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Synergising Quality Assurance For Speedy Defence Procurement And Ensuring Quality

Mahendra Prasad

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SYNERGISING QUALITY ASSURANCE FOR SPEEDY DEFENCE

PROCUREMENT AND ENSURING QUALITY

MAHENDRA PRASAD

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INSTITUTE FOR DEFENCE STUDIES & ANALYSES

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Mahendra Prasad

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ABBREVIATIONS

AAP	Annual Acquisition Plan
AHP	Analytic Hierarchy Process
AO	Army Order
AON	Acceptance of Necessity
ATP	Acceptance Test Procedure
AHSP	Authority Holding Sealed Particulars
BEL	Bharat Electronics Ltd
BOO	Board of Officers
CFA	Competent Financial Authority
CGDP	Controller General of Defence Production
CGIP	Controller General of Inspection and Planning.
CI	Consistency Index
CQA	Controllerate of Quality Assurance
CR	Consistency Ratio
CNC	Cost Negotiation Committee
DDP	Department of Defence Production
DI	Defect Investigation
DIQA	Defence Institute of Quality Assurance
DGAQA	Directorate General of Aeronautical Quality Assurance

DG EME	Director General of Electronics and Mechanical Engineers
DGOS	Directorate General of Ordnance Services
DGQA	Directorate General of Quality Assurance
DPP	Defence Procurement Procedure
DPM	Defence Procurement Manual
DPSU	Defence Public Sector Undertaking
DQA (WP)	Directorate of Quality Assurance, Warship Projects
DQAS	Defence Quality Assurance Service
DR	Defect Report
DRDO	Defence Research and Development Organisation
DTD	Directorate of Technical Development
EME	Electronics and Mechanical Engineers
EMI	Electromagnetic Interference
EMC	Electromagnetic Compatibility
ESD	Engineering Stores Depot
FTP	Fast Track Procedure
GS	General Staff
GSQR	General Staff Qualitative Requirement
HQTG	Headquarters Technical Group
IES	Indian Engineering Services
IHQ,MoD(N)	Integrated Headquarters of Ministry of Defence (Navy)
JSG	Joint Services Guide

LTE	Limited Tender Enquiry
LTIPP	Long Term Integrated Perspective Plan
MAG	Maintainability Advisory Group
MET	Maintainability Evaluation Trial
MGO	Master General of Ordnance
MoD	Ministry of Defence
MoF	Ministry of Finance
MSMEs	Micro Small and Medium Enterprises
MToT	Maintenance Transfer of Technology
NABL	National Accreditation Board for testing and calibration Laboratories
NCNC	No-Cost, No-Commitment
NGO	Non Gazetted officer
OD	Ordnance Depot
OF	Ordnance Factory
OFP	Ordnance Factory Project
PDI	Pre Dispatch Inspection
PNC	Price Negotiation Committee
PP&T	Policy, Planning and Training
QA	Quality Assurance
QAIS	Quality Assurance Information System
QAP	Quality Assurance Plan
QRT	Quick Reaction Team

QSP	Quality Support Plan
RFI	Request For Information
RFP	Request For Proposal
SHQs	Service Head Quarters
SO	Supply Order
SQAE	Senior Quality Assurance Establishment
SCAP	Services Capital Acquisition Plan
SIDBI	Small Industries Development Bank of India
SOP	Standard Operating Procedure
SQRs	Services Qualitative Requirements
TEC	Technical Evaluation Committee
TMLD	Truck Mounted Lifting Device
TPCR	Technology Perspective and Capability Roadmap
UMV	Unit Maintenance Vehicle
URV	Unit Repair Vehicle
WAPI	Weighted Aggregate Performance Index
WE Directorate	Weapons and Equipment Directorate

INTRODUCTION

"Quality is never an accident; it is always the result of high intention, sincere effort, intelligent direction and skillful execution; it represents the wise choice of many alternatives" - William A. Foster

"Quality is doing the right thing when no one is looking." - Henry Ford

"Quality in a product or service is not what the supplier puts in. It is what the customer gets out and is willing to pay for. A product is not quality because it is hard to make and costs a lot of money, as manufacturers typically believe. This is incompetence. Customers pay only for what is of use to them and gives them value. Nothing else constitutes quality" - Peter Drucker

As per Mil Std 109C Quality is defined as- composite of all the attributes or characteristics including performance of an item or product that bear on its ability to satisfy stated or implied needs. While Quality Assurance (QA) is defined as- a planned and systematic pattern of all actions necessary to provide adequate confidence that management and technical planning and controls are adequate to:

- Establish correct technical requirements for design and manufacturing.
- Create products and services that conform to the established technical requirements.

Defence forces in India consistently procure a plethora of military equipment, aircrafts, warships, submarines, communication and navigation equipment, weapon systems etc. in order to modernise themselves and thus ensure that their capabilities remain a step ahead of the envisaged threat perceptions. It is a well known fact that the equipment and the weapon systems in the hands of soldiers in battle have to be rugged and reliable. Also the right equipment at right place and right time not only acts as a force multiplier but also boosts the morale of the troops in battle. Thus, the quality, reliability and availability of military hardware, are of supreme importance and therefore must be taken care of by all the stakeholders involved in their procurement process.

To ensure that the military acquisitions are of the requisite quality and meet the technical, design and operational specifications desired by the users, three main agencies are responsible. These are Directorate of Quality Assurance, Warship Projects {DQA (WP)} for naval vessels, Directorate General of Aeronautical Quality Assurance (DGAQA) for military aircrafts and Directorate General of Quality Assurance (DGQA) for all other military equipment and weapon systems.

Role of DQA (WP), which is one of the directorates of DGQA though, yet has complete autonomy in its technical functioning, is to provide QA cover for all types of marine engineering, hull machinery (including associated electrical / electronics equipment / control system) as also spares procured by defence shipyards, naval procurement agencies and Coast Guard, both for warship under construction and in commission[1]. In order to fulfill this role the establishment performs the following functions[2]:

- Approval of Drawings for machinery and Spares ordered.
- Approval of Quality Assurance Plans (QAPs).
- Inspection & Factory Acceptance Trials as per Approved QAP.
- Acceptance of Imported machinery / equipment / Stores.
- Formulation of Master QAPs.
- Participation in Technical Evaluation Committees (TECs) and Price Negotiation Committees (PNCs) / Cost Negotiation Committees (CNCs) (both at Integrated Headquarters of Ministry of Defence (Navy) {IHQ,MoD(N)} and Naval commands) .
- Vendor Registration through capacity assessment for manufacturing and financial soundness and periodic renewal through vendor rating in accordance with laid down procedure.

Role of DGAQA is to act as a regulatory authority for quality assurance and final acceptance of military aircraft, aero engines, airborne systems, avionics, armament, allied ground system and missiles during development, production and overhaul at various Defence Public

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1 http: / / www.dgqadefence.gov.in / inner.php?id=11 (Accessed July 04, 2013).

2 ibid.

Sector Undertakings (DPSUs). It also ensures documentation, codification and standardisation action for minimising the range of components, equipment and materials. The other services rendered are promotion of small scale industries, post procurement services, defect investigations and technical consultancy to the users, Ministry and the production agencies[3].

From the above it is evident that the DQA (WP) and DGAQA are responsible for quality assurance of naval and air force specific equipment respectively. However, the Navy and Air Force also use many weapon systems and equipment that are common with Army. All these common use equipment and almost all the equipment of the Army (except for the helicopters and aviation equipment for the army) are quality assured by DGQA. Thus, DGQA handles the largest variety of equipment while DGAQA and DQA (WP) handle only a limited range of equipment. In a nutshell, DGQA is responsible for second party QA of all defence stores and equipment, both imported as well as indigenous for the Army, Navy (excluding Naval Armaments) and common user items for the Air Force procured from private sector, DPSUs and Ordnance Factories (OFs). It has, therefore, a vital role to play in defence preparedness of the country[4]. For this reason, the challenges faced by DGQA are unique. The tremendous work being done by DGQA can be assessed from the value of stores it inspects to ensure quality. The value of stores quality assured during the last three years by DGQA is given in Table 1.1.

Table 1.1: Value of Stores Inspected by DGQA

Year	2009-10	2010-11	2011-12	2012-13 (April to December 2012)
Value of Stores (Rs. in Crore)	16,203	19,223	19,140	13,051

Source: "MoD annual report 2011-2012 and 2012-2013", p. 85 and 90 respectively

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[3] http://dgaeroqa.gov.in/about_us.html (Accessed July 04, 2013).

[4] DGQA, "MoD annual report 2012-2013", p .89.

Although the policies and the Standard Operating Procedure (SOP) dictating the QA cover being provided by DGQA to all the three services are same and no major or minor deviations exist. Yet, in-spite of providing QA cover to such a myriad range of products the role of DGQA has come under a lot of criticism, that too mainly from the Army. The Navy and Air Force are more or less satisfied with the QA cover and the post procurement services provided by the DGQA. The criticism is on mainly two accounts. Firstly, the user feels that the QA checks and trials are time consuming and thus delay the acquisitions and secondly, many products inspected by DGQA have a high failure rate and low reliability[5]. For these reasons there is a need to study and analyse the contemporary system employed by DGQA for ensuring that the defence acquisitions are of the quality and reliability desired by the user as also the factors that are responsible for causing the delay in procurement activities. This calls for careful analysis of evolution of the organisation and identifying the shortcomings in the contemporary principles and practices to arrive at possible and implement-able solutions. In a nutshell, if the delays in defence acquisitions due to QA activities need to be minimised and the effectiveness of the QA needs to be improved to reduce post acquisition failures, the following questions need urgent attention:-

- Being an old organisation how DGQA has evolved over a period of time and has this evolution kept pace with the requirements of the users?
- What are the contemporary QA practices adopted by the DGQA and if there exists a room for improving them to augment the efficiency of the organisation?
- Do any dynamics to consistently obtain a user feedback on the quality of the QA service provided by the DGQA on previous procurements exist? If yes, what can be done to use this feedback to improve the effectiveness of QA of future procurements?

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[5] These aspects emerged during interaction with a number of serving officers involved in the procurement and maintenance of acquired products. Interactive sessions were held in the year 2012.

- How can the products of various vendors be ranked on quality parameters using the modern analytical technique(s)?
- What are the future challenges for DGQA in the context of revisions effected in Defence Procurement Procedure (DPP) 2013?

Implementation of answers to these questions would certainly synergise the QA activities with the procurement process and go a long way in enhancing the speed of procurement, as also improve the quality and effectiveness of the quality assurance thus ensuring that only high quality products are introduced in service. Thus, the user satisfaction is bound to increase.

Keeping the above argument in mind the monograph has been chapterised as under:

Beginning with a brief on types of defence procurements, the first chapter details the evolution that DGQA has undergone since colonial days. What organisational changes were brought about to meet changing customers' requirements, efficiently and effectively during important historical events like World War II and independence, have also been enumerated. The chapter ends with the reasoning that DGQA needs customisation of its role to the contemporary requirements of users.

In the second chapter, after giving the present QA procedures that DGQA follows for various types of procurement, a detailed analysis of factors that are responsible for putting a constraint on the organisation's efficiency has been carried out.

Chapter III deals with an important tool in the form of feedback on its services from the customers that the organisation gets. It investigates whether this feedback is currently being utilised to improve the quality of its future services to the customers? If not, are there any factors restraining it to do so?

Fourth chapter deals with a very unique problem. The flak DGQA invites for rejecting vendors on grounds of their products not meeting the quality requirements. A simple but robust and time tested technique has been recommended and elaborated in this chapter to address this problem without compromising on QA that the organisation is entrusted with.

Recommendations to address factors analysed in chapters II, III and IV have been given in Chapter V.

Chapter VI probes the future challenges that DGQA is likely to face in view of focus of defence acquisition shifting to Indian Private Industry and Chapter VII gives the conclusions.

Chapter I

EVOLUTION OF DGQA

1.1 A BRIEF ACCOUNT OF VARIOUS TYPES OF DEFENCE ACQUISITIONS

Defence hardware is procured under 'Capital' and 'Revenue' heads. Two different agencies viz. Directorate General Acquisition and Directorate General of Ordnance Services (DGOS) are responsible for Capital and Revenue procurements respectively. Based on the value of the hardware, a number of Competent Financial Authorities (CFAs) up the hierarchy are empowered to grant the financial sanction for the procurements.

Capital acquisitions are further categorised as 'Buy', 'Buy and Make', and 'Make' cases. 'Buy' cases can be 'Buy Indian' and 'Buy Global'. In addition, the equipment required urgently can be procured through 'Fast Track Procedure'. The procurement plan of hardware from Capital head is covered under three heads[6]:-

- Fifteen years Long Term Integrated Perspective Plan (LTIPP).
- Five years Services Capital Acquisition Plan (SCAP) and
- Annual Acquisition Plan (AAP) which is a subset of SCAP and is "two year roll on plan".

Revenue procurement implies procurement of items and equipment, including replacement equipment (functionally similar) assemblies/sub assemblies and components, to maintain and operate already sanctioned assets in the Services[7]. Guidelines for Capital procurements are given in Defence Procurement Procedure (DPP) while that for revenue procurements are enumerated in Defence Procurement Manual (DPM).

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6 Defence Procurement Procedure (DPP), 2011, pp.2-3.

7 Defence Procurement Manual (DPM), 2009, p.11.

1.2 EVOLUTION OF DGQA SINCE INCEPTION

Since the days of East India Company till the end of World War I, the requirements of the Army for General Stores, Clothing and Armaments were met mostly by import from UK[8]. Some production facilities were however, set up in India during this period to supplement the imports from the UK. A need was felt to superimpose inspection units over these indigenous defence supplies manufacturing establishments to ensure that only best quality products came out of them. The following inspection establishments were therefore progressively set up[9]:

- Inspectorate of the Ammunition Factory, Kirkee, 1869.
- Chief Chemical Inspectorate, Nainital, 1908 and Inspectorate of Explosives and Chemicals, Kirkee, 1920.
- Inspectorate of Guns & Rifles, Jabalpur 1911.
- Inspectorate of Gun Carriages, Jabalpur 1911.
- Inspectorate of General Stores, Kanpur 1912.
- Inspectorate of Ammunition, Kirkee 1921.
- Inspectorate of Small Arms, Ichapur 1921.
- Inspectorate of Guns and Shells, Cossipore 1929.
- Chief Inspectorate of Mechanical Transport, Chakala 1929.
- Inspectorate of Scientific Stores, Rawalpindi 1939.
- Inspectorate of Metal & Steel, Ichapur 1940.

These Inspectorates were responsible for inspection of the family of weapon systems, ammunition and equipment as they were named and therefore were staffed and organised accordingly. Their locations were carefully selected to enable them to discharge their duties efficiently and effectively. During World War II the production rate of defence

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[8] http://www.dgqadefence.gov.in/toplink.php?id=15&pid=23, (Accessed July 08, 2012).

[9] ibid.

hardware was considerably enhanced. This necessitated augmentation of inspection facilities too. Following directorates of inspection were thus created under Master General of Ordnance (MGO): -

- Directorate of Armaments, MGO's Branch
- Directorate of Mechanisation, MGO's Branch
- Controllerate General of Inspection, DGS&D, Ministry of Industry and Supplies.

