Management of Defense Fleet System in the Developing Asian Countries (Allied/Non-Allied Forces) in the War-On-Terrorism

Amjad Bhatti, *Adnan Ashraf, and Manzoor Hashmani, **Member, IEEE and ACM*

***Abstract*—During WoT, one of the biggest challenges raised on borders of India, Pakistan, Iran and Afghanistan (IPIA) is the horrible damages to Allied Forces by ambushing convoys for fuel supply. Such a failure of manual system of defense fleet due to security breaches (under the most advanced surveillance by DRONE aircrafts) has been burgeoning alarms for the joint struggle. In this paper, we analyze the problem and design a new automated fleet maintenance system for a defense organization of the country. We observe during testing phase that minimizing human interactions (i.e. less human resource) in the fleet system makes less prone to information-breach of fleet system. The implementation of our proposed fleet system gives very surprising and economically beneficial reports to the organization. We are confident that our work is applicable to fleet systems of developing countries (allied/ non-allied) in WoT which are sensitive about their biological, mass-destruction command & control systems.**

***Index Terms*—Asian armed forces, automated fleet system, defense fleet, fleet data management system, war-on-terrorism.**

I. Introduction

TO protect the convoys for supplying fuel to NATO on Pak-Afghan border now, has become challenging even under the shades and air monitoring of DRONE aircrafts. Most of times, we observe that military fleet is being stroked down by anti-state terrorists in order to satisfy their anti-American feelings. In this alarming situation, various ad hoc measures have been taken to continue the supply. In order to fully response this challenge, we analyze the largest fleet system of a defense organization and come up with very important observations to the concerned high offices. We analyze the existing management system of defense fleet. We find that defense organization is relying more on traditional system for communication about the fleet movement. We observe that a number of people are involved to carry concerned actions, which in case of an automated system could be done directly with minimum interactions as directly between two end nodes.

Usually, such organizations own the largest on-wheels fleet to cover the geographic areas of the country. Few of these round-the-clock activities include are surveillance of highly sensitive areas, high profile personalities and inhabitant monitoring. Civil defense organizations (e.g. military) expose their fleet systems in civilian operations during emergency hours like, disaster relief, earthquake, terrorist attacks, flooding, and so on. During emergency, the record management becomes highly complex that is based on Pen-Paper-Phone which results traditional but secure FDMS as inefficient. This happens when vehicle operations become highly complex and maintenance management reaches beyond the limits of the resources of the FDMS. In turn, it declines operational efficiency of fleet that causes loss of human lives and leaves the vehicle management demoralized. In this paper, we propose and implement an online FDMS (Fleet Data and Maintenance System) for our civil defense client. The statistical analysis of fleet data, using our proposed FDMS, helps in making some very important observations which is not possible with traditional FDMS. These observations indicate parameters that exist in fleet data and maintenance and have the worst impact on fleet efficiency, workforce and finance. Using newly implemented FDMS, we are able to recommend new reforms for optimization in the fleet maintenance, operations and record management. Based on our recommendations, the organization can preserve its valuable fleet resources to deliver the best of its services during emergency hours, without making extra efforts.

In this paper, we analyze the traditional fleet record and vehicle maintenance system for civil defense organizations of developing countries and then develop a module based on our analysis. Our analysis, proposed implementation and recommendations are general therefore are applicable in other neighboring countries where arsenal of mass-destruction can be hacked by terrorists.

II. Motivation

Maintenance is a word which generates feeling of any operational system already available /installed and need qualified back up team to ensure smooth functioning of the system [1][2]. Fleet of any type needs qualified and versatile team to be available round the clock. Store used to purchase Items from different vendors to make them readily available in the workshop. Users can place the request for the repair of Vehicle to keep it, in road worthy condition. Availability and

Amjad Bhatti is a postgraduate student of MUET, Jamshoro. (phone: 0323-504-3565; e-mail: mamjadbhatti@yahoo.com).

Dr. Adnan Ashraf is faculty member in Mehran University, Jamshoro (e-mail: adnan.arain@faculty.muet.edu.pk).

