CHAPTER 3

MANAGEMENT OF MAINTENANCE AND SUPPLY IN THE RMN

INTRODUCTION

Managing maintenance in the RMN is one of the vital elements of logistics in ensuring that every ship in its inventory is able to achieve the highest operational readiness state. This means that ships that received proper and effective maintenance through out its life will enable its operational availability to be optimized accordingly. On the other hand, ships that do not receive proper maintenance would find the probability of equipment breaking down higher compared to those that are well maintained. It is like the analogy of a car, where good maintenance will ensure that the car can be started and be driven safely at all time. However, for a ship the requirement is much more than to ensure that the ship can sail safely.

In support of the RMN missions, the roles and functions of the ships are not only diverse but also complex and demanding. A typical warship would be expected to do multiple tasking such as to conduct effective surveillance with its sophisticated sensors such radars for detection of other ships and aircrafts and sonar for detection of submarines. The ships would then be expected to identify and to destroy those that are classified as hostile or threat to the ship or to any other friendly units. To do this ships are equipped with an array of weapon systems such as torpedoes, missiles, guns and electronic warfare devices. It is not just a matter of life and death; it is also a matter of protecting the national interest of the nation and in war either winning or losing the war. The expectation of the RMN's higher management is for the RMN Fleet to achieve the level of operational readiness contained in the RMN Direction Statement.

RMN Direction Statement

The Navy has adopted the RMN Direction Statements published on 16 May 1996 to facilitate its strategic planning. It provide high level or macro perspective of RMN leadership on Quality Policy, Vision and Mission Statements, Goals and Objectives Statement and Value Statements necessary to provide its stakeholders the inspiration, directions and objectives against, which to plan, implement towards a higher level of performance overall.

The RMN Mission is to "***prepare and deploy naval forces to protect Malaysia's maritime interests in peace and to ensure victory in war***". In order to fulfil this mission, the RMN Direction Statements have set an objective "***to achieve superior quality fleets of at least 70% available for operations (CAT 1) for each class of ship***". Invariably effective and efficient management of maintenance for RMN ships is therefore vital to ensure that this objective is met.

According to a dissertation by Mohd Anwar (2002), this means that for a class of 4 warships, 3 of them (75%) are to remain at the very highest of Operational Availability denoted by the category, CAT 1, all the times. The remaining ship may be released from operations to undergo maintenance or repair, either based on periodical maintenance or urgent repair required to revert a ship to an operational state. Translation of this requirement is 93.3% of ship operational time must be in CAT1. This status is to be contributed by all systems and equipment onboard that is to have the reliability of 0.933. Operational Availability is categorized from CAT 1 to CAT 5, depending on the equipment or system defects affecting the warship's ability to perform assigned missions. The RMN goals and objectives that have been set are certainly very demanding. However, statistics of the RMN Fleet Operational Availability for 2002 reflects a serious problem in meeting this objective as the figure recorded an average of 71.2% (CAT1, CAT2 and CAT3) where the requirement is 70% (CAT1 alone). It is only

in year 2002 that the statistics reflects above an overall operational availability of over 70% as more ships are sent to other yards and fewer ships are being sent for DLM at PSC-Naval Dockyard Sdn Bhd (PSC-NDSB). Based on the interview with Cdr Jamel Rahman RMN, Chief of Staff Officer (Operation), HQ Fleet Operations Command, the mission capability and operational availability in 2003 increased to 74.5%. The achievement to date is still far from satisfactory in meeting the target set in the RMN Direction Statement.

RMN Maintenance Philosophy

The RMN Ship Repair System at the macro level includes the provision of planned maintenance for ships and also to equipments and systems fitted to RMN Ships. As policy, the RMN carries out Planned Maintenance for all its ships, which covers the provision of preventive and corrective maintenance. Preventive maintenance is maintenance that is carried out in accordance to a defined program to stop defects from occurring. Conversely, corrective maintenance is the rectification action that is carried out whenever an unexpected defect has occurred in the ship. There are three levels of preventive maintenance that are always undertaken; namely, Organizational, Intermediate and Depot Level Maintenance. Ship's crew and sometimes base staffs are tasked to carry out Organizational Level Maintenance (OLM) onboard. Base staff at FMD utilizing facilities and services that are not normally available onboard ship carries out intermediate Level Maintenance (ILM). ILM may also be sub-contracted to vendors through two processes known as the Emergency Repair Procedure (ERDL) and Outside Repair Procedure (NOOR). Depot Level Maintenance (DLM) on the other hand is carried out by a nominated shipyard where ships are sent to undergo dockings according to a specific through-life ship maintenance programme. Currently there have been many formal reports addressing the problems of long delays faced by ships undergoing DLM at the shipyards particularly the PSC-NDSB in Lumut. The most recent and notably is dissertation

written by Vice Admiral Dato' Mohd Anwar Mohd Nor (2002) entitled *Towards Improving The Refit Management of Ships of the Royal Malaysian Navy.*

THE RMN FLEET MAINTENANCE DEPOT (FMD)

Roles and Responsibilities

Following the privatization of the Naval Dockyard on March 1996, the Fleet Maintenance Depot (FMD) had undergone a major restructuring programme. Many of the staffs opted out of the Navy to join the private sector in the new organization known as the PSC-Naval Dockyard Sdn. Bhd. FMD was then given a new role to manage the maintenance support for the RMN Fleet as follows:

- To provide maintenance support for RMN Fleet up to Intermediate Level Management (ILM).

- To provide technical support and advise to ship staffs in identifying defect and subsequently manage its rectification.

- To implement policies on maintenance issued by higher management.

- To supervise the effective implementation of Ship Maintenance System practiced by small ships.

- To collect and analyze records and statistics with the objective of improving performance of maintenance management.

Organizational Structure

FMD original organization structure that was approved is based on three main departments namely Riggers & Sailoft Workshop, Fleet Workshops and Fleet Facilities. Since then, FMD has now restructured its organization based on the current three functional departments namely Administration Department, Fleet Engineering Management Department, and Fleet Maintenance Department (Kamarulzaman, 2002). The new structure further includes ten workshops of which six are now in operations, focusing in maintenance repair to support the RMN Fleet (as shown in Figure 3.1). Having studied the new structure, the functional areas seemed to be adequate and are a marked improvement compared to the earlier structure but it still considered as very compartmentalized.

FMD People

Spiegel, J. and Torres, C. (1995), states that organizations that exist today demand a high level of performance from their employees. Simply complying with rules and obeying supervisors is no longer enough; organizations need employees or staffs who are highly committed and willing to work in new ways. Therefore effective teamwork in the workplace will greatly increase the probability that the organization will achieve their strategic goals.

Based on Kamarulzaman (2002) findings, FMD also have the same expectations from its people. However, according to Cdr Wan Kong Seng RMN, he is finding difficulty to form effective teamwork due to lack of personnel especially officers and senior ratings and also the lack of technical expertise amongst the personnel that are currently appointed to FMD.

Restructuring of FMD

FMD has proposed a restructuring plan in its efforts to increase its overall performance and to address issues of effectiveness and efficiency. This restructuring plan involves an increase of more skilled and experienced personnel, more officers and senior rating. This is due to increasing numbers of RMN ships and also the level of sophistication of its systems and equipment, which require more experienced and skilled maintainers. Currently, the approved billets for FMD have a very high percentage of junior ratings compared to officers and senior ratings. With the introduction of Information Communication Technology (ICT) in FMD and in line with the concept of "lean and mean", the new proposal is able to achieve in an overall reduction of 33 personnel.

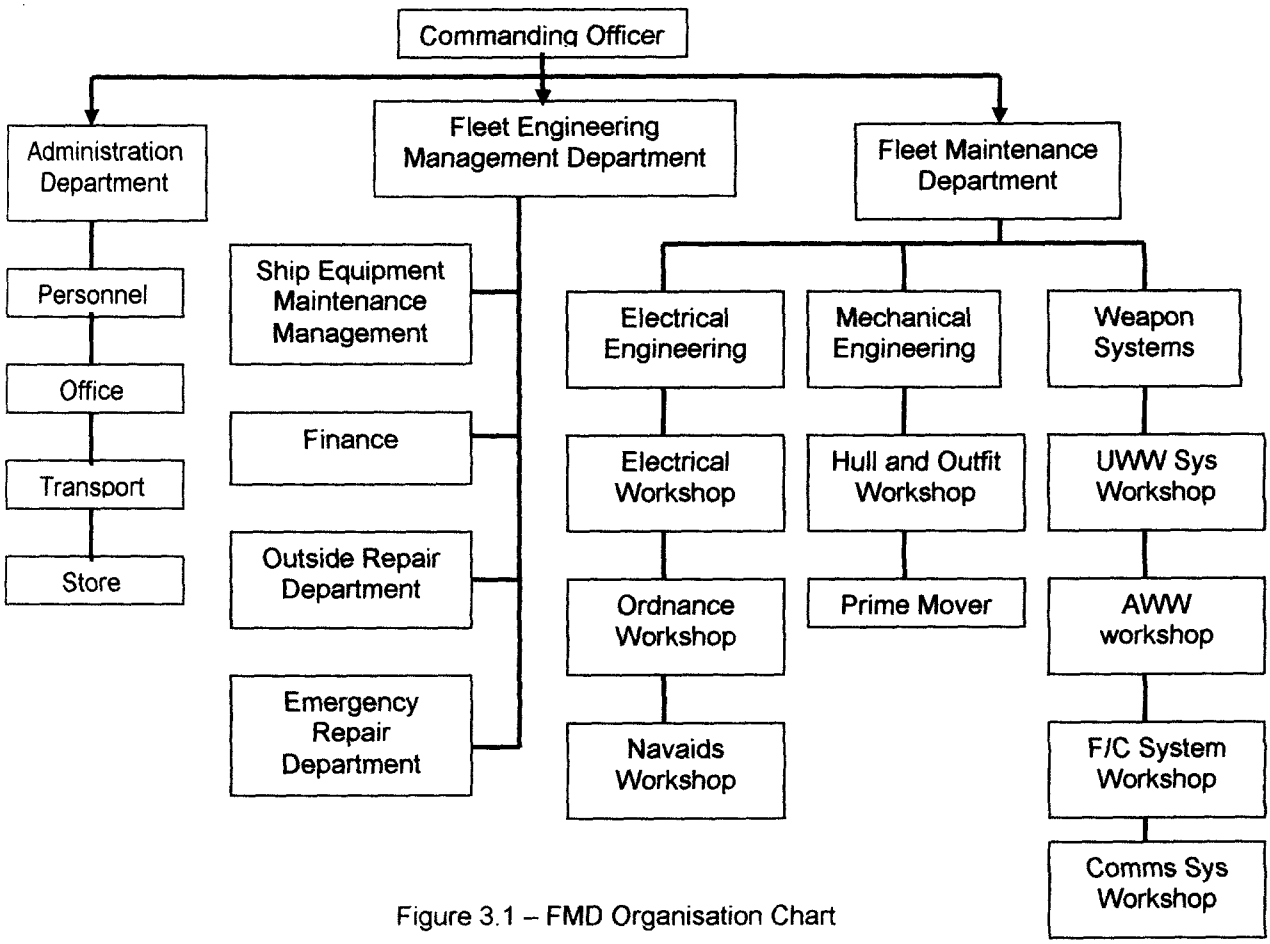

Figure 3.1 – FMD Organisation Chart

Source: FMD Manual Sistem Pengurusan Kualiti

Current Work Policies

Currently the work policies in various departments in FMD are laid down in the standing orders of FMD and several other instructions. This does not include the other policies in various memorandum and reference issues by other agencies and higher management. Having inspected these policies, it is clear that most of these policies have not been reviewed since they were produced. There are newer or later policies but actions should have been taken to rationalize these changes so as to facilitate cross-reference and also to avoid confusion especially to the personnel at the lower level.