They were given the overall responsibility of ensuring the quality of stores manufactured by the Ordnance Factories / trade and supplied to the troops.

1.2.1 Post WW II Era

In 1946 these organisations were grouped to form a composite inspection, Research and Development (R&D) organisation called the Directorate of Technical Development (DTD) under MGO's Branch. It was the first time that the full control of all functions relating to inspection, testing and R&D of armaments, instruments, electronic stores, vehicles and engineering stores, medical stores, petroleum products, jute goods *etc.* were vested in a single technical-cum-administrative authority.

An Inter-Services Store Preservation Organisation (ISSPO) was also subsequently created and placed under the MGO[10].

1.2.2 Post Independence Era

In 1947, the MGO's post in the Army HQ was abolished and the DTD was placed under the General Staff Branch. On re-establishment of MGO's Branch in April 1949, DTD was once again placed under its control. In 1955, Armed Forces re-organisation Committee was constituted and on its recommendation, DTD was transferred from Army Headquarters and placed under the direct control of MoD. It now directly reported to the newly created Controller General of Defence Production (CGDP) which was part of MoD.

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[10] http://www.dgqadefence.gov.in/toplink.php?id=15&pid=23, (Accessed July 08, 2013)

In 1956, DTD was bifurcated into two separate directorates *i.e.* Armaments and General. In 1958, a beginning was made to separate the R & D and Inspection functions of these two directorates. The re-organised Directorate of R & D (Armaments) was transferred to the newly created R & D Organisation while the Inspection Organisation remained under the CGDP and was re-organised into[11]: -

- Directorate of Inspection Armaments.
- Directorate of Vehicles and Engineering.
- Directorate of Research & Development (General).
- Directorate of Production and Inspection, Electronics.
- Directorate of Stores Production (Navy).

In 1961, the Directorate of Vehicles and Engineering was further bifurcated into Directorate of Inspection of Vehicles, which remained under CGDP while Directorate of Engineering was transferred to the R&D Organisation. In March 1963, CGDP was re-designated as the Controller General of Inspection and Planning (CGIP)[12].

In August 1963 the Planning Cell of the CGIP was placed directly under the Secretary (Defence Production) and CGIP was re-designated as the Director General of Inspection (DGI). In 1964, the Directorate of Stores Production (Navy) was re-designated as the Directorate of Development and Inspection (Marine Stores). A new Directorate *viz.,* the Directorate of Warship Project (DWP) was created in 1968 to assist the Leander Class Frigate Project. In 1968, the Directorate of R&D (General) was bifurcated into Directorate of Inspection (General Stores) and Directorate of R&D (General Stores)[13].

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11 http://www.dgqadefence.gov.in/toplink.php?id=15&pid=23, (Accessed July 09, 2013).

12 ibid.

13 ibid.

Due to changing needs, in 1976 these agencies were re-engineered into the following three independent organisations: -

- Defence R&D Organisation.
- Directorate General of Inspection.
- Directorate of Technical Development and Production (Air).

Directorate General of Inspection was re-designated as Directorate General of Quality Assurance (DGQA) on July 04, 1987. DGQA Organisation, at present is under the overall control of Department of Defence Production (DDP) and Supplies in the MoD[14].

1.3 PRESENT ORGANISATION OF DGQA

DGQA, with its Headquarters at South Block, New Delhi transacts its business through four levels of establishments. These are spread all over the country where mainly the OFs, DPSUs and Industrial base exist. Lowest establishments amongst these are the *Senior Quality Assurance Establishments* (SQAEs) which are headed by an officer of the rank of Colonel / equivalent officer from Navy or equivalent civilian officer of Defence Quality Assurance Service (DQAS) cadre. Some SQAEs have established wings in the campuses of OFs and DPSUs for hastening up the process of inspection of defence hardware. These wings are headed by officers of the rank of Lieutenant Colonels / Principal Scientific officers of DQAS cadre. SQAEs are under the technical control of *Controllerates of Quality Assurance* (CQAs), which are headed by an officer of the rank of Brigadier / equivalent officer from Navy / equivalent civilian officer of DQAS cadre. CQAs in turn, are under the direct administrative and technical control of 10 technical directorates. Each technical directorate is responsible for a group of technologically distinct equipment and is headed by an officer of the rank of Major General / equivalent officer from Navy / equivalent civilian officer of DQAS cadre. Two out of these 10 directorates are exclusively for Navy; these are Directorate of Quality Assurance (Navy) and (Warship Projects).

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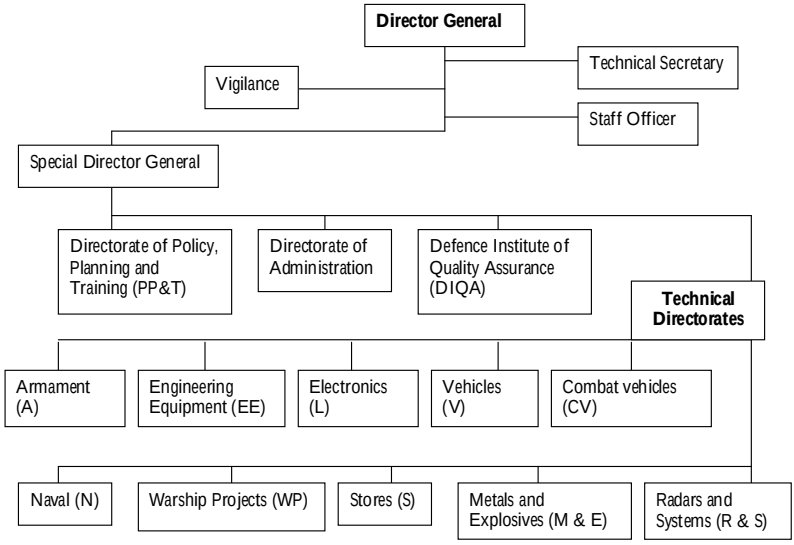
[14] http://www.dgqadefence.gov.in/toplink.php?id=15&pid=23, (Accessed July 09, 2013).

Two additional directorates oversee the administrative work and policy, planning and training. All these 12 directorates report to DGQA through Special DGQA and all but those for Radar and Systems, Combat Vehicles and Metals and Explosives are located at Delhi. As a matter of policy the appointment of DGQA is always held by a service officer of the rank of Lieutenant General while the senior most officer of DQAS cadre holds the appointment of Special DGQA. Chart showing the organisation of DGQA, compiled from its website, down to directorate level is given in Chart 1.1.

Chart 1.1: Organisation of DGQA



Source: http://www.dgqadefence.gov.in/toplink.php?id=15&pid=23 accessed, July 08, 2013

Though at snail's pace, DGQA as an organisation has continued to evolve. It has also made significant strides to modernise its inspection facilities and laboratories. Presently 31 of its 34 laboratories have *National Accreditation Board for testing and calibration Laboratories* (NABL) accreditation[15]. All its field units have obtained ISO 9001:2008

[15] MoD annual report 2012-2013, para 7.116(b), p. 90.

certification[16]. It also invests significant efforts to train its personnel at DIQA to ensure that they upgrade their skills by learning the contemporary and evolving QA techniques, modern technology used in defence, management/ human resource development and information technology. Nonetheless, as an organisation it has not been able to satisfy its customers to the extent they desire. This means a room for customisation to the need of the customers' exits. What are these customisation requirements, at organisational and procedural levels, shall be analysed in next few chapters.

[16] MoD annual report 2012-2013, para 7.116(c), p. 90.

Chapter II

CONTEMPORARY QA PRACTICES: FACTORS LIMITING THEIR EFFICIENCY

2.1 FUNCTIONS OF DGQA: AN OVERVIEW

DGQA provides QA cover for the entire range of Arms, Ammunitions, Equipment and Stores supplied to Armed Forces. In other words the directorate is responsible to ensure that only the right quality product reaches the users.

Apart from QA activities, the organisation is responsible for import substitution and associates with DRDO in the development projects. It also ensures Documentation, Codification and Standardisation action for minimising the variety and range of components / equipment in coordination with the Directorate of Standardisation. The other services rendered are post procurement services like warranty management and repairs, defect investigations, assessment and registration of suppliers / vendors in consonance with the Joint Services Guide (JSG) on the subject, and technical consultancy to the users, ministries and the production agencies. Till 2008, indigenisation of products and their parts was also being done by DGQA. This function has since been taken over by the Corps of Electronics and Mechanical Engineers (EME)[17].

The essential functions performed by DGQA[18] are enumerated below:-

- Quality Assurance of defence stores and equipment procured indigenously or ex-import.
- Rendering assistance in production of DRDO developed projects.
- Render technical advice to service headquarters and promote standardisation.

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[17] Author's interview with a senior serving officer of DGQA, New Delhi, May 2012.

[18] MoD annual report 2012-2013, op. cit., para 7.115(a) to (g), pp. 89-90.

- Investigation of defects and rendering advice on remedial measures.
- Preparation, updating and issue of drawings, specifications, technical publications and quality related instructions.
- Issue of DGQA approvals / assignment lists and cataloguing of defence store.
- Provide technical guidance in formulation of GSQR, associate during trial evaluation, product development etc. and extension of shelf life and post production services of defence stores.

In the procurement process, DGQA gets associated from the inception. Beginning with the vetting of response of vendors to Request for Information (RFI), formulation of General staff Qualitative Requirements (GSQRs), preparation of Requests For Proposals (RFPs), providing inputs to procuring agency about prospective vendors in case of Limited Tender Enquiries (LTEs), pre-bid meetings with vendors, tender opening, vetting of technical bids, field, technical and environmental evaluation of equipment along with the users, cost negotiations, vetting of contract document till the placement of supply order, the technical directorates assisted by CsQA and SQAEs play a crucial role. Invariably a member from DGQA is associated in all these activities as a statute. It is also responsible for independent technical and environmental evaluation of the test sample provided by the vendors using Non-Destructive Testing (NDT) techniques at various laboratories. These laboratories are generally located at various CQAs and SQAEs but certain tests for which the facilities are not available with DGQA are to be arranged by vendors at certified / accredited laboratories at their own cost. DGQA representative is also an associated member of Board of officers (BOO) responsible for Field trials[19] of the equipment.

In order to perform its function of QA during the procurement process, various establishments of DGQA carry out various activities. These activities are elaborated in succeeding paragraphs.

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[19] Defence Procurement Procedure (DPP) (2011), op. cit., p.13

2.2 PROCEDURE OF ACCEPTANCE: CAPITAL PROCUREMENTS[20]

The major role of DGQA in procurement however, comes to the fore after placement of supply order. An Acceptance Test Procedure (ATP) incorporating all the tests and certification for acceptance of the product ordered is prepared. A sampling plan is formulated to work out a significant sample size based on the lot size of the product offered by the vendor, total quantity ordered and the scientific principles of statistical quality control. Based on the delivery schedule mentioned in the supply order/contract document, vendor offers the lots of product, which are inspected by a team of DGQA personnel from the nearest SQAE that is called the area SQAE. Sampling plans approved by the CQA on which these SQAE are dependent for technical guidance are strictly followed. The products, which clear all the inspection tests, are stamped by a unique inspection number and dispatched to the pre-designated Ordnance Depots (ODs) or Engineer Stores Depots (ESDs for Engineering Equipment) for issue to the user units.

An inspection note (I note) is prepared indicating the lot size of the product, number accepted, total number on order and total number accepted till the date of initiation of the I note.

This procedure is repetitively carried out till the supply order is completed. During inspection of a lot all accepted items are marked as 'Accepted' and rejected ones are marked as 'rejected' and segregated in a manner to ensure that they are not mixed into the next lots. In case of imported products, every time the vendor offers a lot of products, a team of DGQA is dispatched to its manufacturing location to carry out Pre-dispatch Inspection (PDI) before the product is shipped to India. The items are then packed and sealed in front of this team with a packing note duly signed by the inspecting team as well as the vendor's representative. On arrival of goods at India, a Joint Receipt Inspect (JRI) is carried out by a Board of Officers (BOO) in the presence of the representative of vendor to check for correctness of the goods and to ascertain any damage that might have occurred during transit.

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[20] Author's interview with a senior serving officer of DGQA, New Delhi, May 2012.

Once an item is procured and it is felt by the user that its replacement would be required in future, the item is introduced into service and the CQA responsible for the equipment is asked to prepare the item's complete technical specifications which include the drawings and blue prints. After approval of these technical specifications, they are sealed and retained by the CQAs and all future procurements of the same equipment is done based on these specifications and not on GSQR of the equipment (Repeat orders under option clause are however placed based on the GSQR). CQAs, for this reason are also referred as Authority Holding Sealed Particulars (AHSP). However, DGQA is not the AHSP for all the equipment of Army; ordnance factories under Director General Ordnance Factories (DGOF) are the AHSP for certain types of 'B' vehicles[21].

2.2.1 Acceptance Test Procedure (ATP)[22]

Whenever a supply order is placed or a contract is concluded, the vendor forwards a standard test procedure, specific to the ordered product, which is generally followed by its quality department. This procedure incorporates various tests and the methodology of conducting them, which are carried out on the finished product after it leaves the assembly line. It also indicates various dimensional measurements and their upper and lower control limits. In addition, this document contains all the tests that are carried out on raw material prior to their acceptance. In case any major assemblies like engine of an automobile or generating set, starter motors, alternators etc. are outsourced by the main vendor, either their certification from a national accredited laboratory or separate test procedures for them are forwarded to the CQA (called the mother AHSP) responsible for the complete equipment. Based on the adequacy of these tests and certifications, mother AHSP can accept them or modify those, incorporating additional tests and certifications.

In case of complex equipment like tanks and self propelled guns, the mother AHSP takes assistance of other CQAs for testing of Systems,

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[21] Principles and General Instructions for QA, DGQA standing Orders (Technical), 2,V, Section I, 2010, p.3.

[22] Author's interview with a senior retired officer of DGQA, New Delhi, May 2012.

assemblies and sub-assemblies of their technological domain. For example in case of a tank the mother AHSP is CQA (Combat vehicle) but the fire fighting equipment of the tank is tested by CQA (Fire Fighting Equipment), all the electronic equipment are tested by CQA ('A' vehicle electronics), all the Nuclear Biological and Chemical (NBC) protection equipment are tested by NBC wing, all the air-conditioning equipment is tested by CQA (engineering equipment) etc. These CQAs are therefore responsible for scrutinising the ATP portion pertaining to equipment of their responsibility. The coordinating agency however, remains the mother AHSP.

After the ATP is finalised, a copy of the same is sent back to the vendor to enable him to make necessary inspection facilities available to the inspection team, whenever the product is offered for acceptance.

2.2.2 Training for Equipment Specific Quality Assurance

DGQA personnel are technically qualified and competent to undertake the general task of inspection. However, there is always a requirement to train them on any new equipment being procured, as the intricacies of quality testing vary with equipment. Specific quality tests applicable to specific equipment can be understood only after learning in detail their design, materials and production processes. This training is imparted to the QA personnel by the same vendor to whom the supply order is placed[23].

