CHAPTER - IV

METHODOLOGY OF THE STUDY

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CHAPTER-IV

METHODOLOGY OF THE STUDY

4.1 Introduction

This chapter covers the details of methodology adopted for the research. During its course, it covers the various stages of research, their implications and interconnections. It explains the types of data used, their sources, methods adopted for collection and analysis. It also briefs about various tools used in data analysis and validation methods adopted. It also spells out the confines within which the research has been carried out and possible extensions in other domains and in future.

4.2 Methodology of Research

The broad scheme followed for the research is pictorially depicted in Figure 4.1 below.

Being a military related subject not much of data was easy to come by. Tacit knowledge bases available with various stake holders had to be captured and integrated without jeopardizing the accuracy of the information in one hand and information security on the other. Impressions had to be sifted through, to get hard information that was workable.
Extensive literature survey was carried out to learn major theoretical bases and state of the art techniques. Interviews with experts were regularly resorted to, to gain correct and comprehensive insight into Military HRM.

*Information on Indian Army was limited to what is available in public domain. No classified information was used.* Most of the literature and theoretical bases were that of US and Canadian Armed Forces.
After necessary literature survey, problem definition was finalized and a draft Research Plan was worked out. Based on the research plan, the theoretical framework and conceptual framework were developed, which guided a focused literature review and in-depth analysis of current status of the military HR management techniques in the world. The hypothesis and data collection plan was then culled out.

Thereafter, the metrics for skills were formulated. Data collection on AS IS and past performance was done through sifting of records as available with various HR agencies and training establishments. Individual impressions were also captured during the research for subjective validation.

Thereafter, a SI Based Model for HR Management an Armoured Formation\(^1\) for a Tank Squadron\(^2\) was worked out. The impact analysis was then carried out through interviews and questionnaires to logisticians at various levels ranging from technicians to Senior Maintenance Engineers. The inferences were then collated and processed through Analytic Hierarchy Process (AHP)\(^3\) method with the impressions of senior officers to ratify the reasoned assumptions.

Finally an organisation wide implementation model was formulated and presented. The same was refined after a series of interaction with various stakeholders.

4.3 Research Questions

The research questions stated earlier may be recollected. The overarching research question is \textit{“Will Skill Based Deployment of Technicians in the warzone enhance the Combat Potential of the...”}
Army?”. This research question was further sub-divided into few specific questions as under for ease of handling:-

1. Can a systematic approach to personnel management and organisational design be based on identification of critical organisation skills?
2. Will skill based deployment of technicians enhance their efficiency and effectiveness?
3. Does skill-based-deployment enhance overall combat engineering support and increase the equipment availability through quick recycling?
4. Will skill-based-deployment enhance skill development of the personnel?
5. Is it time to move from Man-Job fit to Responsibilities /Task Lists – Skill fit?
6. Will skill based deployment of technicians be more effective in Mobile operations?
7. What are the likely challenges in implementation of skill-based-deployment?
8. Will skill-based-deployment lead to any major strategic advantage or limitation in future war scenarios?

4.4 **Objectives of the Study**

The research objectives stated earlier that were formulated in harmony with the research objectives have been reproduced below for easy assimilation and correlating with the research design.
The primary objective of the research is to refine the existing deployment model of technicians, during mobile operations by using Skill Inventory (SI) concepts, so as to achieve optimal efficiency and effectiveness in combat force regeneration in battle fields.

The primary objective has been further subdivided into manageable specific objectives as under:-

- Identifying the skills that matter in a specific domain, task, time and space.
- Evolving metrics with which these skills can be measured and recorded.
- Comparing skill development / loss due to equipment association or lack of it.
- Measuring change in effectiveness of technicians when resorted to skill based deployment
- Evolving a deployment template for logistic echelons involved in equipment maintenance during mobile operations

4.5 Hypotheses

The hypothesis stated earlier has been analysed below for its viability for validation and evolving appropriate techniques. It may be noted that the major challenge in this research is the lack of metrics for measurement of skill and its manifestations. Therefore towards proving the hypothesis, it is essential to break it down to various sub-hypothesis and components associated with them shall be studied subjectively as well as
objective measures taken. Thus the main hypothesis can be proved transitively through proving sub-hypotheses.

