-4 manager noted,

> As long as we have soldiers input data, we're going to have accuracy problems . . . I'd like to see an interrogator at the front gate of a [forward operating base] (to measure odometer, fuel, hours since [the vehicle] last left the gate) so that all that would be collected in an automated fashion rather than having a soldier fill out a 5990 and have a dispatcher who fat fingers it into the system.

In a similar vein, a PM Stryker manager commented,

> One of the big problems we have is that there's no automated barcoding system that works across the board—where you are scanning a system and not looking for human interaction [and] where all the systems talk to each other. There's no system that tracks from the depot, to shipping, to picking up at the post or unit level. That would really be a good thing for parts . . . for vehicles, too. Anything with manual intervention does come down to mistakes.

As with error-proofing, designing more mistake-proofing into information systems would enhance data quality. ULLS-G/AMSS could either completely reject odometer readings that have digits after a decimal point—and provide the reason for rejecting them—or incorporate software changes that allow it to interpret odometer readings with decimal points correctly.

Recommendation: Ensure Collection and Archiving of All LCS Data Needed for Analysis

- **Policy:**
  - **Include analysts in requirements development process for new information systems**
  - **Include requirements for data elements in Army policy**
  - **Establish a renewal maintenance archiving standard for PMs, with central record maintained in LIW**
    - **Ensure this includes contractor data**
- **Design:**
  - **Use list of required data elements to identify gaps in GCSS-A and LMP**
  - **Convert ILAP to two-level maintenance**
  - **Ensure SAMS-E work orders can be opened for all scheduled and unscheduled maintenance**
- **Execution:**
  - **Enforce LCS data reporting with automated reminders and feedback**
  - **Communicate to operational Army (those responsible for executing policies and gathering data) how the data will help them in the long run (Galway and Hanks, 1996)**
    - **Balance burden to the field with data benefits**

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LC Sustainment Data 41 01/10

Just as there are opportunities for increasing the access, use, and quality of LCS data, there are multiple avenues toward more complete data capture overall. First, it is likely that Army policy changes will be needed to ensure better alignment of data policies with strategic decisionmaking and analytical needs. Army policies should specify all data elements that STAMIS need to capture. Such changes could emerge from a policy review and revision process that includes analysts and that considers data elements discussed in this study. Establishing a standard for archiving renewal data by serial number would be particularly valuable.

Second, changes in current and future STAMIS designs warrant consideration. An in-depth examination of GCSS-A and LMP may reveal modifications needed to ensure that SALE provides all critical LCS data elements. In addition, options for converting ILAP to two-level maintenance should be investigated,[14] as should software changes allowing multiple SAMS-E work orders to be open at once for a given serial number.

Third, execution of Army data policies could be improved through automated reminders to units, like monthly reminders to report readiness, or reminders to conduct and open work orders for scheduled services on vehicles. Feedback after a unit provides reports (or does not provide them) may reinforce the idea that usage and readiness reporting are required and that unit compliance is being monitored.

An earlier study of Army data quality (Galway and Hanks, 1996) noted that a key to better execution of data policies may be ensuring that organizations that generate the data understand how it will be used. More specifically, Galway and Hanks (1996:15) observed that the persistence of missing, invalid, and inaccurate data over time can be a symptom of a disconnect—a difference in the perspective of the organization that collects data and the organization that uses the data:

> This can happen when data users and creators are in different parts of an organization or in completely different organizations. In this case, there may be no adjudicator who can balance data burden (for the creators) with data benefits (for the users).

Thus, a vital step toward higher data quality is to communicate to the operational Army—the units responsible for executing policies on data collection—how better data will help them, and the overall Army, in the long run. Additionally, there will need to be negotiation and "agreement within or between organizations as to what data are required, what is acceptable data quality, and how costs are to be allocated and benefits shared" (Galway and Hanks, 1996: 15).

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[14] For example, to capture field-level maintenance, one option may be to offer three types of reports: organizational and DS reports for time periods preceding two-level maintenance and field-level maintenance reports for more recent time periods.