2.2.3 Pilot sample

While carrying out technical and environmental evaluation of equipment it may emerge that an excellent product may require certain modification or minor design change like changing the analogue instruments with digital ones or re-aligning or re-locating a battery compartment/tool box or may be making a winch remote wireless. In order to ensure that a good product is not rejected for trivial issues, an undertaking is taken by vendor to carry out such modifications/ design changes at the time of offering the bulk. The vendor does these modifications/ design changes in the first equipment he offers for inspection and clearance. This first equipment is called the pilot sample and preserved

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[23] This requirement is always mentioned in the RFP as well as SO/ contract document.

till the last lot. The Pilot is included in the last lot. Requirement of pilot sample is waived off in case no changes in the sample offered by the vendor for trials are considered necessary.

2.2.4 Quantum of Inspection and Sampling Plan[24]

Quantum of inspection is categorised as *Qualitative* and *Quantitative.* While the qualitative category dictates the nature and depth (extent) of inspection viz. lenient, normal or stringent based on the number of verifiable parameters and attributes of a product to be checked, quantitative category, better known as the scale of inspection, dictates the number of items to be inspected.

It may be little number of random samples or 100 per cent of the population. Quantum of inspection is laid down in the Quality Assurance Instructions (QAI) of the product by the AHSP, issued as a guideline to the SQAE responsible for inspection. SQAEs prepare Quality Assurance Plan (QAP) for the product based on these QAIs as also the following factors: -

- Whether the production agency/ vendor has carried out 100 percent inspection of the lot and removed defectives, before offering it for acceptance by DGQA.
- Level of confidence in the manufacturer/ supplier. More the confidence level less will be the quantum of inspection. However, in case of any rejections at the acceptance inspection levels the quantum of inspection may be increased qualitatively and/ or quantitatively by the SQAE. Nonetheless, great care is taken if quantum of inspection is to be reduced for a reputed vendor as there are chances of litigation by the not so reputed vendors.

Sampling plan is prepared based on the Indian standard on sampling issued by Bureau of Indian standards (BIS). However, in rare cases, with the approval of technical directorates, 100 per cent inspection may be carried out.

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[24] Principles and General Instructions for QA, DGQA standing Orders (Technical), 2, Chapter V, section I, 2010, op. cit., p.16-17.

2.3 DEVELOPMENT PROJECTS BY DRDO

DRDO is the AHSP for their development projects till the time equipment being developed by them goes into production. They are also responsible for the inspection of raw/input material, and systems/ sub-systems of the equipment. It transfers the inspection and AHSP responsibilities to DGQA only after Army places a production order. It has been observed {as in case of Unit Maintenance Vehicle (UMV) and Unit Repair Vehicle (URV)} that the AHSP transfer at a later stage suffers lot of road blocks as a number of queries raised by the QA agency taking over the AHSP responsibility go unanswered.

2.4 FAST TRACK PROCEDURE (FTP)

In case of new equipment being procured under this procedure the "Technical Evaluation" and "On Site Evaluation by an Empowered Committee" are required to be carried out[25]. The time frame for both these activities has been clearly laid down and there is a requirement to adhere to the time lines due to the fact that this procedure is resorted to in the eventuality of urgent operational requirements foreseen as imminent, or for a situation in which a crisis emerges without prior warning[26]. In a recent case of procurement of boats for Quick Reaction Team (QRT) there has been undue delay on part of QA of Engine.

2.5 QA OF ITEMS MANUFACTURED BY OFS AND DPSUS

These items are also Quality assured by DGQA. The interesting aspect is that all the three agencies viz. OFs, DPSUs and DGQA are under the control of Secretary Defence Production (DP). The authority of inspection of raw material and other input materials like assemblies, sub-assemblies and components has been delegated to the manufacturers of the final product.

2.6 PROCEDURE OF ACCEPTANCE: REVENUE PROCUREMENTS

In case of equipment procured out of revenue budget head, the procedure of QA is similar to that of equipment procured out of

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[25] Defence Procurement Procedure (DPP) (2011), op. cit., p.213.

[26] Defence Procurement Procedure (DPP) (2011), op. cit., p.203.

capital head with following broad variations: -

- AsHSP vet draft Tender enquiry.
- Technical and environmental evaluation of equipment is not carried out. Instead, a tender sample from each vendor is sought along with techno-commercial bids and evaluated against the already sealed technical specifications.
- Prior to placement of supply order, registration status of the vendor (on whom the order is to be placed) is checked. In case the vendor is not registered with DGQA or any of the agencies/ departments of MoD, its capacity verification/ narrative assessment is carried out by AsHSP to assess whether the vendor has adequate manufacturing facilities, human resource, capital and past credentials to successfully meet the order.

Having established the actions of various establishments of DGQA in various activities undertaken during the procurement process, it becomes prudent to establish the factors that lead to delay in procurement or in other words the factors that limit the efficiency of DGQA during the procurement process. Next few paragraphs are dedicated to analysing these activities for identifying such factors.

2.7 FACTORS LIMITING THE EFFICIENCY OF DGQA

The procedure of technical and environmental evaluation of new product and subsequent acceptance inspection has evolved over a long period of time. However, the conditions laid down for acceptance are extremely stringent and capital intensive for vendors participating in the bidding process. In addition to the cost of at least one sample (in many cases where the field trials have to be hastened up, more than one sample is sought to carry out field, maintainability and technical evaluation concurrently) required for trials, the participating vendors have to incur expenditure on the following: -

- Arranging test facilities, which are not available with DGQA.
- Transportation of equipment from one place to another for different tests.

- Movement of equipment to various terrains (desert, high altitude / extreme cold) where the equipment is actually to be deployed.

The stakes are very high as finally only one vendor is likely to get the contract. Expenditure incurred by all other vendors not winning the bid therefore becomes wasteful expenditure and discourages them from fielding their equipment. It has been observed that many vendors withdraw at this stage. This procedure is in consonance with the DPP and DPM and though the expenses on account of technical and environmental evaluation, which is the responsibility of DGQA, range between 25 to 33 percent of the total expenditure incurred by the vendors[27] on trials, yet there is a scope of cost reduction by modifying the evaluation process.

In case of complex equipment where a number of AsHSP are involved, coordination at mother directorate level is far from satisfactory and causes delay in response from the AsHSP that are not under their direct control. In order to cut time delays, user and WE directorates in such cases, resort to direct interaction with all such directorates of QA and many a time with CQAs, that are responsible for various systems of the equipment. Unfortunately, the user directorates lack clarity on which QA directorate deals with which system / sub-system of the equipment and this results in a lot of in-fructuous correspondence thereby causing further delays. The possible reason for this may be the fact that procurement is one of the tasks of the user directorates and probably does not rank very high in their priorities.

Lack of poly-valent / muti-skilled engineering staff with DGQA is invariably evident from the fact that the number of DGQA staff attending a meeting (especially pre-bid meetings with vendors and technical evaluation committee meetings) exceeds those from other departments / branches / directorates. At times, one could find one representative each from DGQA for electronics portion, fire fighting portion, NBC portion, air-conditioning portion, armament portion, stores portion, vehicle portion etc. for complex equipment[28]. This, at

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[27] This emerged during informal discussions with representatives of a number of vendors.

[28] Author's personal experience while serving with DGQA.

times calls for avoidable movement of a number of officers from AsHSP located across the country.

The draft ATP is prepared by the vendor on whom the supply order is placed. Since vendor has a vested interest it may not mention some very important tests for which he does not have the facility and/or certifications, which he might not have obtained for his product. Though, DGQA is empowered to completely change the ATP, yet it needs to be seen as to how many have undergone a complete change from that submitted by the supplier, especially in case of those equipment where a lot of defect reports have been raised which have revealed equipment flaws related to material, process, design and military ruggedisation, after reaching the hands of users. There is a need to prepare a well-researched ATP for ensuring better quality. In addition, the technical and environmental evaluation of the equipment provides relevant inputs for ATP and thus the time spent on these evaluations should not be considered as wasted. If meticulously carried out, these tests assuage the problems faced during trade inspections.

Training of QA personnel by the same vendor, who is supplying the equipment that these QA personnel have to inspect for clearance at a later date, seems rather odd. There is a possibility that a vendor, who wishes that certain parameters of his product should not be verified, will deliberately exclude those aspects from training curriculum.

Not involving DGQA in their equipment development projects since their inception by DRDO is a sore point with DGQA as design and development stage of any equipment allows one to learn better about the equipment than any equipment orientation training at a later stage after its prototype is fully developed. Unfortunately this happens despite the fact that both the agencies, DRDO and DGQA are under the control of a single department viz. DDP.

So far as FTP is concerned, from the case of QRT boats it emerges that no QA strategy presently exists for such procurements. The case in point has brought out very important lessons and these should not be forgotten in order to obviate such hindrances in future.

Normally, it is the prerogative of buyer to satisfy himself regarding the quality of the product he pays for. Therefore, depending upon the

specialty required to inspect the item he intends to procure, he nominates one of his agencies or an independent agency for QA. Under no circumstances can a seller be delegated the authority to validate the quality of the products being supplied[29]. In case of QA of items manufactured by OFs and DPSUs, this fundamental principle is evidently violated and the user i.e. army is forced to accept whatever is supplied to them.

Last but not the least, the quality of human resource undertaking the QA job has a lot of room for improvement. The DQAS cadre is selected based on only an interview while the officers seconded from services, Permanently Seconded Service Officers (PSSO) cadre comprises of a majority of those army officers who have been overlooked for promotion in regular army. Surprisingly, a number of officers not possessing a technical degree are placed to supervise the highly technical nature of QA job. At times officers with basic degree of civil engineering or electronics are deputed abroad to carry out the PDI of equipment, which is mechanical in nature. This mismanagement amongst the officer cadre has led to over dependence on the subordinate staff comprising of Group-B and Non Gazetted officers (NGOs) [30]. Innovative adoption of QA procedures and decision making therefore are the worst casualties. Nonetheless, there are a few brilliant officers and these few good people are the ones who are responsible for the saving grace.

SUMMARY

In this chapter the contemporary QA practices have been described and the factors limiting their efficiency thus leading to delays at various QA stages during equipment acquisition have been identified. Addressing these limiting factors will obviate such delays. How these factors can most suitably be addressed, without tinkering much with the present organisational and procedural aspects of DGQA shall be explained in Chapter V, Recommendations. Due care shall be taken to ensure that no major re-engineering of the present organisation and business processes of DGQA is required in effecting the recommendations.

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[29] Suman Mrinal, "Desperate Measures: Department of Defence Production and Conflict of Interest", Force, 9(8), April 2012, p. 31.

[30] Author's personal experience while serving with DGQA.

Chapter III

EFFECTIVENESS OF QA: NEED FOR DYNAMIC IMPROVEMENT

A closed loop feedback system for ensuring the quality of the equipment is in existence. Notwithstanding this, a number of equipment show a high failure rate at crucial times, like in the face of enemy and are therefore a matter of great concern. These failed equipment have resulted in a number of avoidable casualties as also restricted operational planning by our tactical commanders in field due to the non-availability of equipment for deployment that results from their low reliability or high rates of failure. How far this system is exploited in terms of analysing the feedback from the field Army and using the outcomes of these analyses for incorporating improvements in GSQRs, ATPs,QAPs etc.; all to ensure that a better quality product is procured, need examination to improve the effectiveness of QA for future procurements.

3.1 EFFECT OF EQUIPMENT QUALITY ON MILITARY OPERATIONS: A RETROSPECTIVE

Defence forces in India have to operate in diverse climatic conditions, in most difficult and inhospitable terrains. From Thar to Siachen, the variation in temperature is more than 100 degrees. The soldier and the equipment both have to be rugged enough to bear this variation in terrain and hostile climate. In addition the tactical maneuvers in a battle are also restrained by the equipment capability, reliability and availability. For instance our ability to locate M5 Stuart Light Tanks[31] at Zoji La pass on November 01, 1948 during operation Bison acted like a force multiplier and gave us a winning edge over the enemy after an earlier unsuccessful attack launched by 77 Parachute Brigade. This would not have been possible if the tanks, we possessed at that time had not had the capability, ruggedness and reliability to endure the extreme cold

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[31] Sinha, Lt. Gen. S.K. (1977), "Operation Rescue: Military Operations in Jammu & Kashmir 1947-49", Vision Books, p. 174 and Gp. Capt. Ranbir Singh, "Memorable War Stories", Ocean Books Pvt. Ltd., p. 9-13.

climate and rugged terrain at that location. In the contrast high failure rates of Indian Small Arms System (INSAS) at Kargil as the rifle encountered some reliability problems in the very cold climate in which the conflict took place (due to the cold weather, the rifle would jam occasionally and the polymer magazines would crack)[32] led to numerous setbacks.

Rifle INSAS not performing to optimum level: Army, August 13, 2001, the army had complained that the country's indigenous state-of-the-art 5.56 mm indian small arms system (insas) is not performing to the optimum level, with major defects like cold arrest, breakage and cracking of components reported in active areas like Siachen glacier, Kargil heights and other high-altitude zones. "major defects in assault rifles as well as light machine guns like change lever system, breakage of carrying handle, screw locking butt, crack of retainer and breakage of barrel bulge came to the fore from forward areas.

It is thus imperative that the equipment in the hands of soldiers must be of superb quality and have a high reliability in addition to being rugged. The QA of the equipment must therefore be focused to ensure these aspects. Effectiveness of QA inspections done at the time of procurement of equipment is therefore required to be continuously monitored, feedback on it needs to be obtained from the customer (field Army in this case), gaps in quality and the loose ends that led to these gaps need to be identified and addressed for posterity. It thus, ought to be a close loop feedback system. Subsequently a database needs to be generated which can act as a Quality Assurance Information System (QAIS) for ensuring quality of future procurements. Whether these activities constitute QA philosophy and how these can be institutionalised through a SOP will be probed in subsequent paragraphs.

3.2 EFFECTIVENESS OF QA

An effective QA of equipment will ensure that the equipment perform their intended function under given operating conditions repeatedly, with the optimum maintenance and when operated in accordance with the manufacturer's instructions for the operator. Effective QA in turn

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[32] http://articles.timesofindia.indiatimes.com/2001-08-13/india/27224295_1_assault-rifles-drdo-scientists-small-arms-system, (Accessed November 16, 2012).

ensures that there are no or negligible complaints against the product, that has been quality assured. An ineffective QA on the other hand is evident from the numerous complaints of product failure, especially during its warranty period and for reasons attributable to the *design, material and production process* once the product is taken into service. In other words a product that is effectively quality assured is silent in its service while the one that is not properly quality assured is rather noisy. Thus the measure of effectiveness of QA of a product is the statistic of its failure, especially during the warranty period, due to its quality or the lack of it. The basic principle to ascertain effectiveness of QA should therefore be:-

Quality is invisible when 'Good' and
impossible to ignore when 'Bad'.

The products, however also fail due to the reasons other than design, material and production processes. These are the *maintenance lapses* and *not operating them in accordance with the instructions*. A holistic approach to QA would call for ensuring that a product should fail to perform its intended function or should display a prominent warning through a suitable means of indication like sound or light, if it is not operated in accordance with instructions or not optimally maintained[33]. For instance if the engine oil of an automobile is not changed at the mileage specified by the manufacturer, it should not start or if the operator of an earth moving plant takes any short cut in its operation the plant should shut off automatically.