Kamarulzaman (2002) found that most staffs especially the junior ratings find these policies or orders are not clear but did not attempt to seek clarification from the management but instead just signed them as being read and understood. The finding from the survey conducted also confirmed that policies and instruction are not well communicated especially to the personnel at the lower level. This highlighted the issue of ineffective communication with respect to written policies and instructions.

Current Work Practice

Maintenance management in FMD is currently divided into three major maintenance activities categorized as emergency outside repair (ERDL), normal outside repair (NOOR) and work to be carried out by FMD workshops. ERDL are maintenance repair jobs awarded to vendors based on urgent requirement while the normal outside maintenance repair (NOOR) jobs are those jobs awarded to vendors where urgency is not the criteria.

The current practice is that when ships determined that certain jobs are beyond ship's technical staff capability, work orders in the form of job cards are prepared and sent to FMD for action. The workload of FMD can therefore be

determined by the number of job cards, which in turn determine the number of work managed by FMD. A total of 5919 work orders were received by FMD from January till August 2002, where work orders on electronic is the highest at 27%. Based on the same data the average work orders or job cards received by FMD each month is about 750. Having analyzed the process in managing these work orders, it was found that there is tremendous paperwork and bureaucracies that contributed to significant delays to the overall completion of maintenance work managed by FMD. The problems of bureaucracies and inefficiency of managing paperwork have resulted in delays which are usually twice the duration of the actual repair or maintenance itself (Kamarulzaman, 2002). This reflects the inefficiency of processes even for those jobs that does not require spares. Job that requires spares have time-scales that are effectively is out of FMD's control. It is felt that the significant delays, especially that resulting from paperwork, unnecessary work processes and poor work culture could easily be reduced through some changes and strategies to be adopted by the organization. Management of work orders are currently manually done right from the preparation stage by ship staff, recording at the job card section, checking of spares and handling by the designated work shop or outside repair section takes a very long time. An average paper work chase, including lengthy and bureaucratic procedures may take up to 8 weeks while the actual maintenance repair work may take 2 - 4 weeks to complete! Unfortunately, this is another aspect that is not currently measured by FMD. Since the majority of work orders are outsourced, this further adds to the delay due to the tender process and also from the bureaucratic procedures of getting necessary approval from higher management. Not withstanding the above problems, the author felt that any delays that are due to inefficiency of people, paper work process lags and also bureaucracies should be considered unacceptable.

FLEET SUPPLY DEPOT (FSD)

FSD Mission and Objective

Fleet Supply Depot with its previous name being Central Naval Logistics Depot was established on 3 April 1985. The change of name means restructuring the organisation as well. This move is considered a continuous improvement towards quality.

The mission statement of FSD is 'Managing the supply of spares and equipment to the fleet efficiently and effectively in support of RMN strategic interest and ensuring the high fleet readiness'

FSD operational objective is 'To provide quality, effective and efficient supply services of spares and equipment to the ships and depots in order to achieve at least 70% fleet readiness' (source: Anugerah Kualiti Kementerian Pertahanan 2003 Kategori Inovasi (Sistem)Sistem E-Pembelian).

FSD Organisational Structure

FSD organisational structure which was a result of the restructuring, combine the responsibility of CNLD and Fleet Supply Support Unit (FSSU). This is done with the intention to enhance effectiveness of supply work processes. The approved organisation is as Figure 3.2.

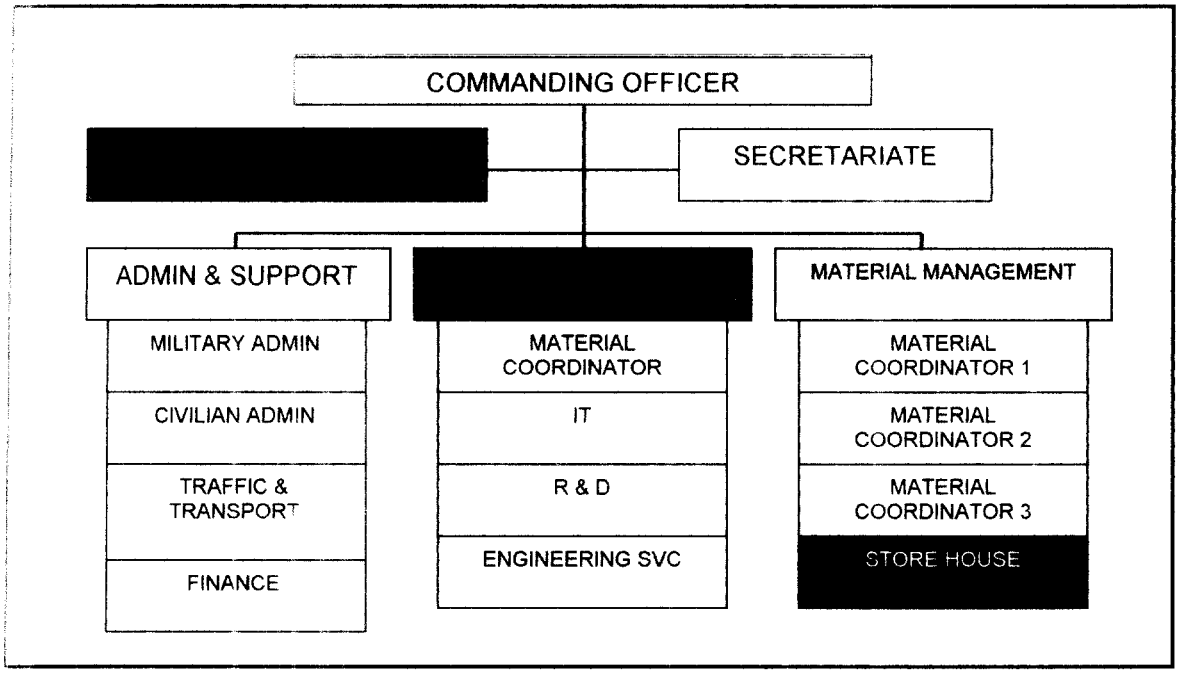

Figure 3.2 – FSD Organisation Chart
(Source: Anugerah AKKP – Anugerah Inovasi (Sistem) 2003

The structure shows three main divisions namely Administration and Support, Inventory Control and Material Control.

Administration and Support. This division focus on the overall administration and support other divisions in human resource management, receipt of inventory, transport, delivery and finance.

Inventory Management. This division is responsible for the control and management of inventory which include inventory accounting, coordination and control of demand.

Material Management. This division is responsible for material procurement, supply and physical stock management (inclusive of spares contract management).

FSD activities is summarised as follows:

- Planning of spares procurement.
- Planning of annual budget.
- Preparation of spares contract.
- Managing the procurement through contract, direct purchase, emergency purchase and Foreign Military Sales.
- Spares inspection and receipt
- Storage
- Issue and delivery
- Preservation
- Disposal

Figure 3.3 – FSD Management Concept

(Source: Anugerah AKKP – Anugerah Inovasi (Sistem) 2003)

FSD Management Concept

FSD advocate to Total Quality Management (TQM) concept since 1996. The financial power entrusted is optimise to provide total logistics support to RMN as a whole the fleet in particular to ensure above 70% readiness. The FSD management concept is illustrated in Figure 3.3. The concept need updating on figure as new assets has been procured since then like the inception of the new helicopters, 6 Superlynx and 6 Fennec and soon the submarines.

FSD Achievement

FSD won the awards known as *Kualiti Kementerian Pertahanan Kategori Teknologi Maklumat* in 1998 and *Kategori Pengurusan Logistik* in 2002. The overall performance in material support for 2003 was reported as an improvement from 2003 as follows:

- Normal demand - 79.87%
- Priority demand 30.15%
- Storedem (demand by signal message) 23.23%

The data above showed that FSD managed to cope with the normal BAT L8 demand which are routine where priority demand is still below average. Urgent demand by signal which denotes urgency and affecting ship's mission and operational availability is well below expectation. The demand and issue flow chart for is as shown in Figure 3.4.