Prof. Dr. Manzoor Hashmani is Professor at IQRA University, Main Campus, Karachi (e-mail: mhashmani@yahoo.com).

quality consciousness is an all-time objective. Once vehicle report to workshop, repair team, analyse fault and ask for requisite spares from store. After obtaining spares, necessary replacement/adjustment is carried out, then after testing by quality control team vehicle is sent out. In case of overburdening or complex work, vehicle is sent to local registered contractor for quick repair. Traditional pen-paper-pen (P-P-P) combination has been in use for many years in this organization having largest fleet for asset transit in the country [3][4]. Now, it is intended to change the 3P's into a versatile Computer Based Information System (CBIS) for the potential users in order to increase the efficiency of organization. Our motivation is to develop a systematic tool that continuously monitor routine maintenance activities in workshop, status of equipment/vehicle, highlight weak areas, towards purchase of spares and technicians efficiency. The design goals is to develop the tool which may exhibit a) simple and easy understanding with design, b) transparent to organizational structure, c) user-friendly interface, d) successful query handling, e) efficient coding techniques, and f) complete documentation before implementation in an organization to minimize the chances of system failure. In this paper, we propose and implement Fleet Data and Maintenance System (FDMS) optimized for a large private organization. A case study is also included in our paper studying a large organization performing security operations 24 x 7 for Civilian and Government Assets. We understand that monitoring and analysis needs availability of data in such a place where it can be manipulated keeping in view the user requirements. Our FDMS facilitates the project head with tools for monitoring and analyzing the operational cost of the fleet. Also, the user friendly interface for data entry and extractions of reports make the application bit efficient. Our proposed system gives a way to compare it with any other FDMS for its operational cost, technicians' efficiency, quality repair and flaws/mismanagement in inventory management /procurement of spare parts. This helps to provide high value services to fleet operators, with proven maintenance processes and technicians skilled using state of art techniques.

III. Methodology

A cyclical methodology, informally known as the spiral, is chosen to develop an FDMS and to optimize it to meet the needs of the organization. The cyclical methodology has four phases. A precise time is initially spent in each phase, followed by several iterations in all four phases. The methodology iterates over the processes of think a little, plan a little, implement a little, and then test a little. The document structures and deliverable types from each phase incrementally change in structure and content with each cycle or iteration. More details are generated as the methodology progresses. Once the products (FDMS) will be ready to ship after completion of all phases, the cyclical methodology may continue shipping multiple versions of the product. System working leads to adopt cyclic methodology that follows the analysis phase of the present system, design phase, implementation and then testing phase as shown in the Fig. 1 below.

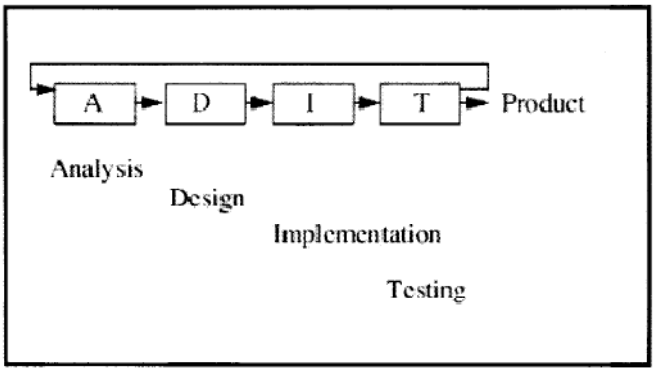

Fig. 1. The cyclic methodology followed for the proposed development

IV. General Requirements of Fleet Systems

In the following, we describe the main requirements of the Fleet from the Organization s' point of view.

A. Maintenance Management

Maintenance management is an orderly and systematic approach to planning, organizing, monitoring and evaluating maintenance activities. A good maintenance management system coupled with knowledgeable and capable maintenance staff can prevent safety problems, yield longer asset life with fewer break downs and result in lower operating cost and high quality of life [5][6][7]. In general, maintenance can be classified into four categories as shown in Table I.

TABLE I
POSSIBLE TYPES OF MAINTENANCE

Routine	Ongoing maintenance such as filters/ belts replacement
Preventive	Periodic adjustment of brake ,clutch pedal and spark plug cleaning
Emergent	An abnormal /unpredictable replacement e.g. engine failure or cable breakage
Predictive	e.g. Change of Disc Pads, cables, spark plugs keeping in view condition

In order to produce report optimization in the FDMS, the classification of Maintenance should be kept as distinct while data is keyed-in. This will not be hard to add an alias for classification of maintenance, at some later stage in web based reporting of the fleet maintenance.