This would however require incorporation of a number of additional features and fail safe mechanisms in the product thereby raising its cost exponentially. It is purely for economical reasons that such features are not advisable unless they are life threatening, e.g. in aircrafts. These aspects are best addressed by a more professional training of operators and maintenance personnel as also by resorting to corrective maintenance wherever required being more economical.

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[33] This emerged during a telephonic discussion with Mrs S Radha, Additional Director, of Defence Institute of Quality Assurance (DIQA), Bangalore, on November 15, 2012.

3.3 RESPONSIBILITY OF ENSURING QUALITY AT THE TIME OF INDUCTION

The global practice is to carry out a detailed technical and environmental evaluation of the prototype in addition to the field and maintainability trials by the buyer. This is followed by inspection of random samples picked up from each lot of the product, offered by the vendor, in accordance with an ATP which is prepared based on a QAP. An identical practice is followed by DGQA. The policy specifying the responsibility of ensuring product quality is very clear wherein the responsibility rests on both, the vendors as well as the customer. The vendors, on one hand, are responsible to carry out all the checks and inspection of their products in such a manner that only those items or lots of items are offered to DGQA for inspection which are considered by them to conform to the product requirements and features given in the contract. QA authority of the buyer (DGQA in the current case), prior to acceptance of the product, is responsible for inspection of the offered products. During this inspection it ensures that the quality aspects, in agreement within the framework of product requirements and features, given in the contract document, have been complied with. Products, which successfully clear both these requirements are accepted, issued to users and are called in-service equipment.

3.4 QUANTUM OF INSPECTION

It is highly desirable that 100 percent inspection of all the equipment being procured is carried out for entire range and depth, in the most stringent manner so that their failure incidents are brought to a negligible level. This however is not advisable due to its prohibitive costs. In-spite of the dual responsibility of ensuring quality of the product (both by the buyer as well as the supplier), it has been observed that howsoever intensive inspection the buyer may carry out, it does not guarantee a 100 percent protection against receipt of inferior quality product. This is generally applicable to all the items but particularly true for highly complex products, the acceptability of which can conclusively be evaluated only by performing destructive testing, which is neither permissible nor feasible. The quantum of inspection by buyer, therefore, remains a function of the ability and willingness of the manufacturer,

to prevent production of defective product and of the evidence, with which the manufacturer supports that ability[34].

Strict quality control by manufacturer is desirable to reduce quantum of inspection by customer.

3.5 IN-SERVICE PROCEDURE

3.5.1 Initiation of Defect Reports (DRs)

Once the product is accepted and taken into service, it is supposed to be maintained and operated as per the manufacturer's instructions given in maintenance and user manuals. Whenever a new defect develops in the product, which is not due to operator's fault or maintenance lapse but attributable to failure of a component or assembly, a DR is raised on that piece of equipment by the officer commanding the unit holding the equipment or the workshop, on whose maintenance load the equipment falls. Detailed instructions for initiating the DRs are in place and contained in relevant order[35]. The major aspects highlighted in the DRs are registration details of the equipment, procurement details like supply order / contract number and date, date equipment taken into service, terrain and climatic conditions where the defect occurred, whether equipment was under warranty at the time of occurrence of the defect, nomenclature and part number of the defective component / assembly and its photograph and illustrative sketch, number of equipment on which identical defect occurred simultaneously (in case more than one identical equipment are affected), probable cause(s) etc[36].

Equipment data in DRs offers detailed customer feedback and eases equipment traceability.

3.5.2 Defect Investigation (DI)

The officer commanding the dependent workshop lists the perceived reasons for occurrence of defect in terms of shortcomings in design,

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[34] John J Riordan, "Protecting the Consumer against Inferior Quality", *Department of Defence Cost Reduction Journal*, 2 (3), 1966, p.41.

[35] For more details, refer relevant Army Order (AO) on DR

[36] ibid, p.37-38.

failure of material etc. The equipment is retained in "as is where is" condition without effecting any repairs[37]. This DR finds its way to the AHSP through the staff channel i.e. through EME battalion, Corps EME, Command EME etc. with comment of everyone up the channel. A copy of DR is sent to Headquarters Technical Group (HQTG) to maintain a database and progress the defect investigation through concerned Maintainability Advisory Group (MAG) that is responsible to take up the matter with the concerned AHSP for expeditious action, in case of delay in investigation. AHSP in turn, and with the assistance of the vendor who supplied that equipment, carries out detailed investigation of the defect *in-situ* and if required in laboratory (In most of the cases where a laboratory investigation is required only the affected component or assembly and not the complete equipment is sent to the laboratory).

Movement and vetting of DRs up the staff channels ensures completeness of the feedback data and removes subjectivity in reporting.

3.5.3 Post DI Action

Having ascertained the root cause of the defect, the corrective action for that defect on the piece of equipment, on which it was reported and the preventive action to prevent occurrence of identical defect on rest of the population of that equipment are worked out in consultation with the manufacturer. These actions are promulgated to the environment by the concerned AHSP through their technical directorates and HQTG If the equipment is under warranty, the AHSP instructs the vendor to rectify the defect in-situ, free of cost. If any modification is required to prevent recurrence of the defect, manufacturer is also instructed to provide modification kits and either carry out or facilitate such modification for entire population of equipment supplied by it. However, if the equipment in not in the warranty period, concerned workshop is instructed to resort to remedial measures to repair/replace the defective component/ assembly as per normal procedure in vogue.

Instructions exist to report follow-up cases of defects in the form of "Follow-up Reports" to maintain an up-to-date statistics of each

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[37] ibid, p.43.

incidence of failure due to the reasons attributable to quality of the product[38].

Thus, a closed loop system is in existence in which the concerned AHSP gets a feedback in the form of a DR about the QA it carried out on a particular piece of equipment. In case the inspection carried out during the QA was adequate, no or insignificant number of defects due to QA aspects would arise and there won't be a feedback, thereby indicating a good quality product. However, inadequate or improper inspection during the QA process of a product would flood the concerned AHSP with a large number of DRs, thus reaffirming the principle applied for ascertaining the effectiveness of QA.

Institutionalised procedure of Defect Reporting assuages the shenanigans by the equipment, which occurs due to inadequacies in their quality. It can also be used for nipping many of these Inadequacies at the inception stage for future procurements.

3.6 FACTORS LIMITING THE USE OF FEEDBACK IN THE FORM OF DRS FOR IMPROVING EFFECTIVENESS OF QA

Though, the time lines for defect reporting and investigation are clearly laid down, yet they are seldom followed. Investigation and closure of many defects takes more than six months and in quite a few cases more than a year. Keeping defective equipment for such long duration without preservation causes its further deterioration, as also deprives the user of the services of that equipment. The user units feel maximum pinch if only one number of that type of equipment is authorised to them. In such case, if the authorised equipment becomes defective, the unit is deprived of the services of this equipment till the time it is repaired. However, if instead of repairing this defective equipment, a defect report is initiated then the equipment can not be repaired before investigation to ascertain the causes and operating conditions that led to the occurrence of the defect is concluded.

This investigation may take a long time and till then the defective equipment is not available to the user unit to which it belongs. For instance if only one generating set is authorised to a minor unit deployed

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[38] ibid, p.42.

in an operational area, and that remains unavailable to them for want of a defect investigation for a year, the unit is condemned to live without electricity for that duration, unless it borrows one from some other unit.

Many times the officers commanding workshops are under tremendous pressure to improve equipment availability, which discourages them from reporting certain defects, and instead carry out repairs of the defective equipment and put them back into service. Thus, many defects go unreported, leading to a distortion in the feedback data on QA through defect reporting.

In case of equipment not under warranty period, there is a tendency to avoid defect reporting. This is due to the fact that even if later on it is conclusively established that the defect occurred due to manufacturing aspect(s) (improper design, material or production process) its cost of repair shall have to be borne by the customer. If that were the case, why the customer should put himself at inconvenience by carrying dead inventory in form of defective equipment? (Though many reputed Indian vendors like Tata motors, Maruti Udyog Ltd., Ashok Leyland etc. sometimes provide repair cover/ component replacements even after warranty as goodwill gesture, yet the users/ dependent workshops are quite apprehensive about raising DR on equipment whose warranty has expired).

In order to encourage manufacturers to improve the quality of their products, DGQA is authorised to permit self-certification of certain manufacturing aspects like QA of raw material and/ or production processes. For this the manufacturer has to consistently demonstrate its ability in those aspects for which it seeks self-certification. This is also periodically reviewed and at any stage if a vendor is found lacking in any aspect of self-certification its authorisation is withdrawn. This is however not true in case of DPSUs and OFs. The DDP has permitted them to carry out the self-certification in respect of raw material and production processes while DGQA carries out inspection of only the finished product. This has led to induction of a number of defective equipment into service. A couple of examples are, Radio set STARS-V, supplied by Bharat Electronics Ltd (BEL) and BMP-II, supplied by Ordnance Factory Project (OFP), Medak with defective materials used in manufacture of their hulls.

The scope of defect reporting is three fold viz. to pin point the exact cause of defect, to ascertain remedial measures and to instruct supplier to provide free replacements, if the equipment is under warranty and rectify the defect in future supplies[39].

However, the complete exercise provides very useful information in terms of causes of defects, which led to failure of in-service equipment. These are: -

- Defects caused as a result of improper operation of the equipment.
- Defects occurring as a result of inadequacies in maintenance practices.
- Defects attributable to QA aspects i.e. those due to improper design, inferior material and inadequate production process(es) and workmanship or a combination of any of these.

Out of these, the first two relate to the user and the maintaining agencies respectively and are utilised for improving training of the operators/ crew and the maintenance personnel as also to identify and plan refresher courses for them. The last one however, remains inadequately exploited. In addition to invoking warranty clause and seeking product modification for future supplies, it can also be utilised to carry out a statistical assessment of the effectiveness of QA and for its introspective analysis for creation of a dynamic QAIS for future applications. This is not being done presently in a formal manner as is evident from the Pro-forma[40] for Annual inspection Report of AHSP and SQAEs/ QAEs. It is observed that in this Pro-forma only the DRs' status is reported. In addition to this, the inspecting officer checks if any important case study on the reported defects was undertaken by the unit being inspected. Whether these case studies have been centrally preserved as a database for quality improvement or the lessons learnt from them are utilised for inclusion in GSQRs/ QAPs/ATPs, is not

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[39] ibid, p.36.

[40] Standing Orders (Administration) 1, for Defence Quality assurance organisation, issued by DGQA, Chapter II, Section 13, "Standing Operating procedure for Annual Administrative Inspection", January 2012, pp.333 to 372.

known[41]. DGQA, as an organisation has sufficiently grown and evolved over a period of time, hence in addition to other aspects like modernisation of their laboratories, automation of their internal administrative matters etc., must also focus on utilising the field failure data, received in the form of DRs, for further improving QA practices for enhancing its effectiveness in a dynamic manner.

The factors listed above need to be dealt with to ensure that the DR data reaching the AsHSP are as authentic as possible. The recommended modalities for the same are listed in Chapter V, Recommendations. Furthermore, based on the DRs, a fresh analysis of complete history of QA of weapon system/ equipment, which is creating unwarranted trouble for its users, right up to the minutes of the meetings of GSQR formulation, can bring important insights into how and at what stage of procurement process, a proactive action to avoid such defect could have been taken. The modalities for this have also been elaborated in Chapter V.

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[41] This aspect emerged during an informal discussion with a senior serving officer on November 2012, who wished to remain anonymous.

Chapter IV

ANALYTICAL QUALITY RANKING: AN ALTERNATIVE TO REJECTION

4.1 THE PROBLEM

One of the sore points in the QA of equipment being procured by Army is that in quite a few cases the equipment that is cleared during the user field trials is rejected by DGQA during technical and environmental evaluation. A case in point is the procurement of Truck Mounted Lifting Device (TMLD). This acquisition case got unduly delayed because of variation in the perception of physical parametres enumerated in the GSQR of the equipment, between the user's trial team and the DGQA team that carried out its field trials and technical evaluation respectively[42]. Later on a number of collegiate meetings were held, just to clarify the correct interpretation of the parametres listed in the GSQR and a limited re-trial of the equipment was ordered. The main cause of this imbroglio was that certain parametres were not very clearly and objectively spelt out in the GSQR and therefore left a room for varied interpretation. There may be many other cases in which the technical testing results are at variance with those of user trials. It is pertinent here to mention that re-trial, as in case of TMLD, not only causes avoidable delay in Army acquisitions but also lead to discouragement to the vendors as it imposes additional financial burden on them because the complete trial evaluation is at their expense as defined in the DPP.

4.2 WHAT CAN BE DONE TO OBVIATE THE PROBLEM?

Ensuring that no ambiguity is left in measurable and tangible parametres while formulating the GSQR shall not only obviate such embarrassing delays in procurements but facilitate timely and accurate trial evaluation as well. For this an expert establishment for GSQR formulation, on the lines of RFP cell, is the need of the hour. This however, may take some time due to the financial sanction required for raising a new establishment and is fraught with the apprehension of bureaucratic resistance and delays.

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[42] Author's personal experience while serving with DGQA.

In the interim it would be prudent to dynamically modify trial evaluation process to minimise such delays. A suggested modification is that the parametres, dimensions and operational requirements specified by the user must be evaluated exclusively by the user trial team while DGQA must concentrate only on the testing of quality encompassing the product design, the material used and the manufacturing process in addition to the environmental testing of the product under simulated conditions. In other words, the domain of user trial and DGQA evaluation must be mutually exclusive. Further, it is suggested that DGQA must be offered to evaluate samples of only those vendors, which are cleared by the user trial team and must therefore, always succeed the user's trial. In case there is a pressing requirement of conducting user and DGQA trials concurrently to save time, the trial methodology must explicitly spell out the parametres to be evaluated by user and DGQA thereby eliminating the chance of a conflicting report at a later stage.

4.2.1 Role of DGQA

What DGQA can do in turn, is to carry out an analytical assessment of the quality of the equipment it inspects and give a quality ranking to various alternatives of the equipment sample, submitted by the qualified vendors. Qualified vendors here mean only those vendors whose product have not only been cleared in the paper Technical Evaluation but also have been cleared during the user field trials. This would considerably reduce the workload of DGQA as they would be evaluating lesser number of samples. This would also prevent rejections at QA stage and would instead, provide a quality ranking of various samples or alternatives of the product, supported by strong scientific and analytical method.

4.3 SUGGESTED METHODOLOGY

Though, a number of such scientific tools are available for such an analysis but the most potent and time tested amongst them is the Analytic Hierarchy Process (AHP). The process was developed by Dr Thomas L. Saaty in early 1970s and is in extensive use as decision support tool for numerous corporate and government decisions since then. It is most useful where teams of people are working on complex problems, especially those with high stakes, involving human perceptions

and judgments, whose resolutions have long-term repercussions[43]. *Ranking* or putting a set of alternatives in order from most to least desirable, is one of the many decision situations to which the AHP can be applied. The steps involved for quality ranking using AHP are as under:-

- Decompose the ranking problem into a hierarchy of criteria, sub-criteria and pick alternatives available in the form of vendor samples. For example the criteria could be the quality of material used, design of product and the manufacturing process.

- Use expert judgment to determine the ranking of criteria e.g. material quality could be twice as important as manufacturing process for a particular product.