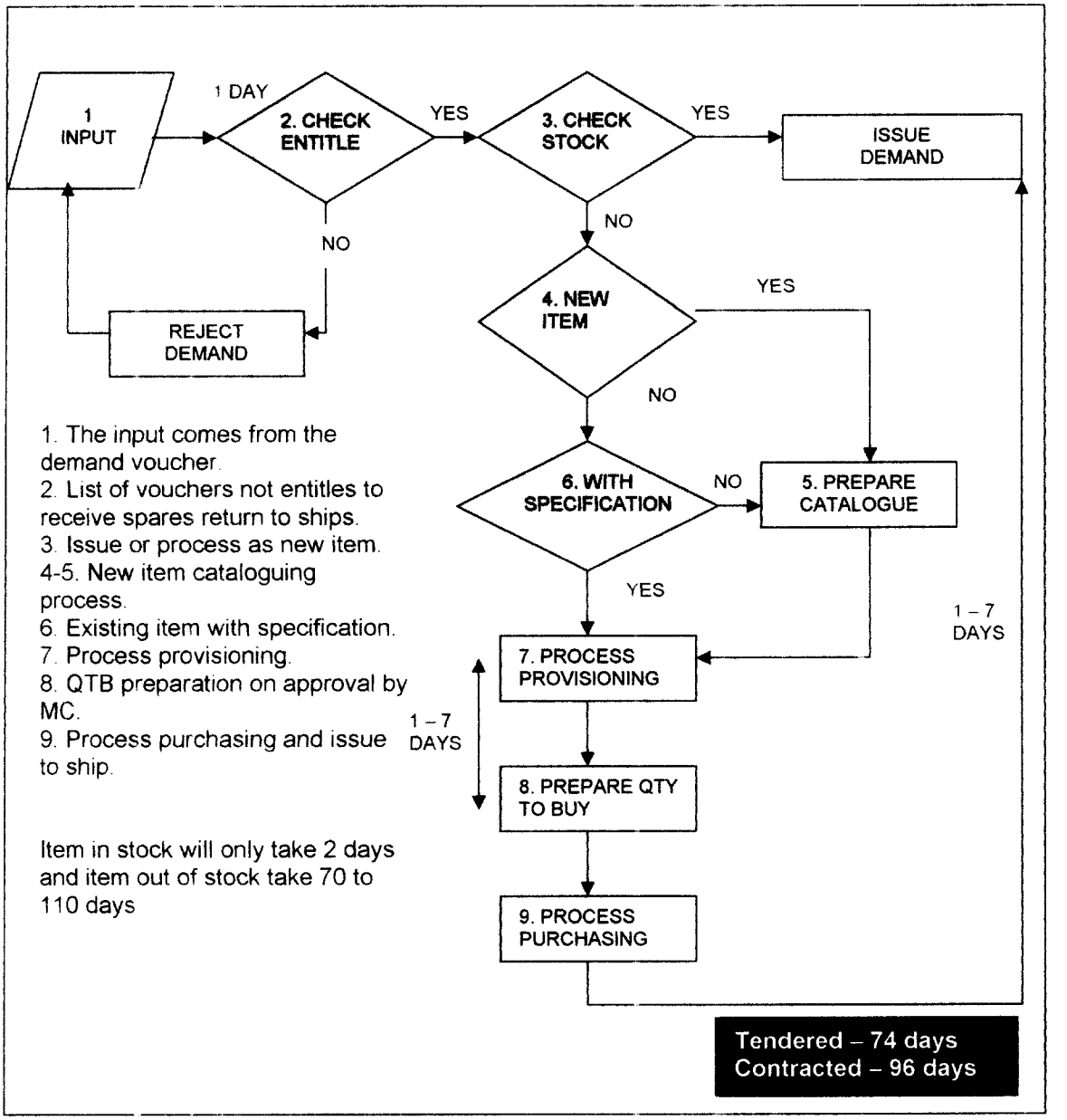

Figure 3.4 – Demand and Issue Process

(Source: Anugerah AKKP – Anugerah Inovasi (Sistem) 2003

The flow chart above is much dependent on the vendors and suppliers efficiency. The purchase deal with inefficient vendors or suppliers take longer delivery period as they need to be reminded on their obligation. A process without reminder will take a total minimum period of 26 days while the one with reminder will take 40 days (an additional 14 days for the reminder delivery date). The internal process once decision to purchase is made take 23 days. Processes

for tender or contract require additional 25 days and 46 days (for items less and more than RM 20,000 respectively) including Ministry of Defence approval. Finally the delivery will take 26 days (without reminder) or 40 days if reminder is necessary.

RMN'S CAPABILITY ENHANCEMENT

As with many other organizations, the RMN's capability too has been enhanced in the recent years, focused in two core areas; namely management operations and combat capability. The navy is in fact the first among the three services of the Malaysian Armed Forces (MAF) and one of the pioneer government agencies to have embarked on a comprehensive ICT programme with the first phase of the RMNnet launched in 2000. Recent survey show impressive result on computer literacy amongst RMN personnel as a result of the RMNnet inception. This effort is in line with the move by RMN to change its structural and management processes. An example of this is the Automated Store Retrieval System (ASRS) that has been installed in the FSD which will reduce the work force by 50% from the current 600. The navy is in fact going beyond that with investment in technology that challenges its work processes and policies with the aim of further enhancing its performance in all sectors (Ghazemy ,2004).

The navy has always been consolidating their requirement and needs in conjunction with reviewing the policies, particularly with respect to upgrading and transforming the existing fleet into the future fleet through various programmes. A comprehensive and structured Service Life Extension Programme (SLEP), is being implemented to upgrade sensors, weapon, communications and where possible upgrading of all areas of warfare. The navy is introducing new concepts of Reliability Centred Maintenance (RCM) and Operational Centred Maintenance (OCM) into our maintenance philosophy.

I subscribe that we focus more on cost effectiveness to attain maximum return on investment in our future procurement and development programmes which will have to take cognizant of our fleet needs. Dato' Sri Mohd Anwar Mohd Nor (Ghazemy ,2004).

The navy will start the RCM and OCM with the concept phase, followed by experimentation phase which will be validated by the Fleet and finally the procurement phase. It is also exploring new initiatives such as Privately Finance Initiatives (PFI) as alternatives to the traditional approach of procurement and infrastructure development especially for the non-critical assets or services to avoid high capital investment and high operating costs. Effort will also be given on pursuing the improvement of Navy Supply Chain Management by adopting the concept of just in time (JIT) in order to reduce inventory holding and minimise risk and wastage. This will be done by promoting smart partnership with local companies in the defence industries who share our vision and together play an important role to collectively deliver combat readiness and creating value for stakeholders. Within the initiatives discussed, the navy foresee improvements in its Fleet deployment with respect to increasing number of sea days. The RMN Fleet combat readiness can also be enhanced by being able to operate at a very short notice. The new RMN maintenance philosophy is aimed to also achieve a higher return on investment and cost saving for the government.

Revolutionising Naval Maintenance with RCM

RCM is a systematic approach to develop a focused, effective and cost-efficient preventive maintenance programme and control plan for a system or product. This technique is best initiated during the early system design process and evolves as the system is developed, produced and deployed. However, this technique also can be used to evaluate preventive maintenance programmes for existing systems, with the objective of continuous product/process improvement.

As mentioned by the Chief of the RMN, 'the navy is introducing new concepts of RCM', this means that the RMN is looking forward to revolutionise its maintenance concept realizing that the present maintenance system no longer can economically sustain the RMN fleet to meet the desired operational availability. 'Operational' encompasses of mission capability as well.

Asset Performance Management

In business world, running a plant can is very complicated but it can be reduced to a few basic principals (Figure 3.5). Business drivers (products, quantities and margins) initiate the process and lead to strategies. The span of encompasses everything from equipment and process design to human resources needs-analysis to the development of key performance indicators (KPI). Within the confines of asset performance health, this phase would involve risk-based inspections, condition-based monitoring and RCM strategies, along with establishing operational and asset reliability metrics. Strategies, in turn, are tactically implemented in the execute phase. This involves the full range of operational and maintenance activities. There are a host of technologies that are used to schedule, monitor and record tasks during this phase including condition monitoring technologies, process control systems, data historians and numerous other small departmental systems. At the end of this phase, both product and massive amounts of data have been produced. While every company employs some form of evaluation of its data, few, if any, perform these analyses on data from both operational and maintenance systems. Furthermore, they rarely, if ever, use the results of the analyses to revise strategy and thereby continuously improve asset health and operational efficiency. The Asset Performance Management (APM) framework illustrated in Figure 3.5 provides a roadmap for management, operations, engineering and maintenance to achieve operational excellence with all its attendant benefits: profitability, predictable production at the lowest possible cost, and failure-free operations. It also provides a context within which to determine the correct technologies to implement in order to

realise best-in-class reliable operations. In addition to employing technology that uses the results of the evaluate stage to revise strategies and improve execution. Another benefit to using APM technology is that it can be implemented in stages. As real opportunities for improvement are identified and addressed, plants can readily adopt incremental improvements without protracted rollout programs, thereby realizing plant performance benefits within a smaller time frame.

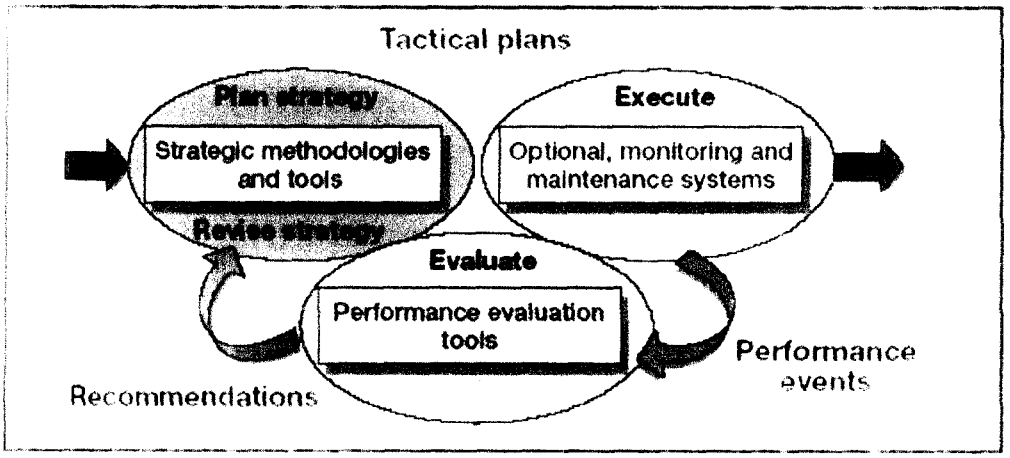

Figure 3.5 - Asset Performance Management
(Source: http://www.meridium.com/news_events/articles/pdf_files/Meridium%20PTQ%202003.pdf)

It is apparent that the Royal Navy has made enormous progress over the pass five to six years in implementing RCM-based maintenance programmes to the Hunt Class MCMVs, Type 23 Frigate and other platforms and that the benefit of RCM no longer need justification in the naval context. Royal Australian Navy (through the ANZAC) and the United States Navy Naval Air Warfare Centre have also started using RCM to review maintenance policies across a range of systems (Alun, 2003). Figure 3.6 illustrate a sample of RCM logic diagram.