B. Spare Parts Management

"Spare parts" refer to the part requirements for keeping owned equipment in healthy operating condition by meeting repair and replacement needs imposed by breakdown preventive and predictive maintenance [8][9]. Spare parts management is a science and an exact one at that. The trade-off between managing parts inventory vis-à-vis meeting service levels translates into a need for forecasting accuracy, managing parts proliferation and high analytical capabilities. Equipment downtime is lost production capacity

V. System Definitions and Requirement Specifications

The requirement gathering process is intensified and focused therefore, to understand the nature of the development, one must understand the information domain as well as required functions, behavior, performance and interfaces. Following the design process, we draw an outline limits for which whole system is required to perform its functions and shall contain the review of users. After tabulating and reviewing with the user, complete requirement in respect of hardware and software is proposed for final approval work. As data handling capacity is ever growing therefore, our recommendations for software and hardware requirements should be good enough to manipulate available data quickly and accurately. Here, we tabularized the system requirements in Table II.

TABLE II
SYSTEM DEVELOPMENT REQUIREMENTS

Interface development	JSP
Programming Language	Java
Web Interface Technology	Ajax, Java Script, CSS
RDBMS	Oracle 10g or above
Web Browser	Mozilla Firefox, IE 7, Chrome
Web Server	OCJ4, Apache Tomcat, ISA
Reports Generation	JSP
Platform	Windows, Solaris, Linux, Macintosh

A. Requirements from an FDMS

In Table III, we enlist main requirements based on requirement analysis for Fleet Data and Maintenance System (FDMS).

TABLE III
SET OF RECORDS / REQUIREMENTS FROM AN FDMS

-To keep the record of the workshop employees, contractors, their accounts & spare parts.
-To keep the record of the repair along with their history at workshop.
-To keep the record of the repair along with their history at out station vehicle. (Contd.)
-To create database for analysis
-Analysis for specific result extraction basing on user defined queries.
-Generation of daily summary as per user defined dates
-To keep the record of the workshop employees, contractors, their accounts & spare parts.
-To keep record / history of the repair performed at workshop.

B. Constraints and Limitations

The following are the constraints and bottleneck observed during the analysis of existing system.

TABLE IV
DESIGN CONSTRAINTS, AND DEVELOPMENT LIMITATIONS

Server-Side Constraints	
Development Environment	JSP
Programming Language	Java
Web Interface Technology	Ajax, Java Script, CSS
RDBMS	Oracle 10g, SQL Plus
Web Browser	Mozilla Firefox
Web Server	OCJ4
Reports Generation	JSP
Platform In-/Dependence	Windows Server 2003 or Higher
Security	PIX Firewall, AVAST Server
Machine Specification	XEON, Intel modular Multi-Flex, 500 GB storage
Power Backup	APC Modular (2 x 7KV)
Cooling Unit	APC Modular 80000 BTU
Client-Side Constraints	
Web Browser	Mozilla Firefox
Platform	Windows Extreme Performance/ VISTA
Security	AVAST
Machine Specs	Intel C2D, 512 MB RAM, 160 HDD
Web Page Constraints	
We follow the standard web security settings for pages and cookies and it's beyond the scope of the theme of this paper.	

VI. The Optimized Architecture of Fleet System

Though, various methods exist to develop an efficient FDMS but, the architecture of an FDMS can only be optimized for a specific environment /organization. In our strong opinion the optimization of FDMS depends upon appropriate selection of methodologies, coherent coding schemes, compatible development tools and project execution strategies. In our R&D, we intend to fulfill these fundamentals requirements with best-fit approach. The system architecture by (Bhatti 2009) coordinates to develop an Entity Relationship Diagram (ERD) of this FDMS.

A. System Architecture

We propose *three-layered* architecture for the aimed FDMS. The *Front-end* (layer 3) is projected for client machine. *Business Logic* (layer 2) is encapsulated in coding runs at server only. The *Back-end* (Layer 1) may reside on the same server if it is a database server. In our case, working with constraints, both the *Logic* and *Back-end* Layers will be addressed by a single server machine. The description of each layer is as given below.

Front-end (Layer 3): In our FDMS, the *Front-end* layer is developed using Java Server Pages (JSP) that requires any compatible internet browser like Mozilla Firefox (optimized for resolution display of 1024x768). Layout and design of the pages are done using hypertext markup languages (html) based queries. The user is allowed to interact only with the system through this layer.

Business Logic (Layer 2): The Java Enterprise Edition

(J2EE) integrates with *Logic* that is developed using Java backed by Oracle through Structured Query Language* (sqlplus).

Back-end (Layer 1): The *back-end* is actually the core layer or database layer. Using Oracle 10g user information, documents information and the access right on these documents will be customized by the System or Database Administrator.