- Express the relative importance of one criterion over another using pair wise comparison. Put the result in mathematical matrix form and square it. Calculate the rows sums and normalise them using matrix algebra. Continue this iteration till the time the results of two successive iterations don't change significantly. The final column matrix called the *Eigenvector* gives the local weights of each criterion.

- Check for consistency of the weights of the criteria with that obtained from the expert judgment.

- In a similar manner obtain the local weight of each alternative for each criterion e.g. alternative 1 may have the material strength twice as much as alternative 2.

- Finally we shall have two matrices; one for alternatives' weights having number of rows equal to number of alternatives and number of columns equal to number of criteria and the second matrix shall be a column matrix with number of rows equal to the number of criteria. Multiplication of both these matrices yields the final weight of each alternative and thus the relative quality ranking of each alternative is obtained.

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[43] Bhushan Navneet, Kanwal Rai, "Strategic Decision Making: Applying the Analytic Hierarchy Process", Springer-Verlag, London ,ISBN 1-85233-756-7, January 2004, pp. 11 to 13.

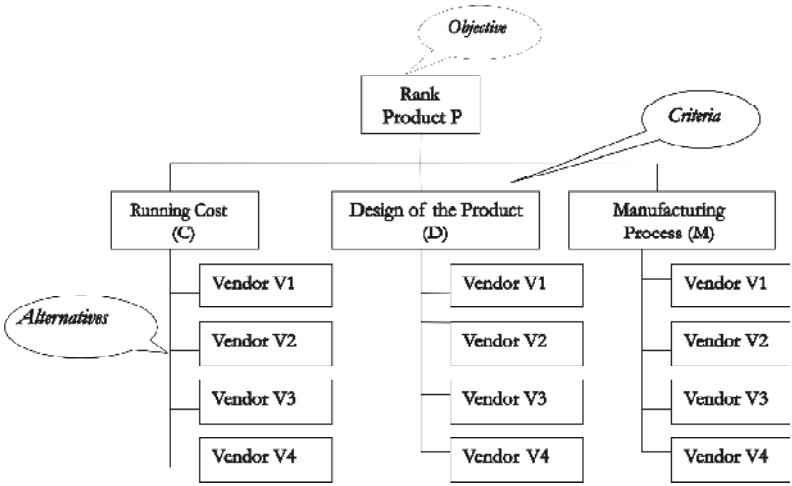
The greatest advantage of this method is its simplicity and requirement of basic knowledge of Matrix Algebra. A number of softwares are available for solving such problems, nonetheless a customised program, using object oriented programming language (C++) can also be written.

4.4 ELABORATION OF THE APPLICATION OF AHP FOR QUALITY RANKING

4.4.1 Let us consider a product 'P' on which we need to apply AHP for quality ranking. In the first step let us assume that the product P, supplied by four vendors namely V1, V2, V3 and V4 has cleared the paper TEC as well as the field trial by users and has come to DGQA for quality testing. Let the criteria pertaining to the quality of product be the *Running Cost of the product (C)*, *design of the product* (D)and the *manufacturing process (M)*[44].

4.4.2 In the second step the above information is arranged in a hierarchical tree as given in chart 4.1.

Chart 4.1: Hierarchical Tree Depicting Objective, Criteria and Alternatives



[44] In order to keep the elaboration simple only three quality parametres/criteria have been chosen otherwise additional criteria like workmanship, quality of raw material, military ruggedisation etc. can also be added.

4.4.3 In the third step Expert judgment is used to determine the ranking of the criteria. This may emerge from the collegiate discussion of the product experts of the organisation i.e. the respective technical directorates and the AsHSP handling the product P. Representatives of the customers/users and academia, if need be, may be co-opted in the collegiate discussion. The process of ranking using expert judgment involves pair wise comparisons i.e. each criteria is compared with every other criteria and their relative importance is decided by the collegiate. The relative importance is rated on a scale of 1 to 9 as given in table 4.1.

Table 4.1: Guidelines for Ranking of Criteria

Pair-wise relative importance	**Definition**	Explanation
1	Equally	Both the criteria contribute equally.
3	Moderately important	Experience and judgment slightly favour one criterion over the other.
5	Strongly important	Experience and judgment strongly favour one criterion over the other.
7	Very strongly important	Experience and judgment very strongly favour one criterion over the other and its importance is demonstrated in practice.
9	Extremely important	The evidence favouring one criterion over the other is of the highest possible validity.
2,4,6,8	Intermediate values	When compromise is needed.

Source: *Analytic Hierarchy Process, brd4.braude.ac.il/~bashkansky/atqe/lectures/AHP/AHP-Saaty/ahp.pptý* and *www.uic.edu/classes/idsc/ids422/ahp.pptý* both (Accessed July 15, 2013).

Thus, following assumptions can be made in ranking of criteria as well as the alternatives:

- *Pairwise comparisons are made with the grades ranging from 1-9.*

- *A basic, but very reasonable, assumption is "If criteria D is extremely important than criteria Q and is rated at 9, then Q must be extremely less important than D and is rated as 1/9".*

Let us consider that the following ranking of criteria emerges out of the collegiate discussion of the experts and on the basis of the guidelines given in table above:

- D versus C- 4/1, C versus D- 1/4.
- D versus M- 2/1, M versus D- 1/2.
- M versus C- 3/1, C versus M- 1/3.

In the fourth step the criteria weights are determined using the following algorithm.

Algorithm for Determining Criteria Weights[45]

Consider $[Ax = I_{max}x]$ *where*

- *A is the comparison matrix of size* $n \times n$, *for n criteria.*
- *x is the Eigenvector of size* $n \times 1$
- I_{max} *is the Eigenvalue,* $I_{max} \Re \in > n$.

To find the weightage of criteria, namely the Eigenvector x:

Initialisation:

Take the squared power of matrix A, i.e., $A^2 = A.A$

Find the row sums of A^2 *and normalise this array to find* E_0.

Set $A := A^2$

Main:

1. Take the squared power of matrix A, i.e., $A^2 = A.A$

2. Find the row sums of A^2 *and normalise this array to find* E_1.

3. Find Difference $= E_1 - E_0$.

4. If the elements of Difference are close to zero, then $X = E_1$, *STOP.*

ELSE set $A := A^2$, *set* $E_0 := E_1$ *and go to Step 1.*

---

[45] *brd4.braude.ac.il/~bashkansky/atqe/lectures/AHP/AHP-Saaty/ahp.ppt*ý (Accessed July 15, 2018).

Thus for product, P the comparison matrix, A, for the quality criteria is:

$$A = \begin{array}{c} \\ M \\ D \\ C \end{array} \begin{array}{c} \begin{array}{ccc} M & D & C \end{array} \\ \begin{pmatrix} 1/1 & 1/2 & 3/1 \\ 2/1 & 1/1 & 4/1 \\ 1/3 & 1/4 & 1/1 \end{pmatrix} \end{array} = \begin{pmatrix} 1.0000 & 0.5000 & 3.0000 \\ 2.0000 & 1.0000 & 4.0000 \\ 0.3333 & 0.2500 & 1.0000 \end{pmatrix}$$

First iteration

Squaring the matrix, A, results into the following matrix:

$$A^2 = \begin{pmatrix} 3.0000 & 1.7500 & 8.0000 \\ 5.3332 & 3.0000 & 14.0000 \\ 1.1666 & 0.6667 & 3.0000 \end{pmatrix}$$

Calculation of first Eigenvector, E_0 by finding the row sums of A^2 and normalising the array results into:

$$A^2 = \begin{array}{l} \begin{pmatrix} 3.0000 + 1.7500 + 8.0000 \\ 5.3332 + 3.0000 + 14.0000 \\ 1.1666 + 0.6667 + 3.0000 \end{pmatrix} \begin{array}{l} = 12.7500 \\ = 22.3332 \\ = 4.8333 \end{array} \\ \qquad\qquad\qquad\qquad\qquad\qquad\quad 39.9165 \end{array}$$

Row sums

Sum of row total

Normalising the array involves dividing each row sum by sum of row total, thus the Eigenvector, E_0 is:

$$E_0 = \begin{pmatrix} 0.3194 \\ 0.5595 \\ 0.1211 \end{pmatrix}$$

Total 1.0000

Here we finish with the first iteration. For second iteration we need to set $A=A^2$

Second iteration

$$A = \begin{pmatrix} 3.0000 & 1.7500 & 8.0000 \\ 5.3332 & 3.0000 & 14.0000 \\ 1.1666 & 0.6667 & 3.0000 \end{pmatrix}$$

and

$$A^2 = \begin{pmatrix} 27.6653 & 15.8330 & 72.4984 \\ 48.3311 & 27.6662 & 126.6642 \\ 10.5547 & 6.0414 & 27.6653 \end{pmatrix}$$

Now, to calculate Eigenvector E1 we calculate the row sums of A^2 and normalise the resultant array:

	27.6653	+	15.8330	+	72.4984		115.9967
A^2 =	48.3311	+	27.6662	+	26.6642	=	202.6615
	10.5547	+	6.0414	+	27.6653		44.2614
						Total	362.9196

Therefore,

$$E_1 = \begin{pmatrix} 0.3196 \\ 0.5584 \\ 0.1220 \end{pmatrix}$$

Total 1.0000

Now the difference between E_1 and E_0 is:

$$E_1 - E_0 = \begin{pmatrix} 0.3196 \\ 0.5584 \\ 0.1220 \end{pmatrix} - \begin{pmatrix} 0.3194 \\ 0.5595 \\ 0.1211 \end{pmatrix} = \begin{pmatrix} 0.0002 \\ -0.0011 \\ 0.0009 \end{pmatrix}$$

It can be seen that the difference between the Eigenvector computed after second iteration and that after the first iteration is very marginal. Hence, we can safely do away with further iterations and set the relative

ranking of the criteria based on the Eigenvector obtained after the second iteration i.e. E_1. Had there been a significant difference between the Eigenvectors, third and possibly subsequent iterations would have also been required.

Now the relative weights and thus the ranking of the criteria, based on E_1 is:

$$E_1 = \begin{pmatrix} \text{Manufacturing Process, M} \\ \text{Design of the product, D} \\ \text{Running Cost, C} \end{pmatrix} = \begin{pmatrix} 0.3196 \\ 0.5584 \\ 0.1220 \end{pmatrix}$$

Second most important Criterion

Most important Criterion

Least important Criterion

4.4.4 Consistency of Judgment

The next stage is to calculate a Consistency Ratio (CR) to measure how consistent the judgments have been relative to large samples of purely random judgments.AHP evaluations are based on the assumption that the decision maker is rational, i.e., if A is preferred to B and B is preferred to C, then A is preferred to C. If CR is less than 0.1 the results are absolutely consistent with the expert judgment. If the CR is greater than 0.1 the judgments are not absolutely consistent. If CR is 0.9 the results are absolutely inconsistent. Thus an inconsistency of 10 percent or less implies that the adjustment is small compared to the actual values of the eigenvector entries while a CR as high as, say, 90 percent would mean that the pair wise judgments are just about random and are completely untrustworthy[46]. Intermediate values of CR (between 0.1 and 0.9) indicate partial consistency and therefore there is a need to go back to the step of *expert judgment* and repeat the process.

The CR is calculated by using the table 4.2 below, which is derived from Saaty's book, in which the upper row is the order of the random matrix, and the lower is the corresponding index of consistency for random judgments.

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[46] *brd4.braude.ac.il/~bashkansky/atqe/lectures/AHP/AHP-Saaty/ahp.ppt*ý, op. cit., (Accessed July 15, 2018).

Table 4.2: Index of Consistency for Random Judgments

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Source: *Analytic Hierarchy Process, brd4.braude.ac.il/~bashkansky/atqe/lectures/AHP/AHP-Saaty/ahp.ppt*ý (Accessed July 15, 2013).

Now,

$$CR = \frac{\text{Consistency Index (CI)}}{\text{Index of Consistency for Random Judgments corresponding to the order of random matrix}}$$

such that,

Consistency Index (CI) $= (l_{max} - n)/(n-1)$

where,

n = order of the matrix (3 in the present case)

and

lmax is obtained from the expression

$Ax = l_{max}\, x$, using the initial matrix, A and its final Eigenector, x (E_1 in the current case).

$$\begin{pmatrix} 1.0000 & 0.5000 & 3.0000 \\ 2.0000 & 1.0000 & 4.0000 \\ 0.3333 & 0.2500 & 1.0000 \end{pmatrix} \begin{pmatrix} 0.3196 \\ 0.5584 \\ 0.1220 \end{pmatrix} = l_{max} \begin{pmatrix} 0.3196 \\ 0.5584 \\ 0.1220 \end{pmatrix}$$

$$\begin{pmatrix} 0.9648 \\ 1.6856 \\ 0.3680 \end{pmatrix} = l_{max} \begin{pmatrix} 0.3196 \\ 0.5584 \\ 0.1220 \end{pmatrix}$$

Threrefore,

l_{max} = average{0.9648/0.3196, 1.6856/0.5584, 0.3680/0.1220} = 3.0180

and

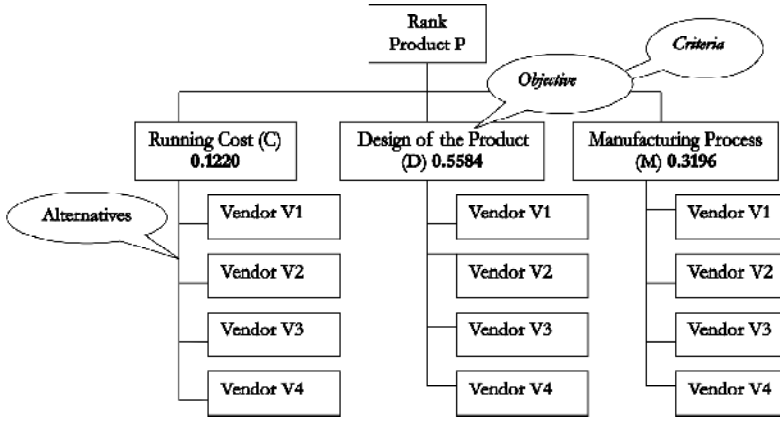
$CI = (l_{max}-n)/(n-1) = (3.0180-3)/(3-1) = 0.009$

Thus, $CR = CI/0.58 = 0.0090/0.58 = 0.01552$, where the Index of Consistency for Random Judgments corresponding to the order (n) of random matrix has been taken from table 3 against the value of n = 3, and is 0.58.

In the current case CR is 0.01552, which is less than 0.1, thus we can conclude that the results are absolutely consistent with the judgment of the experts. Hence, the Eigenvector E_1 truly represents the weights of the criteria Manufacturing Process, Design of the product, D and the Running cost, R in that order.

The criteria weights are now placed in the hierarchical tree (Chart 4.2) and ranking of alternatives on each criterion is carried out.

Chart 4.2: Hierarchical Tree Depicting Objective, Criteria and Alternatives and the Relative weights of Criteria



4.4.5 Ranking of Alternatives

Ranking of alternatives on each criterion is carried out using the same principle of pair wise comparison. However, in this case instead of using expert judgment each vendor's product is compared with that of all other vendors based on the performance of their product on the criterion under consideration. The algorithm followed for the ranking of alternatives is same as the one used for ranking of criteria.