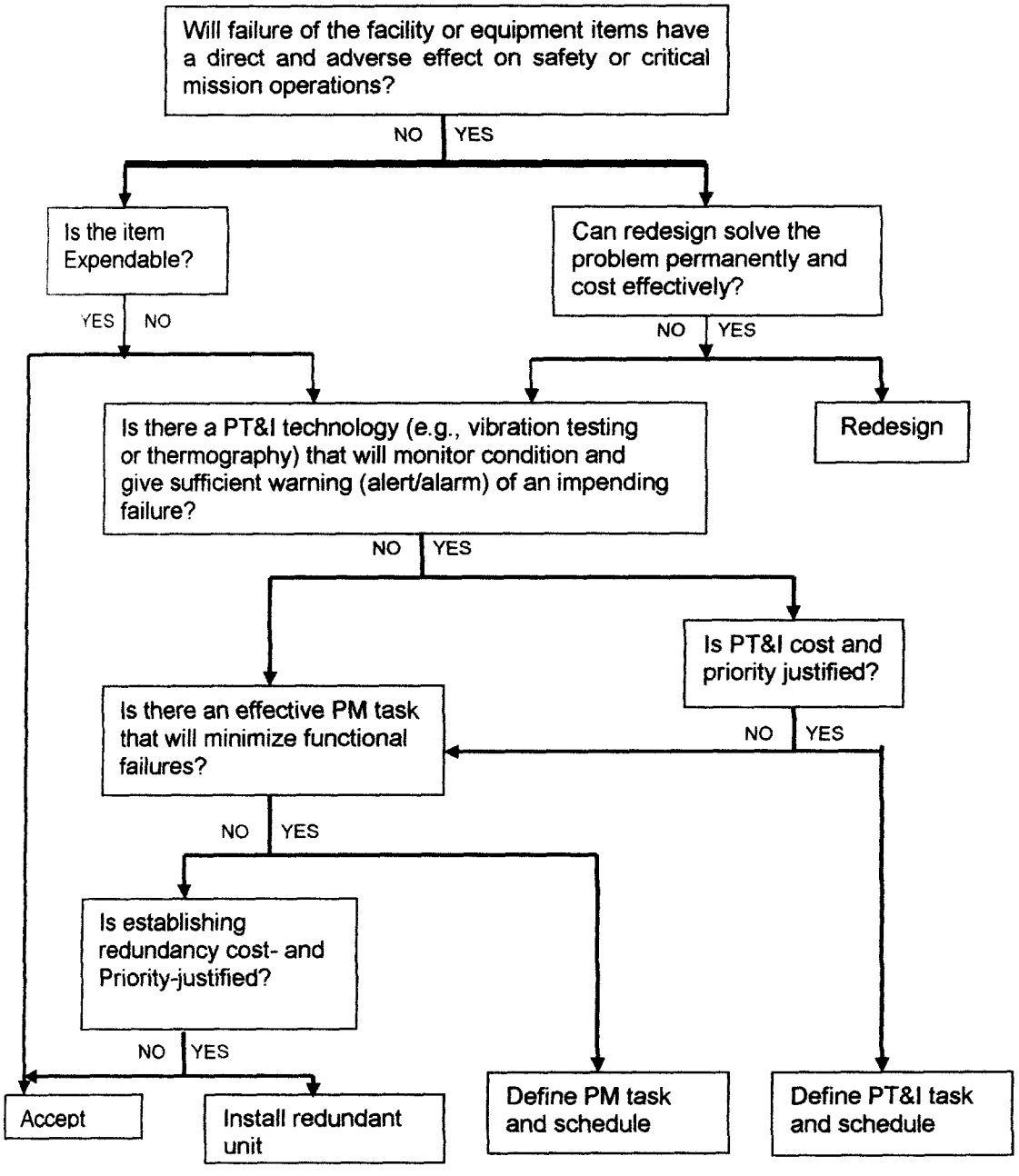

Figure 3.6 – Reliability Centred Maintenance (RCM) Decision Logic Diagram (Source: www.hq.nasa.gov/office/codej/codejx/rcm-iig.pdf - 2290k)

The set goal for RCM is to do more with less. The navy would obtain 'value for money' and in parallel, improve operating system, system reliability and platform availability. The process then requires the examination of each critical failure mode to determine the optimum maintenance policy to reduce the severity of each failure. The chosen maintenance strategy must take into account cost, safety, environmental and operational consequences. The effects of redundancy,

spares costs, maintenance crew costs, equipment ageing and repair times must be taken into account along with many other parameters. Once optimal maintenance policies have been recorded the RCM process provides system performance predictions and costs, expected spares requirements and maintenance crew manning levels. The RCM process may be used to develop a living strategy with the plant model being updated when new data is available or design changes take place.

INTEGRATED LOGISTICS SUPPORT POLICY IN RMN

The Logistic Support Model

RMN presently apply ILS concept in operating its assets. Elements of logistics support in the model advocated by Blanchard (1998) as structured in Figure 3.7 represent only an example of how one may wish to breakdown the resources required for system maintenance and support. Although the particular category descriptors may vary with RMN, the critical issue is to ensure that all of the applicable resource requirements are included somewhere.

The complexity and cost of naval systems, especially weapons and electronics systems, has generally escalated with advances in technology while the corresponding through-life support costs have also increased in proportion with the initial prime system costs. In order to maximise life cycle cost, logistic support requirements and balance between operational requirements, economic and logistics factors must be considered very early, that is in the beginning, during the concept phase of the system life-cycle (RMN Manual, 2004)

Logistic support considerations are intrinsically inter-linked, and hence it is necessary to adopt an integrated approach to provide cost-effective logistic support consistent with preparedness requirements. Logistic support considerations must be developed concurrently with systems design, so that life

cycle support considerations can positively influence design or design selection. Therefore an Integrated Logistic Support approach is to be institutionalised in the RMN for all future naval acquisition programmes.

Policy

The policy of the RMN is to procure naval systems that meet cost, schedule and performance requirements. As supportability is an integral component of performance, ILS principles and practices shall be applied to all acquisition projects and this must be considered in the early stages of acquisitions that is in the concept phase. This is to ensure naval systems that are acquired meet performance requirements at minimum life cycle cost. The principles and practices of ILS shall also be continued to be applied to the in-service management of naval systems throughout their programmed service life. The researchers through a written questions forwarded to Navy HQ obtained the following statement 'RMN adopted the management concept of ILS in ensuring its logistic support for mission ready fleet at all times(Anon, 2004) ILS is a whole life management discipline, which integrates all support and service considerations for individual items and equipment. The elements of ILS as advocated by RMN found to be similar, and as described below according to Blanchard (1998). The cycle of failure in logistic support in RMN as shown in Figure 3.8.

Maintenance and Support Planning

This includes all planning and analysis associated with the establishment of requirements for the overall support of a system throughout its life cycle. Maintenance planning constitute a sustaining level of activity commencing with the development of the maintenance concept and continuing through the accomplishment of supportability analyses during system design and development, the procurement and acquisition of support items, the system

utilisation phase when an on going maintenance and support capability is required to sustain operations and during the retirement phase when material are being recycled or phased-out for disposal (Blanchard, 1998). Maintenance planning should result in the integration of the various facets of support with each other, with the prime mission-related elements of the system, and should lead to the definition and development of the infrastructure as shown in Figure 3.7.

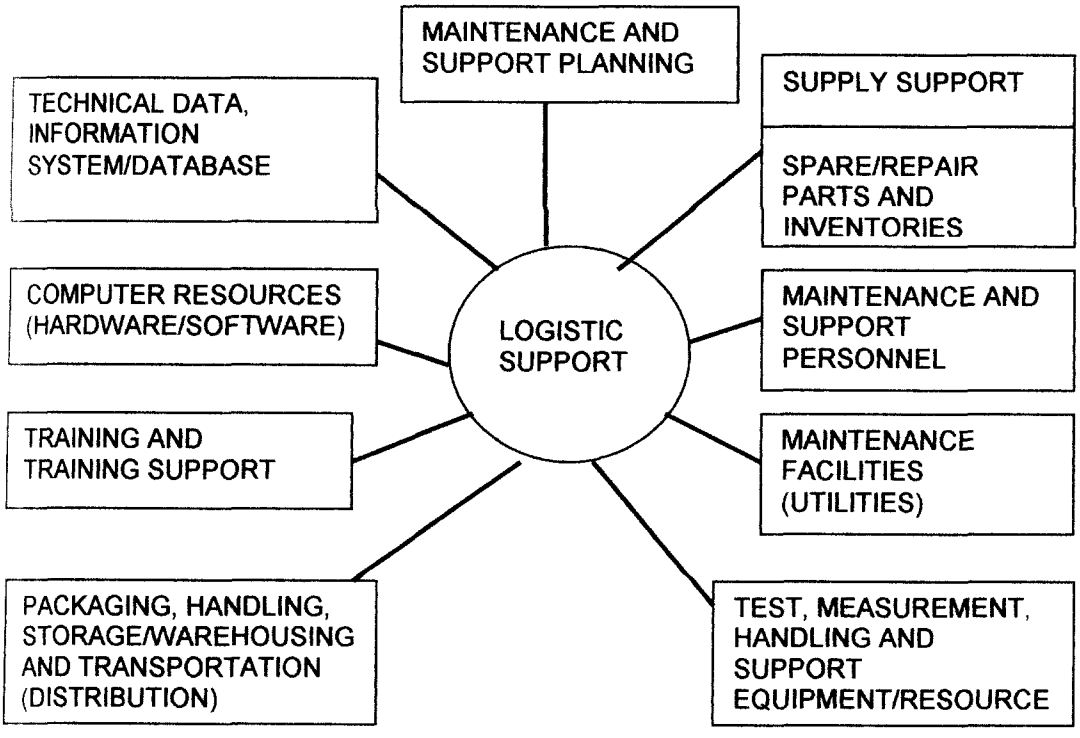

Figure 3.7 The Basic Elements of Logistic Support

Source: Blanchard, B.S. Logistics Engineering and Management.1998

Supply Support

Supply support includes all spares (repairable units, assemblies, modules, repair parts (non-repairable components), consumables (liquids, lubricants and disposable items), supplies, and related inventories needed to maintain the prime mission-related equipment, computers and software, test and support equipment, transportation and handling equipment, training equipment and facilities. Also included are the provisioning and procurement activities and documentation

associated with material acquisition, handling, distribution, recycling and disposal. *This is the main area where RMN should revisit as it seemed to be the* root cause of its logistic support efficiency and effectiveness. From the research, it is found that procurement of spare parts is done through contract. RMN experience showed that the time taken to sign a contract, extend the contract period or increase contract ceiling took long time, As a result, the procurement have to be done via quotation or direct purchase, but these methods cannot fulfil the customer demand. Some demands were kept outstanding until the contract signed.