VII. Performance of fleet data Maintenance System (FDMS)

The development and implementation carried out as per execution strategy described earlier in this paper. The end-user satisfaction observed from results in form of reports generated by FDMS. Analysis of these reports not only given an opportunity to make quick and correct management decision but also pointed out major drawbacks of previous Fleet Data and Maintenance System. The implementation and testing phases of the FDMS comprises various surprising facts about existing fleet, vehicle brands, service schedule, technician skill set, consumption of spare-parts, type of mostly used type of vehicle, life of vehicle, batteries and replaceable spare-parts. The reports by our FDMS give a way to compare either, two FDMS or any number of brands of vehicle, spare-parts and tools being used in the fleet of the organization.

The ability of cost analyses in FDMS reports highly budgeted areas of fleet. Therefore, it is easy for the management to take steps in order to save cost. Hence, we implement an FDMS that is optimized to satisfy the end-user requirements and surely helps management to analyze their TCO (total cost of ownership) against any equipment or service and take steps for cost savings accordingly.

A. Result Analysis for FDMS Optimization

The analysis in our case of organization is performed in the following sequence; a) hypothesis before undergoing result collection; b) collection of results; c) analysis (keeping in view maximum possible important aspects); and d) deductions.

The FDMS is intended to analyze the maintenance system of fleet of the private organization spread all over the country. The organization under study is able to generate reports to assess its existing condition by exploring weak areas in pricing, maintenance and quality repair work. Due to privacy constraint in the organization in the national interest, only four important aspects are shown in our reports to check and verify the current status of repair activities. These aspects are 1) Wheel Replacement, 2) Battery Replacement, 3) Change of Oil Filter, and 4) Engine Tuning. The following paragraphs contain the observations and recommendations made in our developed fleet date management system. Note that the brand names of vehicles, as the classified information, are being abbreviated only as to avoid any impact on their market sale.

Observation#1: Brand type *H is found costing high to the budget of this organization as compared to its competitor i.e. *T. In FDMS, the market prices shows availability of versatility of spares being developed by various vendors for *T due to usage in all over the country. Current technical expertise has a less exposure on brand *H as technicians have less exposure to this brand during technical schooling as well as working in fields.

Recommendations: It is recommended that new policies be maintained to address the following issues while inducting *H brand vehicles in the fleet in order to avoid cost impact.

Observations#2: A major loophole in electrical part of all brands of vehicles observed is maintenance of batteries as pre-mature failure of these batteries is at rise.

Recommendations: There may be number of reasons including user and technician inefficiency and, the FDMS is optimized to cater these reasons by tracking the records of service and maintenance. Vehicle users should give due attention to check batteries before /after driving. At the time of reporting to workshop, vehicle must be checked thoroughly each time, irrespective of fault. Best practice which can be adopted is to instruct team detailed on oil filter replacement, to do it with devotion.

Observations#3: Wheel replacement shows satisfactory results to some extent, however due to non-availability of previous record of brands, premature failures/ bursting of wheels in brands/sizes could not be addressed.

Recommendations: Available data gives us a comparative quality of brands and the priority is described as, the ‘B’, ‘D’, ‘G’, and others.

Observations#4: Oil filter replacement also shows some corrective measures to be taken against observed trend of Pickup, Jeep and Cars to enhance life.

Recommendations: Further data analysis gives us a picture of engine failure trends due to abnormal/ delayed oil filter changes.

Observations#5: Engine tune up gives us an insight of technician’s efficiency. Analysis revealed that old model Jeep/ car along with Motor cycles were troubled areas and show repetition/ recurrence of faults and at times too early.

Recommendations: This aspect was found more in Petrol engine driven vehicles as compared to diesel engines driven vehicles.

Observations#6: An important aspect was observe in updating of out station vehicle history that vehicle being employed near big cities shows more expenses as compared to vehicles operating near small cities.

Recommendations: On the contrary, prices should be low in areas close to big city as availability of spare parts near small cities is less.

VIII. Execution Summary of The Optimized FDMS

As already described that to solve the actual problems a strategy in line with above mentioned cycle was adopted therefore, more emphasis was given to the analysis at the beginning of the project. For this, regular meetings and discussions among all related individual were carried out before start of project to assess the correct nature of field tables and final development of queries. Next stage was designing/defining all parameters including shape of database, creation of related tables, finalizing of front-end display and their correct text words. After design, the next critical stage

was coding for front-end and back-end optimization. Testing and validation of software components was carried at the end before final deployment of the product. Finally developed software was put to test as user feedback. Necessary changes wherever required, were carried out.