4.4.5.1 Running Cost, C

This is a quantitative criterion but contributes to the overall quality of the product. It needs to be determined on common parametres like cost of energy consumption, cost of fuel consumption, cost of expendable materials like oils, greases and other lubricants, cost of maintenance etc. for a common duration of running the product, say 10 days or 100 kilometres for sample of product, P supplied by all the vendors (V1, V2, V3 and V4). The cost of running obtained after trials is in rupees or dollars or any other currency and is thus required to be normalised to enable its usage with the ranking of other criteria.

Let the cost of running of sample of product, P under consideration be as given in table 4.3.

Table 4.3: Cost of Running

Product, P supplied by the vendor	Cost of Running (in Dollars)
V1	34
V2	27
V3	24
V4	28

Normalising the cost of running, results in the values as given in table 4.4.

Table 4.4: Normalised Values of Cost of running

Name of the vendor supplying product, P	Cost of running (in Dollars)	Normalised values
V1	34	34/113 = 0.3010
V2	27	27/113 = 0.2390
V3	24	24/113 = 0.2120
V4	28	28/113 = 0.2480
Total	113	1.000

Thus the Eigenvector of alternatives for the criterion Running Cost, C, is:

V1	0.3010
V2	0.2390
V3	0.2120
V4	0.2480

It may be noted that no consistency check for this criterion is required as the relative weights and thus ranking of the alternatives has been obtained by computing the factual values of alternatives on the criterion and not by expert judgment.

4.4.5.2 Design of the Product, D

This is a qualitative criterion and would require pair wise comparison by experts after conducting the trials. The important design factors that could be considered by the panel of experts could be aerodynamic shape, silhouette, maintainability, reliability, operability, ergonomically designed cabins, compartments and assemblies etc.

Let us assume that the pair wise comparison of all the alternatives against this criterion by the experts and on the basis of the guidelines given in table-2 yields the following results:

- V1 versusV2 – 2/1, V2 versus V1 – 1/2.
- V1 versus V3 – 5/1, V3 versus V1 – 1/5.
- V1 versus V4 - 1/1, V4 versus V1 – 1/1.
- V2 versus V3 – 3/1, V3 versus V2 – 1/3.
- V2 versus V4 – 2/1, V4 versus V2 – 1/2.
- V3 versus V4 – 1/3, V4/versus V3 – 3/1.

Thus the comparison matrix, A, of alternatives V1, V2, V3 and V4 for criterion D is:

$$A = \begin{array}{c} \\ V1 \\ V2 \\ V3 \\ V4 \end{array} \begin{array}{c} \begin{array}{cccc} V1 & V2 & V3 & V4 \end{array} \\ \begin{pmatrix} 1/1 & 2/1 & 5/1 & 1/1 \\ 1/2 & 1/1 & 3/1 & 2/1 \\ 1/5 & 1/3 & 1/1 & 1/4 \\ 1/1 & 1/2 & 4/1 & 1/1 \end{pmatrix} \end{array}$$

or

$$A = \begin{pmatrix} 1.0000 & 2.0000 & 5.0000 & 1.0000 \\ 0.5000 & 1.0000 & 3.0000 & 2.0000 \\ 0.2000 & 0.3333 & 1.0000 & 0.2500 \\ 1.0000 & 0.5000 & 4.0000 & 1.0000 \end{pmatrix}$$

And the corresponding Eigenvector shall be:

$$x = \begin{pmatrix} 0.3790 \\ 0.2900 \\ 0.0740 \\ 0.2570 \end{pmatrix}$$

And consistency check reveals that

$$\begin{pmatrix} 1.0000 & 2.0000 & 5.0000 & 1.0000 \\ 0.5000 & 1.0000 & 3.0000 & 2.0000 \\ 0.2000 & 0.3333 & 1.0000 & 0.2500 \\ 1.0000 & 0.5000 & 4.0000 & 1.0000 \end{pmatrix} \begin{pmatrix} 0.3790 \\ 0.2900 \\ 0.0740 \\ 0.2570 \end{pmatrix} = \lambda_{max} \begin{pmatrix} 0.3790 \\ 0.2900 \\ 0.0740 \\ 0.2570 \end{pmatrix}$$

$$\begin{pmatrix} 1.5860 \\ 1.2155 \\ 0.3170 \\ 2.3820 \end{pmatrix} = \lambda_{max} \begin{pmatrix} 0.3790 \\ 0.2900 \\ 0.0740 \\ 0.2570 \end{pmatrix}$$

Threrefore,

λ_{max} = average{1.5860/0.3790, 1.2155/0.2900, 0.3170/0.0740, 2.3820/ 0.2570} = 5.4821

and

CI = $(\lambda_{max}-n)/(n-1) = (5.4821-4)/(4-1) = 0.2964$

CR = CI/0.9 = 0.329

Here the Index of Consistency for Random Judgments corresponding to the order (n) of random matrix has been taken from table 3 against the value of n = 4, and is 0.9. The calculated value of CR is more than 0.1 (absolutely consistent) but much less than 0.9 (absolutely inconsistent). It implies that the results are moderately consistent with the judgment of experts. Though, there is some percentage of inconsistency hence a need to go back to the step of pair wise comparison using expert judgment yet, for illustration purpose let us assume that the relative ranking of alternatives against the criterion, design of the product, D, for the product, P, may be taken as given by the Eigenvector, x with some confidence level as the value of CR is much less than 0.9.

Hence local weights of vendors or their relative ranking of this criterion is:

V1	0.3790
V2	0.2900
V3	0.0740
V4	0.2570

4.4.5.3 Manufacturing Process, M

This is also a qualitative criterion and would require pair wise comparison by experts after inspecting the manufacturing facilities of the vendors. The important factors affecting the manufacturing process that could be considered by the panel of experts include the strict statistical quality control, inspections, reworking the rejected lots, handling of raw material and their quality testing etc.

Let us assume that the pair wise comparison of all the alternatives against this criterion by the experts and on the basis of the guidelines given in table-2 yields the following results:

- V1 versusV2 – 1/4, V2 versus V1 – 4/1.
- V1 versus V3 – 4/1, V3 versus V1 – ¼.
- V1 versus V4 – 1/6, V4 versus V1 – 6/1.
- V2 versus V3 – 4/1, V3 versus V2 – 1/4.

- V2 versus V4 – 1/4, V4 versus V2 – 4/1.
- V3 versus V4 – 1/5, V4/versus V3 – 5/1.

Thus the comparison matrix, A, of alternatives V1, V2, V3 and V4 for criterion M is:

$$A = \begin{array}{c} \\ V1 \\ V2 \\ V3 \\ V4 \end{array} \begin{array}{c} \begin{array}{cccc} V1 & V2 & V3 & V4 \end{array} \\ \begin{pmatrix} 1/1 & 1/4 & 4/1 & 1/6 \\ 4/1 & 1/1 & 4/1 & 1/4 \\ 1/4 & 1/4 & 1/1 & 1/5 \\ 6/1 & 4/1 & 5/1 & 1/1 \end{pmatrix} \end{array}$$

or

$$A = \begin{pmatrix} 1.0000 & 0.2500 & 4.0000 & 0.1667 \\ 4.0000 & 1.0000 & 4.0000 & 0.2500 \\ 0.2500 & 0.2500 & 1.0000 & 0.2000 \\ 6.0000 & 4.0000 & 5.0000 & 1.0000 \end{pmatrix}$$

And the corresponding Eigenvector shall be:

$$x = \begin{pmatrix} 0.1160 \\ 0.2470 \\ 0.0600 \\ 0.5770 \end{pmatrix}$$

And consistency check reveals that

$$\begin{pmatrix} 1.0000 & 0.2500 & 4.0000 & 0.1667 \\ 4.0000 & 1.0000 & 4.0000 & 0.2500 \\ 0.2500 & 0.2500 & 1.0000 & 0.2000 \\ 6.0000 & 4.0000 & 5.0000 & 1.0000 \end{pmatrix} \begin{pmatrix} 0.1160 \\ 0.2470 \\ 0.0600 \\ 0.5770 \end{pmatrix} = \lambda_{max} \begin{pmatrix} 0.1160 \\ 0.2470 \\ 0.0600 \\ 0.5770 \end{pmatrix}$$

$$\begin{pmatrix} 0.5139 \\ 1.0953 \\ 0.2661 \\ 2.5610 \end{pmatrix} = \lambda_{max} \begin{pmatrix} 0.1160 \\ 0.2470 \\ 0.0600 \\ 0.5770 \end{pmatrix}$$

Threrefore,

λ_{max} = average{0.5139/0.1160, 1.0953/0.2470, 0.2661/0.0600, 2.5610/0.5770} = 4.4210

and

CI = $(\lambda_{max}-n)/(n-1)$ = (4.4210-4)/(4-1) = 0.1403

CR = CI/0.9 = 0..1558

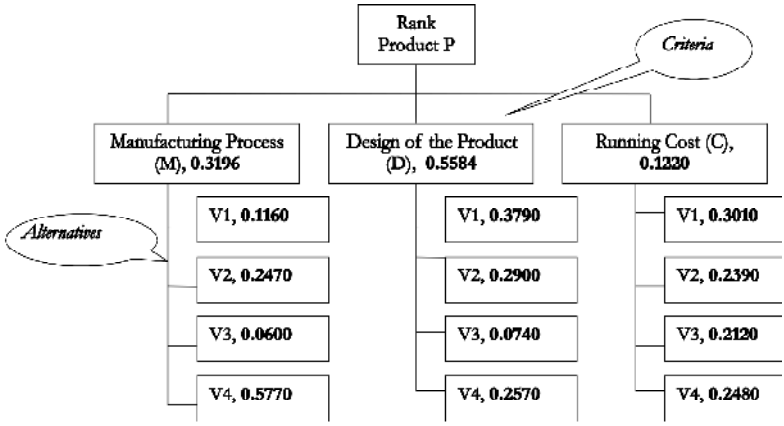
Here also the Index of Consistency for Random Judgments corresponding to the order (n) of random matrix has been taken from table 3 against the value of n = 4, and is 0.9. The value of CR has been found to be more than 0.1 (absolutely consistent) but much less than 0.9 (absolutely inconsistent), It implies that the results are moderately consistent with the judgment of experts. Though, there is some percentage of inconsistency hence a need to go back to the step of pair wise comparison using expert judgment yet, for illustration purpose let us assume that the relative ranking of alternatives against the criterion, manufacturing process, M, for the product, P, may be taken as given by the Eigenvector, x with some confidence as the value of CR (0.1558) is much nearer to 0.1.

Hence local weights of vendors or their relative ranking of this criterion is:

$$\begin{matrix} V1 \\ V2 \\ V3 \\ V4 \end{matrix} \begin{pmatrix} 0.1160 \\ 0.2470 \\ 0.0600 \\ 0.5770 \end{pmatrix}$$

Now placing all the weights of the criteria as well as alternatives in the hierarchical tree we obtain the chart 4.3.

Chart 4.3: Hierarchical Tree Depicting Objective, Criteria and Alternatives and their Relative Weights



and a little more of matrix algebra gives us the solution:

$$\begin{array}{c} \\ V1 \\ V2 \\ V3 \\ V4 \end{array} \begin{array}{c} \begin{array}{ccc} M & D & C \end{array} \\ \begin{pmatrix} 0.1160 & 0.3790 & 0.3010 \\ 0.2470 & 0.2900 & 0.2390 \\ 0.0600 & 0.0740 & 0.2120 \\ 0.5770 & 0.2570 & 0.2480 \end{pmatrix} \end{array} \begin{pmatrix} \\ 0.3196 \\ 0.5584 \\ 0.1220 \end{pmatrix} = \begin{pmatrix} 0.3060 \\ 0.2720 \\ 0.0940 \\ 0.3280 \end{pmatrix} \begin{array}{c} \\ V1 \\ V2 \\ V3 \\ V4 \end{array}$$

Therefore the quality ranking in reducing order, of the product, P, supplied by vendors, V1, V2, V3 and V4 is as given in table 4.5.

Table 4.5: Ranking of Product, P, of Short listed Vendors

Quality weight of P	Ranking	Vendor
0.3280	I	V4
0.3060	II	V1
0.2720	III	V2
0.0940	IV	V3

SUMMARY

In actual practice many times it so happens that the products of many vendors fail on quality parametres which may lead to single vendor situation or a situation in which no vendor qualifies. In such cases re-tendering is the only option which means repetition of complete procurement cycle. Such situations generate avoidable dissent amongst the customers (services in the current case) and DGQA is seen as the agency responsible for stalling the procurement process.

Some of the common problems faced during the field evaluation of equipment and weapon systems are[47]:

- Trial of new equipment with differing technologies is a highly specialised task.
- Trial units are totally untrained and ill equipped for the same.
- Trial directives are issued as a matter of routine.
- Many aspects are indeterminate and are viewed differently by trial units.
- Trial reports tend to be subjective as per the views of commanders in the chain and couched in generalities.
- Field commanders while giving final recommendations incorporate new parametres.

In view of the above, the products perceived to be best by the user during field trials sometimes fail on quality parametres. Though, the current practice and procedures of quality testing is much more objective than the field trials by user, yet such rejections by DGQA are considered as game spoilers. Instead of rejection if the QA authorities give a quality ranking of the products using the AHP, such situations can be avoided. In addition user shall have more flexibility in selecting the vendor whose equipment suites them the best.

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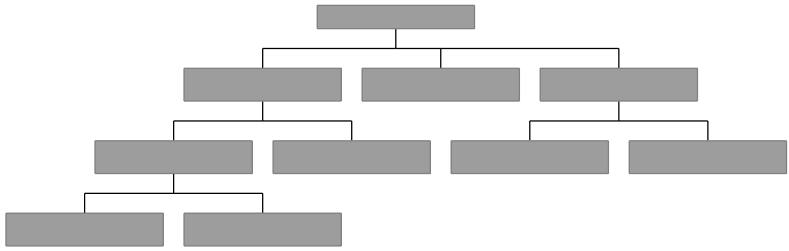
[47] Suman Mrinal, "Weapons Procurement: Qualitative Requirements and Transparency in Evaluation", Strategic Analysis, 30(4), October-December, 2006, p. 735.

This was the illustration of AHP to a simple case. Many levels of criteria and sub-criteria exist for complex problems:



In the first look the application of AHP for quality ranking of the products may look quite labourious and cumbersome. However, professional commercial software *Expert Choice*[48] developed by Expert Choice Inc. is comercially available which simplifies the implementation of the AHP's steps and automates many of its computations. Software "*Matlab"* can also be used for this purpose.

[48] *brd4.braude.ac.il/~bashkansky/atqe/lectures/AHP/AHP-Saaty/ahp.ppt*ý, op. cit., (Accessed July 15, 2018).

Chapter V

RECOMMENDATIONS

Analysis of various factors which limit the efficiency and effectiveness of DGQA in performing its functions related to procurement has been carried out in chapters II and III respectively. The factors are both, internal to the organisation as well external. The stalled efficiency causes delays in the QA and thus the overall lead time of procurement while the deficiency in effectiveness leads to introduction of poor quality product into the service. In this chapter the measures required to address these factors have been discussed. Due care has been taken to ensure that no major organisational or business process re-engineering has been suggested for incorporation. It has been ensured that only those minor adjustments to the existing organisation and business processes are recommended which can obviate the setbacks caused by various factors discussed earlier as also that are easy to implement and without seeking a host of additional resources. In the end reasoning for resorting to Quality Ranking in place of Quality selection / rejection has been given along with its benefits.