In summary, the Army has been facing data challenges for some time and has been actively pursuing STAMIS changes to address them. However, a current assessment of LCS data issues, causes, and opportunities was needed to inform ongoing and future improvement efforts. This study aimed to provide such an assessment. Our findings highlight a range of data access, quality, and breadth issues that merit attention and also suggest that a combination of policy revisions, information system design changes, and better policy execution are critical to addressing such data issues. Taking a comprehensive approach to LCS data improvement will help ensure that Army managers and analysts have the information needed to manage equipment life cycles effectively.

Appendix A: Reports of LCS Data Problems Hindering LCM Decisions

The following tables list studies that discuss effects of data gaps on military and commercial fleets. Organizations in the studies experienced problems such as inaccurate reports of reset completions, unclear data on reset funding obligations, low-quality data on equipment utilization, and failure to retain baseline cost-performance analyses (to compare actual and expected performance) for contractor logistics support. The right-hand column of each table lists (in red) LCM decisions and analyses hindered by these data problems.

Prior Studies Have Reported Cases of LCS Data Problems Hindering Key LCM Analyses and Decisions

Report	Fleets	Data Problems	Hindered LCM Decisions and Analyses
AAA 2008	Army fleets	Funding obligations for reset Reset completion data	- How many systems are available to distribute to units? - How much to budget for reset - How many systems have washed out?
GAO-09-865	Army and Marine Corps Fleets	Workload forecasts	- Determining depot capabilities needed for future workloads - What depot resources are needed to support new and modified weapon systems?
Congressional Research Service 2006	Military equipment	Condition and disposition data	- Which equipment should be disposed of, and how?
GAO-06-141	Military and civilian ground fleets	Usage data	- Whether to downsize fleet

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LC Sustainment Data 43 01/10

Prior Studies Have Reported Cases of LCS Data Problems Hindering Key LCM Analyses and Decisions

Report	Fleets	Data Problems	Hindered LCM Decisions and Analyses
Saltzgiver 2004	Commercial ground fleets	Utilization data (mileage)	- What is cost/per mile to operate? - Are vehicles utilized appropriately? - Are continuous improvement efforts effective? - What preventive maintenance intervals are appropriate? - Which vehicles should be disposed of?
GAO-04-645	Federal civilian agency aircraft	Number of aircraft Usage data Support cost data	- How much to budget for operations - How much to budget for maintenance - Whether to dispose
GAO-02-306	Army and Navy weapon systems	Not retaining baseline estimates of contractor logistics support cost-effectiveness	- Are initial cost estimates for CLS are being achieved? - Are adjustments in CLS needed? - Should the military continue outsourcing logistics support for a system?

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LC Sustainment Data 44 01/10

Appendix B: Interview Questions

We Asked Subject Matter Experts About Experiences with LCS Data in the Army

Topic	Questions
Background	What is your role in your organization, and what types of equipment sustainment data do you use for your work? How do you normally obtain these data (from what sources)?
Uses for life cycle sustainment data	For what types of tasks (e.g., analyses, plans, or decisions) are such data needed?
Data limitations	Do the data that you use have any limitations (e.g., quality, breadth, accessibility) that you would like to see addressed? If so, please describe.
Impact of data limitations	What is the impact on your work, your colleagues' work, or the overall organization of these data limitations? (Can you provide examples of plans, decisions, or analyses that were or adversely affected by sustainment data constraints?)
Factors affecting data breadth, quality, accessibility	What factors (e.g., human factors, organizational processes, organizational structures) may be contributing to data problems? Do you anticipate that any planned changes (e.g., in systems, organizations, or policy) will affect the breadth or quality of sustainment data available? If so, please describe.

RAND LC Sustainment Data 45 01/10

The above questions were used in the interviews conducted for this study. Because the interviews were semi-structured, we used the questions as a starting point but in some cases adapted them or supplemented them with additional questions.

Appendix C: Standard Sources of Army LCS Data

The tables below list the sources of STAMIS data examined by the research team. We obtained accounts to access the information systems directly, became familiar with each, ran reports, and evaluated both the data source and the data extracted.