IX. Conclusion

In this paper, a case study of traditional fleet system in a largest defense organization is analyzed due to its immense importance for War-on-Terrorism (WoT). Based on the analysis, we emphasize on the need of developing an optimized fleet system and maintenance record for the defense organization. Our contribution consists of the methodology development, the draft of requirement specification, and implementation of newly online fleet system. Our implementation system is a systematic tool for monitoring and analysing various fleet parameters, which are helpful to overcome the severe challenges to ally forces at Pak-Afghan-Iran borders. On the other hand, this proposed system makes the decision making efficient at the high offices by providing preventive data security and eliminating threats of disinformation from secret/ unknown resources.

Further, based on statistical analysis of this fleet system on the organizational data, we give recommendation to bring reforms that would be an aid to economics of fleet assets in the organization. The dynamic reporting of our proposed systems indicates crystal clear the faulted trends in decisions regarding the fleet operations and record management of fleet movement. The system understudy provides an insight to grey areas in fleet maintenance and helps to take preventive approaches for the optimization of fleet system. The preventive approach covers the early scheduling of vehicle service, periodical maintenance checkup, worker efficiency records, utilization of spare parts, and budget allocation. It has an easy to understand design, user-friendly interfaces and successful query handling mechanism. We are confident that our work is generally applicable to fleet systems of other developing Asian countries, allied/ non-allied in WoT, who are highly sensitive about their biological, mass-destruction command & control systems. Therefore, our contribution would be helpful to achieve the targets of WoT in the predefined timeframe of 2011 by the Allied Forces. During this time, the observation of weak service areas in the fleet system and identification of those parameters, which can deteriorate the fleet's efficiency, can be eliminated forever.

Acknowledgment

Mr. Amjad would like to thank to his high command at civil defense for the time they shared during the design, development and implementation phase of the project. Also thankful for accepting the recommendation based on statistical analysis of past years in the best interest of citizens of Pakistan**.**

References

[1] Bohlin, M Forsgra, M Hoist, A Levin, Anderson (2008), "Reducing Vehicle Maintenance using condition monitoring and dynamic planning" (IET International Conference, railway Condition Monitoring) Derby, pages 1-6.

[2] Amik Grag , S.G. Deshmukh (2006) , "Maintenance Management: Literature review and Direction (V -12 , No 3 pp 205-238)

[3] H. Springer L (2009), "Recent advances in maintenance and Infrastructure Management" 1st edition

[4] Mark Goh, Gnan-How toy (1995) , "Implementation of quality maintenance System in Military Organization" (International Journal of quality and Reliability management, V – 12, No 4 pp 26 – 39)

[5] James Lawrenson (1986) "Effective Spares Management" (International Journal of Physical Distribution and Logistics Management, V – 16, No 5 pp 3 – 111)

[6] P.K.Doran (1986), "A total quality improvement program" (Management Decision V -24 , No 2)

[7] Arvind Verma, Srinagesh Gavinenei (2006), " Measuring Police efficiency in India, an Application of data Envelopment analysis", (International Journal of Police Strategies and Management V -29, No 1, pp 125 -145)

[8] John P Ulhoi (2004) "Open source development : A Hybrid in innovation and Management Theory" (Management Decision V – 42, No 9 pp 1095 – 1114)

[9] David Sherwin(2000), " A review of overall models for Maintenance Management", (Journal of quality in Maintenance Engineering V -6, No 3 pp 138 – 164)

[10] Porten, Ronald E. Cuda; Daniel L; Yengling, Arther C; Fletcher ,Charlas V Drake, David A (April 2003) : "Exploring a new defense Resource Management System"

[11] Richard Sarwal Vice president Oracle Corporation "Oracle database 10g The self managing data base"

[12] The ICT Advisory team (2005): "Adding resources to the Digital brain resource management database" by Oracle Database

[13] Chip Dawes , Bob – Bryla Joseph C Johnson , Mathew Weishan Book (2004) "OCA – Oracle - 10g – Administration Study Guide "

[14] Toyota Motors (2006) "Technical Manual & User Manual Corolla XLI"

[15] Toyota Motors (2006) "Technical Manual & User Manual Corolla 2.O.D"

[16] Honda Motors (2007) "Technical Manual & User Manual Honda City"

[17] Pak Suzuki Motors (2007) "Technical Manual & User Manual Cultus"