5.1 MEASURES FOR IMPROVING EFFICIENCY OF DGQA FOR HASTENING UP PROCUREMENT PROCESS

In order to cut costs and time required for technical and environmental evaluation it is recommended that only those tests should be undertaken by DGQA, which are not possible to be carried out anywhere else at various laboratories accredited by NABL, in the country. Vendors can be intimated about all the tests at the RFP stage and told to get their products tested before offering them for trials and produce requisite certification from NABL accredited Laboratories. Though, presently also DGQA is accepting these certifications, but all vendors do not produce them and a considerable time is used for testing of equipment samples offered by such vendors. They may also be apprised of the specific tests that will be carried out by DGQA in its laboratories for which facilities do not exist anywhere else in the country. Also provisions to compensate the vendors who offer their products for trial should

be made in DPP. This will encourage vendors to offer their product for trial.

Reputed vendors may be permitted self-certification on case to case basis taking into account their past performance. In case of foreign vendors certification from their respective government's regulatory authorities may be considered on case to case basis.

To address the interaction problems of user and WE directorate with DGQA, it is felt that a single window system for interaction with DGQA will go a long way to obviate this long-standing sore point. For this the present single window of DGQA i.e. directorate of PP and T needs to be augmented with staff pooled in from all the technical directorates. Alternately, the proposed Directorate of customer services under their cadre review proposal needs to be sanctioned by MoD and established on priority to enable single window interaction with services.

At a later stage once the staff involved in the procurement process starts getting trained at Defence Acquisition Institute (whenever it is set up) as proposed by Mrinal Suman[49], this requirement may automatically fade away.

For creation of a pool of staff possessing multiple skills, bifurcation of staff into broad streams mechanical, electronics and computer science may help. Skill development may be carried out by inter-directorate postings and augmentation of training facilities at Defence Institute of Quality Assurance (DIQA), Bangalore. Adequate exploitation of vacancies for equipment oriented training at Category 'A' establishments of Army also needs to be carried out as was done earlier.

Regarding ATP it is felt that a well-researched and stringent ATP can minimise occurrence of a number of defects due to material and manufacturing inadequacies, after the equipment is put into service. It is therefore recommended that although the draft ATP is welcome from the supplier but it should be compared with what other vendors manufacturing similar equipment are doing to ensure quality.

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[49] Suman Mrinal, "Defence Acquisition Institute: A Viewpoint", *Journal of Defence studies*, 6(2), April 2012, p. 1-11.

International best practices should be researched and incorporated in the ATPs. For this an ATP cell (a virtual one to begin with) may be required at the AsHSP. A standard exhaustive ATP format needs to be prepared after deliberate research and uploaded on the website of DGQA for reference by the vendors.

QA personnel who have to finally carry out the inspection of bulk of the ordered equipment should not only be trained by the vendor on whom the supply order is placed but also by other vendor or any other agency dealing with identical equipment even at the cost of repetition. Alternately few of them could be trained by different agencies / vendors and can exchange notes to ensure that all the aspects of QA of the equipment have been covered. This will also assist in preparation of a comprehensive and effective ATP.

For better synergy between DRDO and DGQA it is mandatory to involve the QA agency that is going to take over the AHSP responsibility with DRDO developmental projects from their inception. This would not only ensure a smooth AHSP transfer at production stage but also assist in development of a better quality product due to concurrent quality suggestions that the AsHSP are competent to make. Additionally, it allows for a simultaneous development of a QA plan for the equipment. DDP needs to coordinate this aspect more efficiently and forcefully.

In case of fast track procurements of new equipment, wherein technical evaluation and on-site inspection by an empowered committee are mandatory requirements, a viable, efficient and effective QA procedure needs to be evolved in the form a Standard Operating Procedure (SOP). This SOP can be suitably customised to fit the type of equipment being procured beforehand, in order to ensure that the procurement does not get delayed due to the QA and the vendor does not offload its junk to us due to paucity of time, as well.

Army has to seriously take up the matter to bring DGQA under its control to ensure that the QA of items being procured from OFs and DPSUs is carried out without any bias and with complete objectivity. In case this is not forthcoming a cell under Director General of Electronics and Mechanical Engineers (DGEME) may be created for QA of all equipment being procured repetitively from OFs and DPSUs.

The selection process of the officer cadre needs a complete revamp. While the DQAS cadre needs to come out of Indian Engineering Services (IES) the PSSOs need to be inducted early, perhaps between eight to 12 years service through a written test in engineering and aptitude for QA job. To eliminate subjectivity in selection process for deputation abroad for PDI, it needs to be ensured that the process is not merely based on recommendation up the chain of command but also on the skill and knowledge about the equipment to be inspected.

5.2 MEASURES FOR IMPROVING EFFECTIVENESS OF DGQA FOR IMPROVING QUALITY

5.2.1 Actions by DGQA

DGQA vision statement reads….

"Trust of the Trusted"

Trust and confidence of the nation stems from the trust in the people, who are guarding the borders. In the battlefield trust emanates from the confidence in the performance of the equipment at the given time. Such confidence in the defence equipment is generated through quality assurance by DGQA organisation.

The vision statement says it all. The first and the foremost responsibility of DGQA is to ensure that equipment in the hands of troops guarding our borders is of such quality and reliability that their trust on the equipment is never broken. Thus, quality and reliability of equipment in the hands of troops has to be of the highest order. For this the *quality* of quality assurance needs to be impeccable. In order to ensure this impeccable QA, DGQA must aim to improve its prime service of QA of weapons and equipment procurements, consistently. With this aim it is imperative that DGQA must constantly strive to improve the quality or effectiveness of the QA it does on the equipment procured, by bringing about changes in their QA tools on the basis of dual input i.e. feedback from the field Army in the form of DRs, as well as from Expert Judgement[50]. So far as feedback received in the form of DRs

[50] Klas M, "Predicting Defect Content and Quality assurance Effectiveness by Combining Expert Judgement and Defect Data- A case Study", "Software Reliability Engineering", 2008, accessed through digital Library IEEE Xplore on November 16, 2012.

is concerned it can be utilised for improving effectiveness of QA using the under mentioned model.

5.2.1.1 Model for Establishing Voids in QA Using DR Data

This model enumerates the sequence, in which the investigation of DR data can be made, to pin-point the stage(s) of QA process undertaken during the procurement, where additional checks and balances could be incorporated to prevent such occurrences in future procurements.

- Though, in ideal case none of the equipment should fail, however for the reasons enumerated under the head "Quantum of Inspection" earlier in this paper, it is neither feasible nor possible. AsHSP may however work out a figure (or a range) of expected number of defects that are likely to arise due to manufacturing defects, on the basis of inspection data and taking into account the total population cleared for acceptance after inspection, total number of lots, lot sizes and the sample sizes chosen for assuring a certain percentage of success, with certain confidence level, in respect of each equipment inspected.

- Only those equipment for which the number of DRs, with defects attributable to manufacturing causes (called the attributable-defects), cross the upper limit of this range, warrant further investigation into the QA carried out at the time of their acceptance.

- Segregate these attributable-defects on the basis of assembly/ sub-assembly/ component. Check whether the defects of a particular assembly/ sub-assembly/ component come from the same lot. If yes, review the procedure of picking up the samples i.e. whether the samples were drawn randomly, did they truly represent the strata, were these equipment earlier offered in some other lot and rejected and later on reworked by the manufacturer and offered again in some different lots, who inspected those pieces of equipment (can be ascertained from the Inspection Note, IN number) etc. A questionnaire listing out all the aspects of sampling can be prepared for examination.

- In case nothing wrong is found in the sampling, check whether ATP had directions to inspect the affected item of the equipment separately, was any test certificate from any accredited lab accepted

for that item, were any failures reported on that item during field / technical / environmental evaluation, did the supplier not mention inspection of this item in the draft ATP etc. Another questionnaire for this aspect can be prepared and exercised. A more comprehensive check of the quality control and manufacturing / assembling processes may be made at manufacture's premises.

- If no fault is found in ATP, QAP and GSQR can be similarly probed.
- Analysis regarding occurrence of a particular defect in specific terrain and climatic condition can also be similarly carried out to improve upon the environmental evaluation of the equipment.
- Check whether the defect occurred due to any aspect for which self-certification rights were granted to the manufacturer.

The above model is only indicative and not exhaustive. It has lot of room for improvement and needs refinement before implementation[51]. It would be quite a laborious process in the beginning as all the required data would seldom be available at one place and would have to be brought together. A lot of *data mining* shall also be required. A possible solution is to maintain databases at AsHSP or technical directorates in a suitable form and regularly update them. A number of suitable quality improvement Tools like *"Fishbone analysis, Histograms, Scatter Diagrams* etc. can be incorporated in the model wherever they fit, to reduce effort.

Nonetheless, a modest systematic beginning can be made and the model can be improved with the expert opinion of DGQA staff. To begin with, the Officers and staff of DGQA undergoing various courses at DIQA can be given projects on individual cases as part of their course curriculum. The DR database available at AsHSP can be made available to them to ensure that their effort leading to an analysis of this sort is not wasted as accumulated literature at a training establishment but has

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[51] An in-house study team, which has access to all the database and information that cannot be put in public domain being classified in nature, needs to carry out a study to refine this model to an implement-able form.

some real time applicability for the organisation. Initial database may be created from these project reports and centrally maintained by directorate of Policy Planning and Training (PP and T) at headquarters DGQA or decentralised to AsHSP, whichever is found to be more effective in its application and convenient. Subsequently, in order to reduce time required for analysis, software consisting of various modules can be prepared which may be used as an information system to obtain important inputs for improving the complete QA exercise, beginning with commenting on quality aspects in GSQR, technical and environmental evaluation, preparation of QAPs, ATPs and final inspection for acceptance of finished product. Once this system firms up it shall offer an excellent feedback to all QA activities related to procurement i.e. it would in true sense become QAIS.

5.2.1.2 Auditing Quality of QA[52]

Officers heading the technical directorates, carry out complete inspection of activities of AsHSP internally during their annual inspection, as per procedure in vogue. Though, the audit of quantity of QA, its and financial effect, facilities like laboratories and their up-gradation etc. are carried out annually, yet, there is a need to check the quality of QA also and take corrective concerted action if it is found wanting in any aspect. Pro-forma for annual inspections may therefore be amended accordingly.

5.2.2 Actions by Army Units, Workshops, DPSUs, OFs and DDP

For the above exercise to be successful it is necessary that the users (field Army) report the defects meticulously. The problem of units, which have only one of a type of equipment available to them, will have to be addressed by centrally controlling such equipment at higher

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[52] Expert Judgment can, concurrently be used for Audit of effectiveness of QA and would entail incorporation of relevant inspection aspects in the annual inspection Pro-forma, to be checked during annual inspection of AsHSP and SQAEs/QAEs, by Additional Director Generals heading the technical directorates.

An external audit by an independent agency comprising of experts from Army, industry and academia is also recommended for second opinion and a worthwhile assessment. Its frequency may be decided by DGQA itself and may vary based on the pace of procurement activities.

levels such as brigade and division. Temporary inter-unit transfer of equipment will mitigate such problems as hither-to-fore. Importance of defect reporting has to be understood and applied with all sincerity in the larger interest of the organisation. Agencies responsible for reporting defects viz units holding equipment, Electronics and Mechanical Engineering workshops and MAGs may be sensitised on this very important aspect.

The self-certification privilege granted to Indian Industry, especially DPSUs and OFs should be taken by these organisations in the right earnest. They must strive to prove themselves worthy of such privilege in each supply of stores to the Army. While DGQA is empowered to cancel this authorisation for private industry if they fail to ensure quality in the self-certification aspect, DPSUs and OFs are immune to this. Any shortfall in the aspects for which a self certification authority is granted to them should be viewed seriously by the DDP and if improvement is not demonstrated to address such shortfall, DDP may consider withdrawal of this privilege from the defaulting DPSU (s)/ OF(s) on specific recommendation of the MAGs and / or user. This would ensure a *level playing field*[53] in the aspect of quality control for the private and government funded industry, thereby bringing improved quality products at competitive rates.

Since there is a human tendency to cut short the procedures, 100 percent correctness in maintenance and operational aspects of equipment, as recommended by the manufacturer in user and maintenance manuals are difficult to achieve. Though, the user and maintaining agencies must continuously strive to improve the training of their operators and technicians, DGQA can help them by ensuring that, wherever it is feasible as also economical, manufacturers incorporate necessary design features in the equipment to ensure that it would not operate if not operated or maintained in accordance with the instructions. Such advice can be given to users and the maintaining agency for incorporation in the GSQRs.

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[53] For more details on aspects needing "level playing field" for private industry, refer to "Defence Procurement Procedure, The Unfinished Agenda", Amit Cowshish, *Journal of Defence Studies,* 6 (3), July 2012, p.8-9.

5.3 QUALITY RANKING VERSUS QUALITY ACCEPTANCE/ REJECTION

Quality ranking of samples of equipment submitted by the vendors during technical and environmental evaluation using AHP shall have three major benefits. Firstly, no equipment will be rejected on quality aspects. Secondly, General Staff (GS) would be empowered to select or reject best equipment in their GS evaluation based on the reports of the user trial, quality ranking and the maintainability trials and later on during commercial evaluation will have to apply themselves intelligently and analytically for arriving at a decision in selection of equipment. They may again apply AHP as envisaged in Chapter IV by using user trial report, Maintainability Evaluation Trial (MET) report, EMC/EMI report and QA rankings as criteria and suitably break it into sub-criteria before ranking the alternatives in the form of vendors. Alternately, they may use *Weighted Aggregate Performance Index* (WAPI) as elaborated by Mrinal Suman[54], rather than just collating the information. Last but not the least, vendors will not have to incur any additional expenditure on re-trial as there shall not be any scope of variance in opinion between the user trial report and QA report since both the events would be mutually exclusive. The biggest benefit will be in terms of time saved in trials by eliminating re-trials and avoidance of collegiate discussion on points on which the user, DGQA and other stakeholders are at variance in their perception.

For this reason it is recommended to use the procedure elaborated in chapter IV for quality ranking of the vendor samples. To begin with a few exercises can be given to the officers and staff undergoing courses at DIQA and as such should be included in their curricula.

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[54] Suman Mrinal, "Weapons Procurement: Qualitative Requirements and Transparency in Evaluation", op. cit., p. 733.

Chapter VI

DPP 2013 AND FUTURE CHALLENGES FOR QA

In order to achieve self reliance in defence production, enhancement of indigenous private industry's role in R&D of defence systems, sought by the defence forces is inevitable. Accordingly, amendments to DPP-2011 have been approved. Along with all the stake holders, DGQA too needs to gear up for the new challenges this new policy is going to offer.