Standard Army Sources of Life Cycle Sustainment Data

Database	Purpose
AEPS (Army Electronic Product Support)	AMC Logistics Web Portal to provide various types of supply, maintenance, technical, and acquisition logistics information
AWPS (Army Workload and Performance System)	System for managing maintenance workload, managing maintenance resources, and tracking performance of depots and other facilities
FEDLOG (Federal Logistics Database)	Logistics information product, published by Defense Logistics Information Service (DLIS), with cataloging information for stock numbers and part numbers
ILAP (Integrated Logistics Analysis Program)	System providing supply, maintenance, and financial management reports
LIDB (Logistics Integrated Database)	Database with multiple logistics reports, including • Serial number usage report: odometer readings for usage-reportable equipment • Ground equipment tracker: year of manufacture from TEDB (The Army Maintenance Management System (TAMMS) Equipment Data Base)

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LC Sustainment Data 46 01/10

Standard Army Sources of Life Cycle Sustainment Data

Database	Purpose
MMIS (Modification Management Information System)	HQDA G-4 system to track modification work orders (MWO) that are applicable to an item, have been applied, and are scheduled to be applied.
OSMIS (Operating and Support Management Information System)	SAFM-CE system tracking operating and support information for Army weapon/materiel systems
PBUSE (Property Book Unit Supply Enhanced)	HQDA G-4 system for property accountability
RIDB (Readiness Integrated Database)	Database tracking current and historical availability of readiness-related equipment
SLAMIS (Standard Study Number-Line Item Number Automated Management and Integrating System (SLAMIS))	Application to provide access to "chain of custody" data relationships and tools to support LCM of major end items. Includes a Nonstandard Line Item Number (NSLIN) catalog with unit price, manufacturer, supply class, and other information about NSLINs.

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LC Sustainment Data 47 01/10

Appendix D: Data Issues: Bases of Medium and Low Ratings of Data Elements

The slides in this Appendix describe the basis for our earlier “M” and “L” ratings of demographic, operations, maintenance, and disposal LCS data elements in Army STAMIS.

Issues with Demographic Data on Army Equipment

Data Element	Data Source	Ease of Use/ Access Issues	Quality Issues	History Issues
Serial Number	**ILAP** **LIDB** **PBUSE**	PBUSE access requires special permissions that can be difficult to obtain.	All 3 databases contain many serial number errors: typos that cause the same serial number to look like two different numbers, serial number and registration numbers reversed, unit notes in registration number or serial number field (in PBUSE).	
NSN **NSLIN**	**LIDB** **SLAMIS**		Some NSNs are not accurate (e.g., do not correspond to the serial number sequence or are not consistent--for the same vehicle--in usage and maintenance data sources). NSLIN corresponds to wide variety of systems with wide price range	
Age	**LIDB/** **TAMMS**		Many fleet serial numbers lack manufacture dates in TAMMS. Some manufacture dates do not correspond to the vehicle type ; they instead correspond to an older variant.	

Potential Contributing Factors

- *Information system design:* manual data entry and quality checks; inconsistent serial number field lengths in maintenance and supply databases; multiple prices allowed for same NSLIN; recapitalization date can overwrite original year of manufacture
- *Policy execution:* Insufficient training and enforcement of policy to retain serial number throughout item life cycle

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LC Sustainment Data 48 01/10

Issues with Demographic Data on Army Equipment (cont'd)

Data Element	Data Source	Ease of Use/ Access Issues	Quality Issues	History Issues
Weight/ Cube/Cost	**FEDLOG**		Weight/cube data not available for many class 7 items and are questionable for many class 9 items.	NA for weight and cube data. Historical price data are not available.
Unit	**LIDB PBUSE**	PBUSE access requires special permissions that can be difficult to obtain.	In both systems there are invalid and missing UICs. ARCENT Asset Visibility team indicated that forward detachments should have UICs ending in 0 or 1 – but that some do not.	ARCENT asset visibility team indicated it is not possible to determine when a TPE item arrived in theater and track where it moved over time. In PBUSE, one can only tell if an item is currently in theater, not when it previously was in theater.
Location	**LIDB PBUSE**	PBUSE does not appear to offer a query by location or standard geographic region.	In LIDB the translation of UIC is non-standard; same UIC can have multiple translations. PBUSE consolidated property listing has no translation of UIC.	