System Operation - Mission

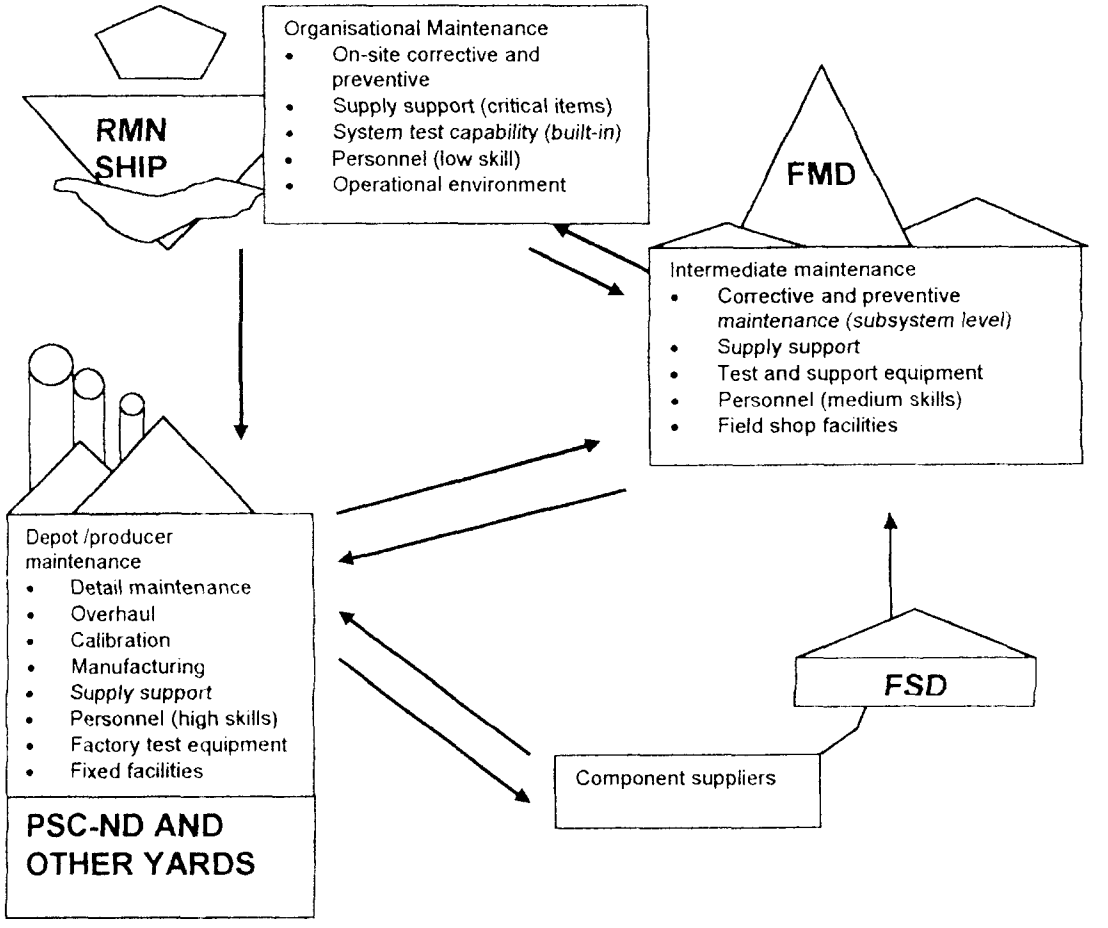

Figure 3.9 –Infrastructure

Source : Own Model Based on ILS Support Infrastructure

Maintenance and Support Personnel

Manpower and personnel is one of the important elements in ILS. This includes the identification of human resource with ranks and skills classification necessary to manage, operate, maintain and support the equipment throughout its life cycle. RMN policy on this aspect is 'Right man for the Right job'. RMN adopted Skill Matrix (trade/specialization/knowledge) as guideline of requirement. In manning the directorate gave priority to ships and key personnel to overcome shortage of manpower. This category includes personnel required for the installation, checkout, and sustaining maintenance and support of the system, its prime mission-related elements and the other elements of support (e.g. test equipment, transportation and handling equipment and facilities). FSD is currently is running at 63% complemented (manpower strength) and these present a great impact in it effort towards service improvement. The work load on average ranges between 700 to 1,000 demands per day. An interview with Lt Cdr Shamsol RMN, revealed that shortage of trained and skilled personnel to handle computer system posed a problem to the proper management of *Sistem Pengurusan Inventori Armada* (SPIA). The updating of data also were found difficult as a result of the rapid transfer of personnel.

RMN Planning and Implementation

ILS concept in new acquisition programmes is well understood and quite easily be implemented as the RMN is involved from the very beginning. As for the new acquisitions, the proposal progress from concept through options to naval system, the through-life logistic support aspect shall be considered integrally with the proposals. Most of the cost-drivers of in-service support are determined by decisions made during early capability analysis, development proposals and naval project definition studies and through General Staff Requirements (GSR). Adequate recognition must therefore be given, during the

concept and acquisition phase, to the factors needed to establish and maintain effective and efficient life cycle logistic support.

The ILS transition plan will address the in-service logistic support management plan (ILSMP). The ILS management plan developed during the acquisition phase, and which is part of the transition plan document, must be reviewed, updated and continuously improved throughout the life of the naval systems to meet operational readiness objectives. In-service management of naval systems must also consider the interrelationship of all the ILS elements when reviewing proposed designed modifications, upgrades and modernisation programmes and variations to activity levels or operational roles.

Logistic support analysis in term of availability, reliability, maintainability, supportability and life cycle cost analysis must be carried out continuously to improve the ILS deliverables and elements developed during the acquisition phase.

Training and Training Support

This includes all personnel, equipment, facilities, data/documentation, associated resources necessary for the system operational and maintenance personnel, to include initial and replenishment training. Training equipment (such as simulators, mock-ups and special devices), data and software are developed and utilised as necessary to support both the informal day-to-day training and that of a more formal nature. Training and training support has to some extend been 'neglected' or become second priority due to shortage of man power and limited budget. This aspect is vital and has great effect on system reliability, maintainability and availability. Simple questions like 'are the personnel on board ships fully trained to operate the expensive systems?' and 'are the maintenance personnel ashore fully trained to perform the ILM they are expected to do, with reference to up-to-date documentations utilising proper tools and facilities?'

RMN Training and Education

ILS training and education needs to be continued and sufficient knowledge must be given to officers and men who will be involved in the development of ILS in the RMN, ILS managers for new projects, logistic support analysis in the Fleet System Command, engineering/supply officers in Naval Support Command and ILS instructors and maintenance officers in the Naval Education and Training Command (NETC).

The policy provides high level guidance for the provision of effective and efficient through life support for naval system at minimum life cycle cost. This policy also provides the direction for the development of ILS management, processes and procedures.

The application of ILS consideration in the early stage of acquisition programme for new capabilities in the RMN is the way ahead (Royal Malaysian Navy Integrated Logistic Support Policy and Procedures Manual, 2004). This process will offer the user a system that not only meet the operational and performance requirements, but one that can be expeditiously and economically supported throughout its programmed life cycle.

The concept of ILS management approach shall also be applied to the existing assets to institutionalise continuous improvements to the present support system and infrastructure. However, reviewing to the present support system should provide avenues and facilitate interfacing and integration of future support requirements for new RMN capabilities (RMN Manual, 2004)

Test, Measurement, Handling and Support Equipment

This category includes all tools, condition monitoring equipment, diagnostic and checkout equipment, special test equipment, metrology and calibration equipment, maintenance fixtures and stands and special handling equipment required to support all scheduled and unscheduled maintenance actions associated with the system. Test and support equipment requirements at each level of maintenance must be addresses as well as the overall requirements for test traceability to a secondary standard and ultimately to a primary standard of some type. RMN has lost some of its special tools and equipment to Naval Dockyard in the process of privatisation of the later, which end up as a separate entity as PSC-NDSB. These losses were never regained.

Packaging, Handling, Storage/Warehousing and Transportation

This element of logistics includes all materials, equipment, special provisions, containers (reusable and disposable) and supplies necessary support the packaging, preservation, storage, handling and/or transportation of the prime mission-related elements of the system, personnel, spares and repair parts, test and support equipment, technical data, software and mobile facilities. This category basically covers the initial and sustaining transportation requirements in support of the distribution of materials and personnel and the maintenance cycle. Transportation shall include all available means possible to support it (air, highway, railway, waterway and pipeline). The process may well be looked at starting from 'order ship time'. For RMN this element is tagged with Spare Parts Contract. The contractual clauses do not side the FSD who serve the fleet. Delivery period of urgently needed spare parts for ship undergoing maintenance in yard are not met. There is no provision to allow for urgent supply. The weakness of the logistic support system starts with the long lead-time of even standard spares (which is not categorised under long lead-time spares by Original Equipment Manufacturer (OEM). These lead times clocked at times until

12 months. In addition to this, the government policy on delivery of spare part, forming part of the spare parts contract is either Freight Onboard (FOB) or FCA (via aircraft - using the International Commercial Term) employing national transport operator (MTO). MTO fails to meet the customer needs.

Maintenance Facilities

This category includes all facilities required to support scheduled and unscheduled maintenance actions at all levels (see Fig. 3.9). Physical plant, portable buildings, mobile vans, housing, intermediate-level maintenance shops, calibration laboratories and special repair shops (depot, overall, material suppliers) must be considered. Capital equipment and utilities (heat, power, energy requirement, environmental controls, communications and etc) are generally included as part of facilities.

RMN Support Centres

The FOS task is no easy matter and it will require a dedicated management team to keep the ILS programme going. Depending on the size of the task it may be more sensible to develop a single identity which is responsible for a class of ship. For smaller units such as ship systems, these can be managed under a combined office set up for a specific type of equipment for example, communications, radar, guns or missiles.

The establishment of the single support resource requires resources such as man power and in some cases it may not be cost effective. Regardless of whether the management 'cell' is a separate identity such as Support Centre or whether it is subsumed in a larger management centre does not matter. What is important is that a management responsibility has been assigned (RMN Manual,2004).

One of the major issues in ILS management is the dependency on figure of merit (FOM) which are sourced from:

a. The manufacturer.

b. Historical experience

c. Predetermined values from defence references, for example; 30% of prime equipment cost.

Even using the values determined from the above, in the case of modern equipment it is unlikely that systems will be trailed to their failure point since that would be costly in terms of time and equipment. The Mean Time Between Failures (MBTF) of a diesel engine may be quoted as 10,000 hours which is a long time to run equipment to confirm original FOM. Therefore, one element of through life management is to actually provide a mechanism which gathers real usage data to validate those original FOM and make any necessary adjustments to the support package. This aspect is a small part of the management but essential in reducing the 'too much' or 'too little' levels of support (RMN Manual, 2004)

Perhaps the major aspect of the through life management is the continued integration of the elements which was determined from planning in the concept and acquisition phases. These elements, the operational requirements, the ILS elements and the funding aspects are all well addressed during the period when equipment acquisition process is being regularly reviewed by the Committee System and by the Navy in general. As a consequence of separate responsibility during the operational phase of equipment, namely:

a. Fleet Operation Commander for operation of ships and equipment.

b. Fleet System Commander for Follow on Support.

c. Naval Education and Training Commander for the continuation training.

d. RMN HQ for the audit and adjustment of policy requirements to represent user requirements during operations.

There is ample opportunity for the cohesion, the integration aspects of the planning to be diluted and changes occurring in element for what ever reason are sometimes not related back to the needs of others. Thus in terms of management of a platform for the whole of its useful life, there is clearly a need to have some central focus which continues the integration aspect of support planning developed in the early phases of equipment life. Such a management function could be conducted by a platform/system Support Centre.

Computer Resource (hardware and software)

This covers all computers, associated software, interfaces and the network necessary to support scheduled and unscheduled activities at each level of maintenance. This may include condition monitoring programmes, diagnostic tapes and associated requirements for the implementation of a computer-aided integrated maintenance management (CIMM) capability. FSD is taking drastic effort to improve its personnel capability to operate SPIA by continuously training them as well as to provide networked computers to all departments including the store house.

Technical Data, Information System and Database Structure

Technical data may include system installation and checkout procedures, operating and maintenance instructions, inspection and calibration procedures.

overhaul instructions, facilities data, modification instructions, engineering design data (specification drawings, material and part list and digital data), supplier data, logistics provisioning and procurement data that are necessary in the performance of system development., production, operation, maintenance and retirement function. Such data should not only cover the prime mission-oriented elements of the system but the other elements of the support infrastructure as well (i.e. test and support equipment, transportation and handling equipment, training equipment and facilities). Included within this category are the information system capabilities , and associated databases that allow for the implementation of effective electronics data interchange(EDI) processes and the requirements associated with continuous acquisition and life-cycle support (CALLS). An interview with Lt Cdr Shamsol (Staff Officer- Material Controller 1), it is found that the system itself (hardware and software) means nothing as the much needed asset is the trained personnel with correct work culture and dedicated. Data that is available may at time not updated into the system and spares are not stored in their proper stowage and more often than not, spares with broken seals were not properly preserved.

The mismatch of data, documentation and physical state of spares will undoubtedly renders the logistic support system ineffective and degrade its effectiveness. There need to be a body that monitor the work process of data management, documentation updates and the matter is taken as a serious root cause to the efficiency and effectiveness of RMN logistic system. FSD is embarking on major stock muster and computer account, due to shortage of manpower, this job would probably be outsourced (contracted). These will include part numbers synchronization (NATO and OEM) and elimination of duplication and unauthorized data in SPIA.