6.1 MAJOR CHANGES APPROVED IN DPP

The vision for indigenisation of defence production emanates from the fact that Indian Industrial base has not only evolved at a very fast pace in last two decades but also it is geared up to take on research and development of defence hardware. If the government makes rules that reduce red-tapism, eliminate bureaucratic delays and provides a level playing field to private and public sector, the public sector is more than willing to embark on the path of developing and manufacturing world-class defence hardware. The benefits of indigenously developed defence hardware need no elaboration. With this backdrop, the Defence Acquisition Council (DAC) has approved amendments to the DPP. The salient points of these amendments as published by Press Information Bureau (PIB)[55] are as under:

- **According Priority to Various Categories of Capital Procurement.**

  Preference for indigenous procurement in the Defence Production Policy 2011 has now been made a part of DPP through an amendment that provides for a preferred order of categorisation, with global cases being the last resort. The order of preference, in

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[55] Sitanshu Kar, "DAC Approves Major Changes in DPP to Encourage Indian Defence Industry", http://pib.nic.in/newsite/erelease.aspx?relid=94799, (Accessed July 24, 2013).

decreasing order, shall now be: First, "Buy (Indian)"; second, "Buy and Make (Indian)"; third, "Make"; fourth, Buy and Make with (Transfer of Technology) ToT"; and last, "Buy (Global)". Also it has been made a mandatory requirement now to state reasons for excluding the higher preferred category / categories whenever a proposal for lower preferred procurement is initiated.

- **Technology Perspective and Capability Roadmap (TPCR)**

  In order to enable the private industry to plan ahead for capacity building and directing its R & D, a public version of Long term Integrated Perspective Plan -2012-2027 (LTIPP-2012-27) called the TPCR has been released. The objective of the TPCR is to give an opportunity to the Indian industry to draw up business plans for developing technologies, which could be transformed into capabilities required by the armed forces[56].

  Procedure for the category "Buy and Make Indian" has been simplified to enable faster procurement of Capital goods under this category.

- **Removal of Embargo on Maintenance ToT (MToT)**

  Through this amendment the power to nominate MToT partners by DDP has been withdrawn. This shall remove the monopoly of DPSUs and OFs on MToT, as now the MToT partner shall be selected by competitive bidding. This measure is certainly going to have a positive impact on private sector participation in maintenance, repairs and overhaul work[57].

- **Initiation of Advance Consultation for Items to be Procured under "Make" Procedure**

  A mandatory requirement has been imposed on Service Head Quarters (SHQs), to begin consultations, sufficiently in advance

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[56] Amit Cowshish, "Technology Perspective and Capability Roadmap 2013", http://www.idsa.in/idsacomments/TechnologyPerspectiveandCapabilityRoadmap2013_acowshish_020713, (Accessed July 24, 2013)

[57] Sitanshu Kar, op. cit., http://pib.nic.in/newsite/erelease.aspx?relid=94799, (Accessed July 24, 2013).

of actual procurement, so that capital acquisition plans can be translated into national defence R&D and production plans. In addition, a high-level Committee has also been constituted for simplification of "Make" procedure, with a view to unleash the full potential of this important category[58].

- **Defence Items List and Dual Use Items**

  To enable full participation of private sector, Indian defence industry was opened to them in 2001. However, an embargo of Licensing was placed upon them. However the private sector always brought out the issue of lack of clarity pertaining to the items they must obtain the license for. Now a Defence Items List has been finalised by the MoD about which Department of Industrial Policy and Promotion (DIPP) shall issue the notification. In addition, MoD has clarified to DIPP that no licensing shall be required for the dual use items. Both of these steps are expected to bring required clarity in the licensing process.

- **Improving Efficiency and Transparency in Defence Procurement**

  In order to improve the efficiency of procurements, to speed it up and to make the process more transparent, it has been decided that the Services Qualitative Requirements (SQRs) shall be frozen prior to according the Acceptance of Necessity (AON). Also, the AON shall now be valid for only one year against the earlier validity of two years.

- **Issues Pertaining to Taxes**

  In order to put Indian industry at ease in matters related to taxes, a case has been taken up by MoD with Ministry of Finance (MoF), wherein the issues pertaining to rationalisation of tax and duty structures affecting the Indian defence industry and resolution of deemed export status for certain defence projects have been sought to be addressed.

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[58] Ibid.

- **Power to Approve Deviations**

  Deviations from DPP will now be approved by DAC and not the Defence Minister.

- In order to enhance indigenisation, "Indigenous Content" of defence products has now been redefined. This definition brings more clarity, common understanding and ensures removal of ambiguities. This is likely to ensure that the defence forces have reliable supply chains of these components / products at all the times, especially when their requirement is urgent.

- Instructions have been issued to ensure speedy conclusion of existing pending acquisition cases, which fall in the category of "Make" and "Buy and Make Indian".

- **Issue of Security Guidelines for Indian Defence Industry**

  Draft Security Guidelines that will apply to all licensed defence industries have been circulated for consultations with various stakeholders. It is expected that a complete security framework for Indian private industries participating in defence cases will be in place in the near future[59].

- **Funds for MSMEs in the Defence Sector**[60]

  The Defence Production Policy 2011 requires the setting-up of a fund to provide necessary resources for development of defence equipment. In order to ensure regular supply of funds to Micro Small and Medium Enterprises (MSMEs) involved in manufacturing of defence products, Small Industries Development Bank of India (SIDBI) has decided to earmark an amount of Rs. 500 crore for providing loans. Further, a fund of Rs. 50 crore for equity support out of "India Opportunities Fund" managed by its subsidiary; namely, SIDBI Venture Capital Ltd has been earmarked.

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[59] Sitanshu Kar, op. cit., http://pib.nic.in/newsite/erelease.aspx?relid=94799, (Accessed July 24, 2013).

[60] Ibid.

- **Enhanced Financial Powers**

  The financial powers of Service Chiefs/ DG Coast Guard have been enhanced from Rs. 50 crore to Rs. 150 crore for capital procurements.

With the above amendments to DPP along with the new Defence Production Policy in place there is likelihood of increase of participation of indigenous private players in R&D as well as production of Defence systems. DGQA is going to be confronted with new challenges for which it needs to be prepared well in time. One of the sore points of DGQA with DRDO is that DRDO does not involve the QA establishment in its developmental projects from inception, which leads to numerous problems at the time of transfer of sealed particulars after a defence system is developed. Furthermore, all the activities involving testing and evaluation are carried out by DRDO during the development stage of its products and DGQA does not play any role at this stage.

However, in case of future projects, which may be entrusted to private players, the MoD is likely to invest a substantial amount of funds. Thus, there would be a need to install a monitoring agency for consistently updating it on the progress of the projects, ironing out any bureaucratic ruffles and last but not the least ensuring that the operability, quality, reliability, maintainability, technological modernity as well as integrity of the product under development is in consonance with the aspiration of the user (services in this case) to the extent possible. This is where a heterogeneous mix of various members from user, maintaining agency, DGQA, bureaucracy etc. are likely to work under the supervision of a common project manager.

6.2 FUTURE CHALLENGES

In order to contribute constructively towards development of a desired product DGQA shall need to plan pro-actively and list out the activities it may be called upon to perform. Testing and Evaluation for quality is one such envisaged activity. Information collected through each stage of testing and evaluation is going to be the most important input for five major decisions enumerated below:-

- QA tests required in the next stage of product development and the test facilities
- that would be required for conduct of those tests.
- How much progress in the product development has been made and how much more time is likely before the product can be ready for production?
- How can the product design be improved for better performance and costs can be cut using the principles of value engineering?
- Does the product being developed works as specified by the user?
- What type of operator and maintenance training would be required in future?

6.3 ENVISAGED FUTURE ROLE

From Quality Assurance Plans (QAPs) DGQA would be required to graduate to Quality Support Plans (QSPs) which would facilitate and enable it to provide all the inputs at all the stages of Research and Development and production of a Defence system, as enumerated above. The QSPs prepared by DGQA for the defence system under development will have to be amalgamated in the Total Quality Management (TQM) philosophy of the respective Industry that is called upon to develop a particular system. For this reason, the QSPs have to be flexible to accommodate the TQM philosophies followed by various manufacturers and cannot be akin to the rigid document like the contemporary QAPs. Also, developmental testing and evaluation will have to be planned to address the following purposes:-

- Identification of technical capabilities and limitations of available concepts and design options under consideration.
- Listing the stresses that the system under development will have to be subjected to, in order to ensure robust design, short listing of most suitable materials and best production processes.
- Assessment of project in a manner to ensure that the critical technical and operational parameters envisaged by the user are met.
- Certifying the system's readiness for operational or field evaluation based on analysis of the test data.

Though, many tests being performed by DGQA during No-Cost, No-Commitment (NCNC) trials shall have to be shifted to testing and evaluation of the defence systems at developmental stage, yet the contemporary practice of QA at production stage for acceptance of the product shall remain with DGQA. Another major difference between such developmental projects and the QA practice in contemporary procurement cases would be that the QA testing and evaluation in the former case would have to precede the field/ operational evaluation trials. The QA personnel would also be required to assist the field trial teams to carry out operational testing and evaluation of the product as hither-to-fore. Additional task perceived to be allotted to DGQA is related to MToT. Since a number of private vendors are now likely to get MToT as against only the DPSUs and OFs earlier, the inspection of overhauled equipment may be delegated to DGQA due to its vicinity to Industrial base. This would call for a better synergy between DGQA and DGEME.

6.4 FOCUS AREAS

During the development of a defence system of a product for defence use, a pro-active approach by DGQA would call upon DGQA to focus upon three major areas viz. critical operational parametres, critical technical parametres and the measures of effectiveness and suitability. Critical operational issues would necessarily mean that the system, when fully developed, shall be able to perform its mission e.g. in case of a weapon system, successfully engage intended target at desired range while being operated safely in a combat zone. Critical technical parameters would be the engineering design and material factors that the system must meet or exceed to ensure that established performance thresholds are achieved. Measures of effectiveness and suitability would determine the extent to which the system would perform its intended mission and the interoperability, reliability and maintainability of the system respectively.

SUMMARY

Call for self-reliance in development and production of defence systems has opened a new vista for private indigenous industry. It is indeed a "New Dawn for Defence Production in India", as told by Amit

Cowshish[61]. However, being an extremely challenging task, the Indigenous private players would look at DGQA for guidance and expert advice in development of quality defence systems. For this DGQA shall need to plan in advance. This chapter brings out certain new challenges that DGQA is likely to be confronted with, and few suggestions to act as an enabler for the Indian industry as the latter gears up for this new challenge.

[61] For more details read, Amit Cowshish, "A new dawn for defence production in India", Issue Brief, http://idsa.in/issuebrief/Anewdawnfordefence productioninIndia_acowshish_060413#footnote1_o4rh2es, (Accessed July 29, 2013).

Chapter VII

CONCLUSIONS

For the success of any military mission, right equipment, at the right time, in the hands of soldiers is as important a factor as the training and physical fitness of soldier himself. Thus, factors causing delay in procurement of Army hardware need to be identified analysed and eliminated. Though, mostly inadvertent, these delays occur at various stages of procurement of equipment and none of the agencies involved in procurement can be absolved of the responsibility of causing them. Further, two most important features that equipment in the hands of soldiers must possess are high reliability and military ruggedisation. Military equipment are required to be operated in war / warlike situations and must not fail during the missions. It is for these reasons; the importance of quality assurance at the time of their induction in service assumes a critical role. In Chapter II, an attempt has been made to identify and analyse factors causing delays in procurement process due to QA procedures, as also to analyse few hindrance-causing factors in the QA modalities in procurement of hardware for Army. Solutions to these detrimental factors have been enumerated in section 5.1 of Chapter V. These are mostly minor procedural and organisational changes and do not require much of financial and human resource effort. It would rather be prudent to say that under all likelihood, these changes won't invite resistance from within the organisation and their benefits shall outweigh the effort needed to implement them.

In order to ensure that the defence forces perform their operational tasks efficiently and effectively, it is necessary that only high quality and reliable equipment and weapon system be provisioned to them. QA organisation responsible for ensuring quality and reliability of these equipment and weapon systems, therefore needs to be empowered by the DDP, as also, the organisation needs to empower itself internally by continuously improving its ability and upgrading its skills. Creation of a QAIS based on the model suggested in section 5.2.1 of Chapter V, wherein feedback from users is analysed to identify the root cause of the problems and their application to relevant activity of QA,

coupled with expert judgment in the form of internal and external audit of the quality of QA, would prevent stagnation of these activities and result in a dynamically improving and evolving effectiveness of the organisation, which is highly desirable at the moment. Recommendations given in Section 5.2.2 of Chapter V, if implemented, shall act as enabler for DGQA in implementing the model and creating a robust QAIS, which can be used for improving the quality of QA it, provides.

Shortlisting of product samples of various vendors, post technical and environmental evaluation is a process involving complex decision making. It invites the flak from the users whenever the procurement projects get into jeopardy due to being reduced to single vendor situation or no vendor situation in case all the vendors get rejected on quality aspect of their products. The reason for this is that the user has to re-initiate a long procurement cycle for the same product due to product deficiency or a very stringent GSQR. However, they try to apportion the complete blame on DGQA for causing this delay. It is for this reason the decision to accept or reject a vendor on the grounds of quality must be left with the buyer and DGQA must only give quality ranking obtained using strong and time tested scientific decision making tools like AHP. Quality ranking using AHP as elaborated in chapter IV can therefore, act as a first stepping-stone in this direction.

Efficient and effective organisations maintain a close vigil on the requirements of their customers and accordingly select their goals. *"Well begun is half done"* Therefore, advance planning to meet the future challenges is a mandatory organisational requirement. Keeping this spirit in mind a few challenges that DGQA may be confronted with, in next couple of decades, in light of the effort being made to bring self-reliance in defence, have been outlined in Chapter VI. A strategy needs to be prepared to handle these perceived challenges.

Finally, it needs to be appreciated that DGQA is a service industry and one of its functions is providing third party QA cover to the products being procured by the services. It must therefore, to remain in business, consistently ensure its customers are satisfied with the services it provides. To meet this purpose it has to regularly bring about minor changes in its organisation, procedures and processes to keep pace with contemporary technological developments, business practices and the

changing dynamics of the customers' requirements. Delays in consistent and constant evolution process may necessitate incorporation of major changes in organisation, procedures and processes at later date to regain the efficiency and effectiveness of the organisation.

The Directorate General of Quality Assurance (DGQA) is the organisation that is responsible for ensuring the quality of a wide range of military hardware at the time of their procurement. This is a very old organisation and has evolved over a period of time to meet the aspirations of its customers. However, since the introduction of Defence Procurement Procedure it has invited lot of criticism from its users due to the delays caused in procurements and attributable to Quality Assurance (QA), as also the introduction of sub-standard equipment in service. This monograph analyses the factors that are causing the delays as also those limiting the quality of the QA of military hardware being procured. It also gives certain implementable solutions in the form of minor re-engineering of the organisation and the business processes of DGQA. Due care has been taken to ensure that the existing organisation and QA procedures are not tampered with. It also lays down a roadmap to address the greatest concern of the parent procuring directorates regarding rejection of vendors based on quality of their product leading to single vendor/ no vendor cases. Future challenges that the DGQA is likely to face in view of a more determined approach to establish a robust indigenous defence industry, have also been enumerated in this monograph.

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