Potential Contributing Factors

- *Information System:* Design: limited error & mistake-proofing (dependence on manual detection/ correction via "AMDF Discrepancy Report" or "Price Challenge Form" on LIW); PBUSE queries designed for field users rather than analysts.
- *Policy:* PAM 700-32 allows multiple data entry points: When weight/cube data not in FEDLOG, Army installations can develop such data, which may be submitted to the Army Master Data File (AMDF, part of FEDLOG).
- *Policy execution:* Insufficient training and enforcement of policy on UICs for forward detachments.

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LC Sustainment Data 49 01/10

Issues with Operations Data on Army Equipment

Data Element	Data Source	Ease of Use/ Access Issues	Quality Issues	History Issues
Readiness	**RIDB**		RIDB covers a low percentage of fleets.	
Usage: Mileage/ Operating Hours	**LIDB OSMIS**	Location of usage data by serial number (in MMR Serial Reporting module) is not readily apparent in OSMIS. Also, it is only possible to pull 2 months of odometer readings (1 month of usage) at a time.	Mileage quality is poor – we see negative usage, implausible usage, and many missing odometer readings, especially for deployed units and equipment .	There are more historical data in LIDB than in OSMIS.
Usage: Fuel Consump-tion	**OSMIS**		Not by serial number; not considered accurate (according to TACOM Cost and System Analysis dept); estimates rather than actual values	
Usage: Rounds Fired	**AEPS**	Data not readily accessible. First need to apply for AEPS access, then apply for access to rounds fired data.	According to interviewees, breadth is low (few systems with rounds fired data) .	*Could not be determined; did not have direct access to rounds fired data.*

Potential Contributing Factors

- *Policy:* DA PAM 750-8 fosters dependence on units for manual data entry and checks; policy conveys fuel reporting as feasible (via form 5987-E) but not mandatory; no policy prohibiting “zeroing” odometer when vehicle is reset.
- *Information system design:* Limited error- and mistake-proofing of odometer readings; lack of flexibility (in OSMIS) to pull more than 2 months of odometer readings (1 month of usage) at a time.
- Policy Execution: Insufficient training and enforcement of policy requiring valid monthly odometer readings and readiness reporting, even while units are deployed.

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LC Sustainment Data 50 01/10

Issues with Maintenance Data on Army Equipment

Data Element	Data Source	Ease of Use/ Access Issues	Quality Issues	History Issues
Field-level maintenance repair time and dates	**ILAP**	Canned reports in ILAP limit query options. "Dynamic query" option provides more flexibility for some of the maintenance datasets.	There are serial-level maintenance data in ILAP, but work orders are not capturing most unit-level maintenance and scheduled maintenance. Parts used and cost are well captured for deadlining unit-level repairs in EDA, but some systems are not in EDA or have little EDA data. Quality is better in more recent years than in earlier years.	About 5 to 10 years of maint. data available, depending on system.
Field-level maintenance cost: parts and labor	**ILAP**			
GS repair time and dates	**ILAP**			
GS cost: parts and labor	**ILAP**			
Renewal time, dates, and cost (parts and labor)	**AWPS & SDS**	AWPS: Access to DMOPS was approved quickly, but RRAD data access was denied.	Data lack precision – no renewal dates or costs at serial number level. TPER data not included.	Reports prior to 2003 not found.
Configuration Mgmt.	**MMIS**		Data capture is better for some systems than for others -- and there are some fields with inconsistent data types (e.g., MWO field).	
Disposal: Est. Cost to Replace	**FEDLOG**		Missing cost data on some fleets (e.g., MRAP)	
Disposal: Validated Losses	**AEL Tracker**		Many records not validated and/or have loss type missing.	

Potential Contributing Factors

- *Policy:* PAM 750-8 requires ORG WON for inoperative equipment but not for non-deadlining repairs; AR 750-1 relies heavily on PMs for managing renewal data rather than encouraging single centralized source
- *Information system design:* No separate field on electronic form 2408-9 for renewal dates; no archiving of renewal dates by serial number

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LC Sustainment Data 51 01/10

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