Follow on Support

The types of Follow on Support (FOS) which are applicable are:

Maintenance. In the maintenance programme the various levels of maintenance established and resource/tasks identified to carry out the activity. In some instances there will be some requirement to transfer responsibility from one level to another and in some cases tasks will also be combined. Periodicity of tasks may also vary as ready use data becomes available which indicates, through condition monitoring and other methods of assessment, which maintenance needs to be carried out sooner or later. This change in task and periodicity will have an impact on the other ILS elements especially supply and training.

Supply Support. The levels of sparing developed in the acquisition phase are based on manufacturer's recommendations and experience. Much of the data used is estimated and for that reason the result obtained in terms of actual support levels will be somewhat flexible. As real data becomes available these levels will need to be adjusted.

Training. Courses and course content which has been developed for the equipment will need to be validated by work study as the courses are conducted. Validation requires the course to be run and then the performance of the operators and maintainers need to be evaluated at the work place to validate the training standard to ensure they are capable of completing the set tasks. Amendments to the training plan will also be created by changes in maintenance and supply.

Documentation. Manuals and digital information needs to be validated in real life and amendments provided where process does not meet the actual practice.

Configuration Management. During the development of the ship or equipment a base line for configuration is established. This is particularly critical when ships are built in flights with slight variations in fit between the different builds. The accuracy of configuration is essential in retaining the validity of the support package. If the equipment is modified or replaced by the next model, it is not much value retaining the spares and tools for the original piece of gear at the expense of the new piece. The FOS requirement will vary when re-supply is required and if each ship's configuration is not known when modification are proposed or new spares listing are provided, the opportunity to corrupt the support level is quite high.

ILS Issue in RMN

Having applied ILS principles and practices in the Acquisition Phase alone will not be cost effective if these are not transitioned effectively to the Operational Phase to design deliverables with operational data in the RMN in-service support environment throughout the system life-cycle.

The comment of the present RMN in-service support today is that it is very centralised and supported mainly by the following headquarters and units (Lumut area):

- Fleet Operations Command - Assistant Chief of Staff Logistics.
- Fleet System Command - Functionality of Trials, Refit, Maintenance and Supply Support.
- Fleet Maintenance Depot - Repair Agency.
- Fleet Supply Depot - Supply Agency

Although it seems that the present organisation address all the functions required for support, but these functions appear to be undertaken separately and not integrated adequately to provide an effective and efficient life-cycle support.

Enormous data and information is produced and/or processed by these units but the management of these data is not centralised, integrated or coordinated effectively and efficiently. Supply Support considerations may not be in alignment with Maintenance Planning; and Maintenance Planning Concept may not be in alignment with skill levels and manning.

Presently the focus is primarily on functional effectiveness and few performance measures are formulated for the *class of ship* or even *system/equipment*. There is lack of Logistic Support Analysis (LSA) in terms of Availability, Reliability, Supportability and Life-Cycle Cost for the ship, system and equipment. This makes it very difficult to validate the existing logistics support baselines in an integrated system engineering approach and to institute continuous improvement in a cost effective manner. Logistics Support deliverables that are acquired during Acquisition Phase need to be validated in the Operational Phase to ensure initial planning achieves the operational readiness objectives. Without the analysis, RMN would not be able to measure the effectiveness of the ILS deliverables to conform whether they are accurate and adequate. The inception of IT would enhance the work process towards centralised data management and become the tools for the analysis requirement. Enhancement of the IT system into Decision Support System would further expedite the much needed analysis process, the performance measures. Analysis result and relative supportability information can be made available in a single database and can be accessed in an organised and uniform manner.

Standard Marine Engineering Maintenance System

All RMN ships are required to maintain all equipment officially borne onboard according to the instructions specified in 'The Management of Ship Maintenance System (SMS), a book of reference well known as BRL 1985, unless instructed otherwise by official orders to omit or amend any specific sections of the BRL 1985 based on review by the Headquarters FSC from time to time.

The instructions in BRL 1985 apply to all RMN ships. For capital ships, Master Planners are borne onboard. For small ships, the Master Planners operates from the respective FMD, Area Logistic Depot 1 (ALD 1) and ALD 2. Systematic and effective maintenance and repair are laid down in the relevant instruction cards. The responsibility to implement depends on the type of ship (capital or small) and the periodicity of maintenance due. Thus, due to manpower constraints of small ships, the 3 monthly or 250 hours routines and above are done by the relevant area technical support units.

Upkeep of Equipment/Structures

As mentioned earlier, for the upkeep of equipment/structures in the RMN the works involved falls into four categories, namely; preventive maintenance, corrective maintenance, breakdown maintenance and modification, alteration & additions (A & A).

These maintenance approaches to be adopted depends on many factors. The standard approach is preventive maintenance based on periodicity/running hours of the machineries. For other categories, it will depend on the decisions by the relevant authorities according to the criticality of the problem. For the purpose of equipment/structure upkeep, the following documents in Table 3.1 (see Appendix) are provided which specify the routine preventive maintenance

required and how it is to be carried out, and the provision made for initiating, planning and recording it. BRL 1985 are cross referred (read in conjunction with). The vast documentation, procedures and bureaucratic decision making can be seen from the list of documents required for the ship preventive maintenance system.

ASSISTED MAINTENANCE PERIOD

Assisted Maintenance Period/Self Maintenance Period (AMP/SMP) are periods allocated by the repair authority for ships to perform planned maintenance schedule, defects rectification and other works that require the ship to remain alongside in harbour throughout the period. The period allocated is normally 2 weeks.

AMP is applicable to smaller classes of ships below OPV class. Its period is normally slotted in the maintenance cycle between the last refit/slipping and the next refit/slipping of the vessel. SMP is applicable to all classes of ships of OPV and above. Its period normally slotted in the maintenance cycle between the last refit/slipping and the docking for essential defects (DED) or between the last DED and the next refit. When the refit itself is deferred, the chain reaction of shift right programme will occur within the ship operating cycles.

AMP/SMP Planning

Ships are to plan their maintenance period in accordance with their yearly operational tasking and request for the allocation of that period from the appropriate operational command at least 8 weeks in advance. Ships are to submit proposed work list and required spare list at least 8 weeks before start date of AMP/SMP. The work list to include:

- All planned maintenance schedules of four-monthly and six-monthly periodicity and other planned maintenance schedule work that has been deferred. Maintenance schedule for both ship staff and base staff work are to be listed.
- All existing known defects.
- All approved 'A & A' which are within ship staff and base staff capability.

The works which requires base staff assistance are to be followed by job cards. Work planning and control are the responsibility of the ship's engineering officer or senior engineering staff onboard. Not knowing the procedure, the ship schedule will be jeopardised. The resultant is will be the AMP/SMP being deferred to next available period and the maintenance due date of equipment will be over due.

Procedures

Detailed procedures on implementing the AMP/SMP for RMN ships are described in the current FSC general memo. A meeting will be conducted before AMP/SMP commences as a control tools. The meeting will be chaired by a representative from base supply depot, the CO and other key personnel from the ship are to be present. For works beyond the ship staff and base staff capability, they are normally tendered out for repair through NOOR section or emergency repair.

On completion of the AMP/SMP, ships are required to submit a report on the status of work. Incomplete works will be listed and ships will raise comments and observations against such works.

Pre/Post Refit/Slipping Trials and Preparations

Pre/Post Refit/Slipping trials are conducted to determine the operational and performance capability of an equipment or system based on the pre-set standards. Trials can be classified under 2 categories; Routine Trials and Occasional Trials. The conduct of the trial determined the standard achieved where technical skill and knowledge of RMN personnel is important. Lack of skill and knowledge and the ageing ships and equipment is a great challenge (the flow of trial process as displayed in Figure 3.10).

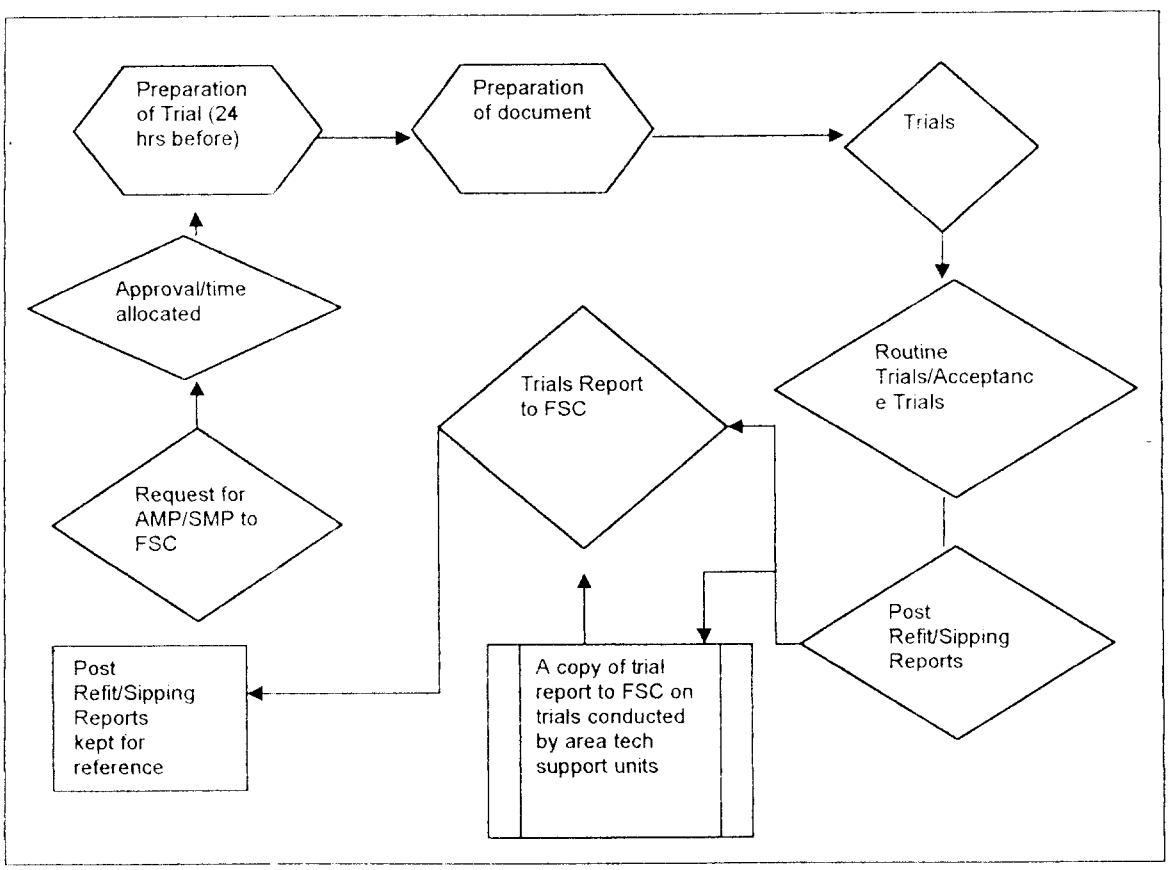

Figure 3.10 - Flow Process of Trials

Source: Own Design Based on Refit Trials

Conduct of Ships in Shipyard

This area is not covered in this paper, however it must be noted that the outcome or product of the shipyard do contribute to the availability of mission ready ships as some of them do join the fleet either as conditionally accepted. These conditions also cover the mission essentials systems and equipment. This issue is not dealt with in this research because it is beyond the control of the RMN, however its contribution to maintainability, reliability and availability of RMN fleet. The matter shall be dealt with through cooperation with the shipyard(s). Mohd Anwar (2002) proposed that the cooperation as depicted in Figure 3.11.

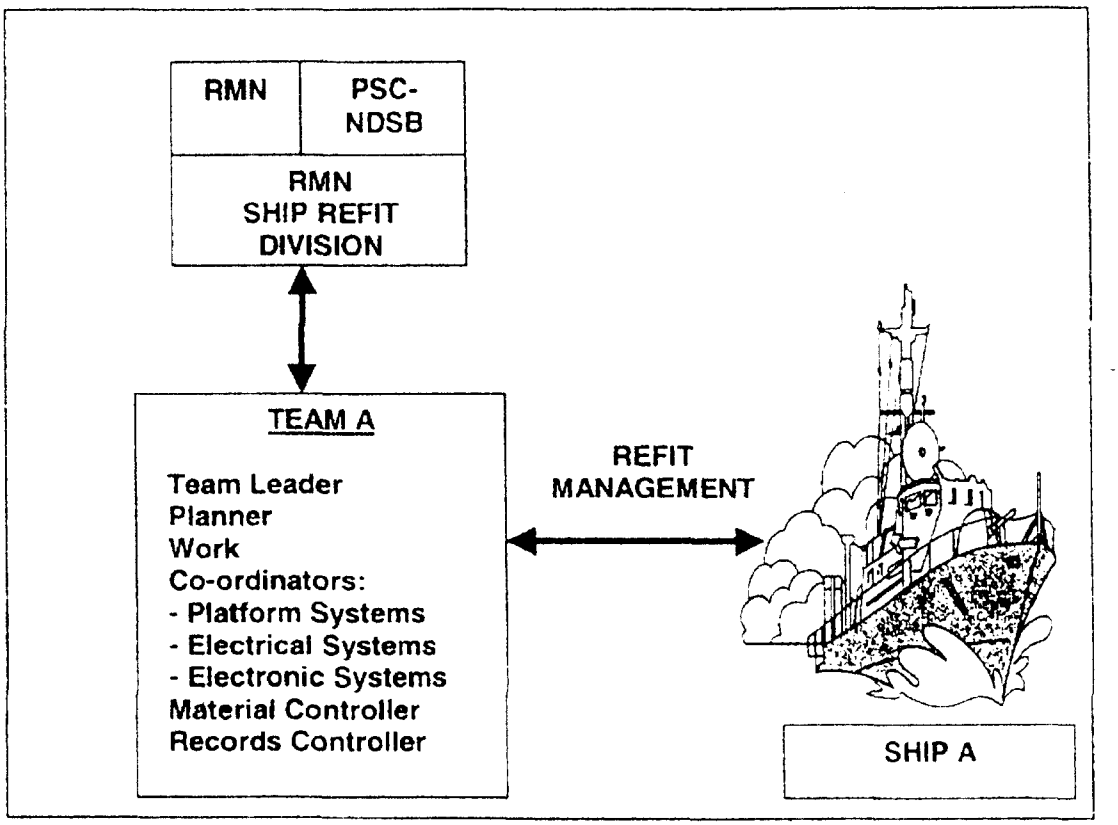

Figure 3.11- Cooperation Schematic (RMN-Shipyard)

Source: Mohd Anwar bin Mohd Nor (2002)

Presently all ships undergoing Long Refit, Refit, Docking, Docking Essential Defects or Slipping are still under their respective command in aspect of their personnel and operational administration. For management of the repair project, Principal Naval Overseer for the ship is answerable to the Commanding Officer of the area's Unit *Pengawasan Senggaraan TLDM (UPS TLDM)*. On the aspects of administration of the maintenance of the ship, the FSC promulgated a publication known as The Management of Ship Maintenance System (SMS)

The customer's (fleet) satisfaction has been very low as far as shipyards performance are concerned based on verbal interview and both researchers' personal experience. Further study on this matter is needed as this area is not covered here.

Emergency Repairs and Outside Repairs

Defects Requiring Base Assistance. Defects that are beyond ship's capability to repair are to be brought to the attention of the Base Maintenance Depot for their assistance and further remedial actions. The defects are to be reported through Job Cards or Urgent Defect Signals message (URDEF) depending on the urgency of the defects. URDEF are to be followed by Job Card. All defects reported will be investigated and repair attempted by base staff.

Modes of Repair. Defects that are beyond the capability of base staff will be repaired through one of the following means:

- **Emergency Repairs**. Defects which are critical or affecting the ship's operational readiness to a category lower than CAT 2 will be repaired through *Emergency Repair* (by Base Maintenance Depot). Emergency repairs will be carried out in the shortest possible duration and at reasonable cost. Base Maintenance Depot will process the tendering of the work to the registered outside firms.

Prior to that, approval from Ministry of Defence (MoD) is a pre-requisite and the cost of repairs is subjected to query by a committee set up in MoD. Base Maintenance Depot is responsible for the coordination and overseer whilst ship staffs are to provide full assistance.

- **Outside Repairs**. Defects that are not affecting the ship's operational readiness will be repaired through *Outside Repair* by Base Maintenance Depot through NOOR Section. NOOR Section will process all repairs through available government contracts with outside firms, without which repairs will be done through tender with registered firms. The processes of repair through tender are to follow the Local Purchase Order/BB1/BB2 depending on the total cost of the repair. NOOR Section is responsible for coordination of the outside repair and payment process on completion of the repair.

- **Deferred to Next Refit/Slipping**. Defects that are not urgent in nature but the repair may require the ship to be in harbour, alongside or requiring dockyard facilities (affecting the ship's operational state), will be deferred to the next refit/slipping programme of the ship.

The abovementioned process and procedures are subjected to and governed by:

- Treasury Instructions.
- Ministry of Defence Instructions.
- Navy HQ Instructions.
- General Memo of FSC.

It is obvious that the focus of maintenance and repair processes and procedures is on ship's operational status and defects affecting its operation only. A ship that is down in its mission readiness (based on equipment fit, examples are: radar, missile launchers, sonar, torpedo launchers, gun directors, gun, and cranes and ram doors) can still be in CAT 2. An operational ship may not be a mission ready ship. Repairs on mission system and equipment normally take a long time due to the limited capability of ship, base and depot personnel. Fault identification, removing assembly and isolating the defect is not a problem if the repair is by replacement of defect parts but it becomes complicated when the fault finding itself need expertise from the manufacturer. The availability of that expert, the process of fault finding and the lead time of spares may consume up to 12 months for an equipment repair. The down time will be very long.

Inventory Management

The purpose of inventory management is to maintain the correct amount of spares in the appropriate locations to support maintenance. The procedures used to manage spares inventories are the same at each level of supply (OLM ILM and DLM)(Jones,1995)

A supply activity maintains a quantity of a spare. The inventory cycle process start as a customer submit requisitions and are issued spares, the quantity on hand decreases. The supply activity requests quantities from its source to replenish its inventory. The objective is to maintain an adequate quantity on hand to satisfy customer demands.

In theory this sounds simple, but in reality it never quite works out that way. The reason for this is the unpredictable fluctuation in customer demands. That is why the inventory cycle is a series of events that are designed to react to

changes in customer demand so that the necessary spares are on hand when needed. Figure 3.12 illustrates the theoretical inventory cycle.

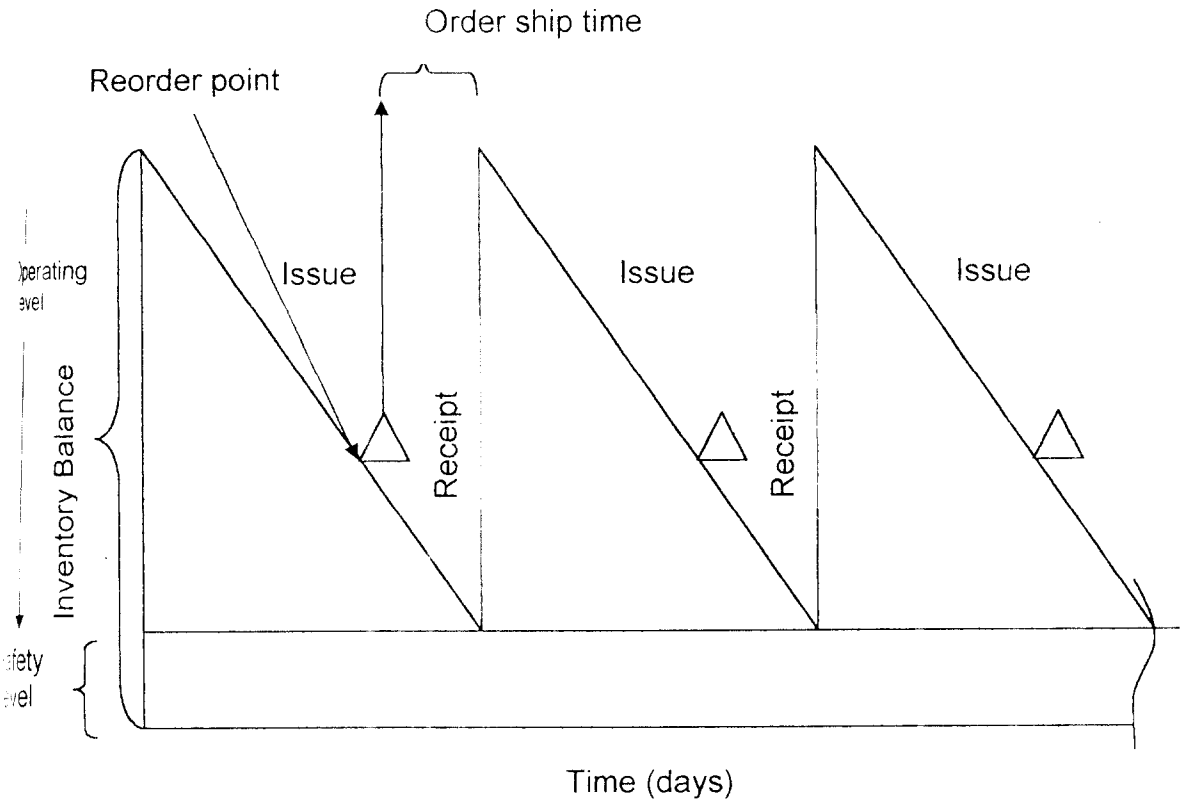

Figure 3.12

Inventory Cycle

(Source: Jones James V, Integrated Logistics Support Handbook)

The key to successful inventory management is to accumulate and maintain a sufficient historical database to compute the days of supply of a spare that should be stocked to satisfy customer demands. In RMN this may be the major stumbling block as database management is still at its infant process even though the Fleet Supply Depot proper organisation has been in existence in Lumut Naval Base since 1980's and the navy has been supported by its native organisation's structure since 1965 (40 years ago).

The first point to consider is how to determine what item a supply activity should stock. This is determined by customer demand. A line of supply is not stocked until sufficient customer demands are received to warrant stockage.

For example, at intermediate level, six demands for an item within a 90-day period may constitute a sufficient number of demand to qualify for stockage. After an item has qualified for stockage, a minimum number of demand must be received during each succeeding period to retain the item as an authorized line of supply. This practice limits the number of lines that a supply activity maintains to those really needed to support its customers. RMN has to determine the quantity to be stocked for each line of supply. The support should be calculated to support the customers for a predetermined number of days of supply.

For example:

Stock in term of days	OLM	ILM	DLM
No. of days of authorised supply	30	90	360
No. of days for safety level of supply	NIL (critical to mission only)	10	30

This quantity can then be used to compute the operating level, safety level and stockage level for the line of supply based on the number of days of supply that an activity is authorised to stock as shown below (computing supply level) (Jones, 1995):

Day of supply = number of demands ÷ number of days

= 60 ÷ 120

= **0.5**

Operating level = authorized number of days X day of supply to stock

60 X 0.5 = **30**

Safety level = authorized number of days X day of supply safety stock

60 X 10% = **3**

Stockage level = operating level + safety level

30 + 3 = **33**

In additional, the other major hindrance to the successful inventory management is the procurement lead time. For RMN, spares are procured abroad and shipped by sea or air and road. This geographical location of supply activities and the different modes of transportation used to ship spares, this figure can be different for each activity and each line of supply. Each supply activity use historical data on supply system performance to determine the applicable production lead time or order ship time. The days of supply and the production lead time or order ship time are used to calculate the reorder point as shown below:

Reorder point = (order ship time X day of supply) + safety level

= (20 X 0.5) + 3

= 13

if the following data used:

authorised operating level = 60 days

authorised safety level = 10%

number of demand for last 120 days = 300

order ship time = 20 days

computation:

days of supply = 300 ÷ 120 = 2.5

operating level = 60 X 2.5 = 150

safety level = 60 X 10% X 2.5 = 15

reorder point = (20 X 2.5) + 15 = 65

stockage level = 150 + 15 = **165**

The stock level is calculated based on demand historical data and not merely OEM recommendation which is probably to the advantage to OEM. The historical data also should correctly represent the equipment failure based on the way RMN operates the ship. Current stock of Five Years Base Spares and the Squadron Base Support are not based on the way the ships are operated. It is important to note that if RMN do not advocate to a specific ship's operating schedule or projected tasking, the data will become variables and cannot be used as basis for calculation.

Mission Capability as operational capability alone is not sufficient to measure the logistic support system effectiveness. Operational availability includes ships of CAT3 which may, to a particular ship, not a mission capable status. Respondents rate their satisfaction based on individual expectation without a proper understanding of the statement of mission capability and the related the measurement tools, if there is any. Therefore the closest understanding of mission capable can be construed as the reliability of equipment and ships to perform in according to what they are designed for and related to operational reliability. The researchers find it difficult to identify the RMN **Supportability Analysis** which could help in identifying the effectiveness and efficiency of the logistic support system in use. Supportability Analysis covers all aspect of ILS element (as displayed in Figure 3.13). The researchers attempt to answer all statements but the constraints of time do not allow sufficient data collection as depicted by 'No Data'. Information in Figure 3.13 is just a sample for consideration in conducting a Supportability Analysis.

SUMMARY

In this Chapter, the authors discussed maintenance and supply management in the RMN, which is the vital elements of logistics in ensuring ships in the RMN Fleet achieve the highest state of operational readiness. It is very complex and challenging function as it not only involves various systems and equipment but also involves a host of issues. These issues include the involvement of other agencies or stakeholders and the requirement to meet the objectives and targets set in the RMN Direction Statement. The management logistics in the RMN is very much in line with its maintenance philosophy of schedule as well as corrective maintenance approach. These are being implemented in three levels, namely organizational, intermediate as well as depot level maintenance. The authors restudy and concur with the study by Kamarulzaman on FMD, the authors examines the RMN supply organization and view it in the customer perspective. Management concerns with the organization being highly bureaucratic over-centralized and lack of interfacing between divisions was also discussed. The authors also discussed the human resource or human ware issues as people are the most important assets in any organization. The authors also laid down the ILS model as comparison and the approach to the reliability of asset enhancement based on Reliability Centred Maintenance. Inventory management and engineering support must be integrated to provide sound supportability which can be done through a comprehensive Supportability Analysis.

MAINTENANCE AND SUPPORT INFRASTRUCTURE

What is the reliability (effectiveness) of support capability?- **JUST SATISFACTORY**
What is the logistics response time? - **JUST SATISFACTORY**
What is the efficiency of support - **JUST SATISFACTORY**

SUPPLY SUPPORT

Spares/repair part demand rate – **RECORDED**
MTBR – **NO DATA**
Spare/repair parts processing time – **UNSATISFACTORY**
Inventory item location time – **UNSATISFACTORY**
Probability system success with spares – **NO DATA**
Probability of spares availability - **NO DATA**
Inventory stokage level – **UNSATISFACTORY**
Inventory turnover rate – **UNDER STUDY**
Economic Order Quantity? **NO DATA**
Cost per supply support action? **NO DATA**

MAINTENANCE AND SUPPORT PERSONNEL

How is personnel quantities and skill levels ? **HIGH SHIP STAFF INVOLVEMENT**
How is personnel attrition rate? **SHORT OF PERSONNEL**
What is labour hour/maintenance action? **HIGH UNSCHEDULED MAINT AND SCHEDULES ARE NOT ADHERED TO (REFIT CYCLE)**
What is personnel error rate – no measure.
Cost – no measure

TRAINING AND TRAINING SUPPORT

Quantity of personnel trained/period – **NO CONTINUOUS TRAINING IN RELATION TO SYSTEM**

TEST, MEASURES, HANDLING AND SUPPORT EQUIPMENT

Utilisation period, utilisation time, equipment availability, reliability, maintainability, calibration rate and cycle time, cost per test, cost per hour of utilisation - **NO DATA**

PACKAGING, HANDLING, STORAGE AND HANDLING

How is transportation mode, route and distance ? **SHORT DISTANCE DELIVERY BY SHIP, AIR AND ROAD IS EFFICIENT**

MAINTENANCE FACILITIES

Number of items processed per period – **NO DATA**
Item process time – **NO DATAN**
Item turnaround time – **NO DATA**
Waiting line – **NO DATA**
Material consumption rate – **NO DATA**
Utility consumption per maintenance action – **NO DATA**
Utility consumption per period – **NO DATA**
Cost per maintenance action - **NO DATA**

COMPUTER RESOURCES

Is software reliable/maintainable? **YES**
Is the software complex? **DIFFICULT FOR PERSONS NOT TRAINED**
Are there many software modules? **YES. 9 MODULES (MASTER, DEMAND/ISSUE, PROVISIONING, PURCHASING/ACCEPTANCE, RETURN STORE, STOCKTAKING. MATERIAL COORD, FINANCIAL AUTOMATED STORE RETRIEVAL SYSTEM , SISTEM PENGURUSAN INVENTORY ARMADA,TLDMNET - AND INTERNET**
Is the software costly? **YES**

TECHNICAL DATA/INFORMATION SYSTEM

Data item/system, data format, data access time, database size, information processing time, change implementation time measured? **PARTLY NO DATA – 400,000 line items**

Figure 3.13 – Supportability Analysis

Source: Own Design

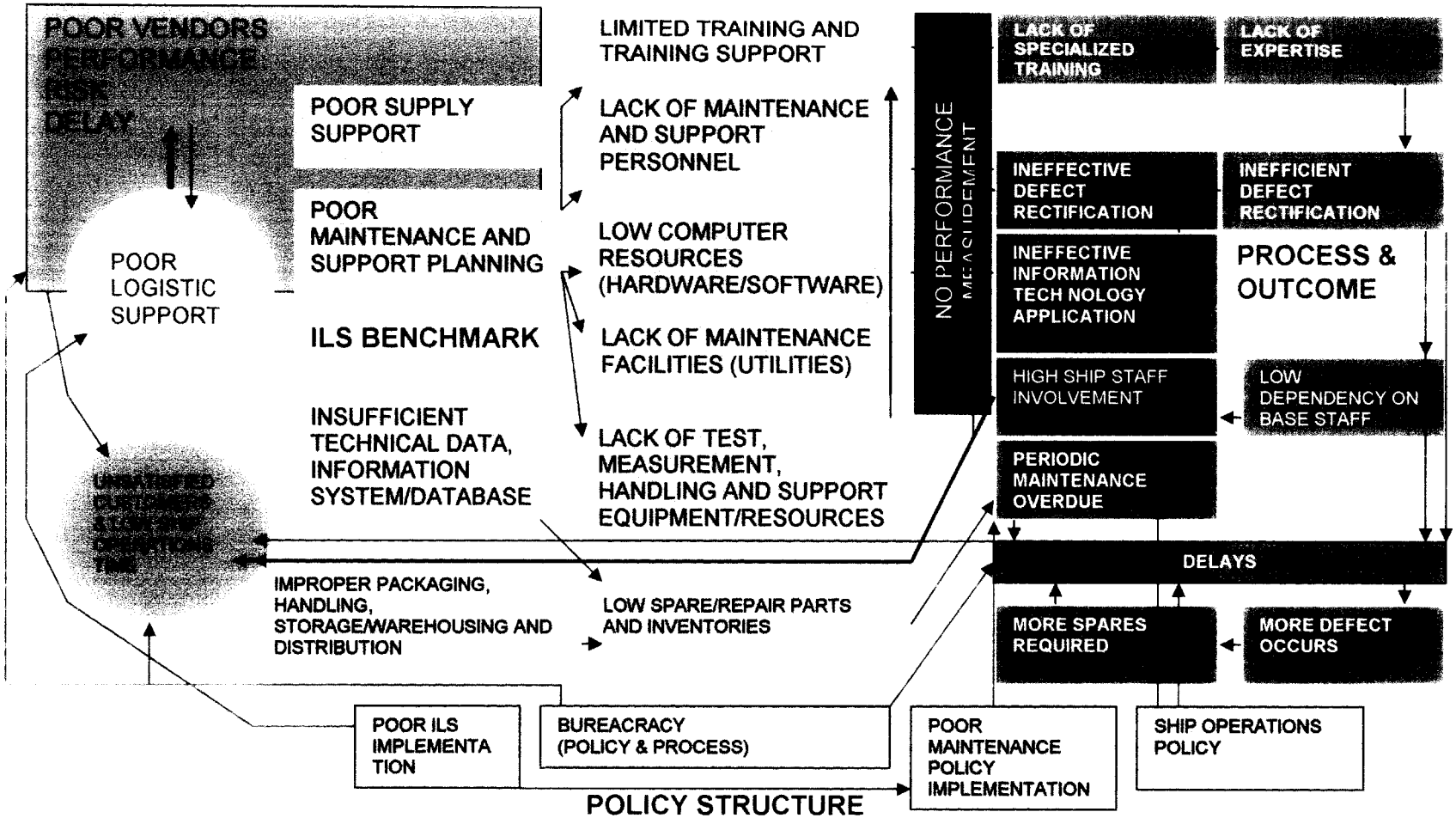

Figure 3.8 Cycles of Failure in RMN Logistic System