4.5.1 Null Hypothesis

The Null Hypothesis defined for the research is as under:

\[ H_0 : \text{Skill based deployment has no effect on effectiveness of combat engineering support to weapon systems in a Tank Squadron during Mobile Operations.} \]

This Null Hypothesis gives way to two possible Alternate Hypotheses as given below.

4.5.2 Alternate Hypotheses:

The alternate hypotheses, spanning both the extremes of research variable, are as under:

\[ H_{a1} : \text{Skill based deployment enhances the effectiveness of combat engineering support to weapon systems in a Tank Squadron during Mobile Operations.} \]

\[ H_{a2} : \text{Skill based deployment reduces the effectiveness of combat engineering support to weapon systems in a Tank Squadron during Mobile Operations.} \]
4.5.3 Alternate Hypotheses:

One of the alternate hypotheses is attempted for proof as the other is mutually exclusive. Towards this effect, the Alternate Hypothesis $H_{a1}$ has been broken into several sub-hypotheses as under:-

$H_{a11}$ : Skill based deployment enhances skill development.

$H_{a12}$ : Skill based deployment enables extended equipment association.

$H_{a13}$ : Skill decays without equipment association.

$H_{a14}$ : Skill Development is contingent on Equipment and Role Specific deployment.

$H_{a15}$ : Effectiveness of Combat Engineering Support depends on Skill availability.

$H_{a16}$ : Equipment specific deployment enhances combat engineering support.

$H_{a17}$ : Role specific deployment enhances combat engineering support.

$H_{a18}$ : Skill Management is essential relevant for Combat Engineering Support.

$H_{a19}$ : Skill specific training is essential for Modern Battle Fields.

$H_{a20}$ : Effectiveness of Combat Engineering Support depends on adequate availability of skill in forward echelons.
Ha21: Requirements of skill in forward repair teams can be addressed through deploying personnel with measurable skill factors.

Ha22: Skill presence can be estimated through measurement of skill components.

4.6 Hypothesis Validation

With lack of quantifiable metrics, it was not possible to prove the hypothesis directly; hence attempts were made to prove it transitively through qualitative treatment.

Steps associated with hypothesis validation are as under:

- Environment scan was carried out to firm up basis for hypotheses and also to be established shared perceptions.
- The findings were corroborated and refined through interactions with experts and using Pair wise comparison technique of preferences as used in Analytic Hierarchy Process (AHP).
- Skill factors, that are relevant, measurable, recordable and usable, were identified through ibid process. They were further refined and weightings assigned.
- Skill indices that can be used to quantify ibid skill factors were identified and tentative measures allotted through experts preferences, duly rounded off, for ease of usage.
- Based on skill indices and skill factors, a group of technicians operating in mobile operations were studied and their skill levels
estimated. This data was subjected to internal consistency and anomalies removed.

- The context of battle field was studied in detail and key attributes of battle fields were frozen. In relation to these attributes, skill requirements in the battle field were identified. These factors were further subjected to rank ordering and their inconsistencies were removed.

- These requirements were subjected to experts’ analysis and AHP was applied to find out their importance weightings.

- The sample respondents were subjected to detailed testing by a panel of experts, and presence of skills in each of the skill requirement silos was estimated. Thus the net skill presence in each respondent was calculated, duly assigning with importance weightings.

- Skill factors, that are relevant, measurable, recordable and usable, were identified through ibid process. They were further refined and weightings assigned. Their internal congruence was validated through correlation analysis.

- Multivariate Regression Analysis was applied on following parameters:-
  - Estimated Skill (dependent) Vs Skill Requirements
  - Skill Presence (dependent) Vs Skill Factors
  - Skill Presence (dependent) Vs Estimated Skill

- Thus the relation between Skill Requirement and Skill Factors was established. It also served to validate the skill indices assumptions.

- Based on the above findings and also the survey conducted on related aspects, the sub-hypotheses were validated.
Based on the validation of sub-hypotheses, the Alternate Hypotheses were validated.

Through the proof of Alternate Hypotheses, the Null Hypothesis was validated.

Based on the findings, the research questions were revisited and enriched with specific answers. The research objectives were also revisited and degree of accomplishments towards objectives, was highlighted.

4.7 Data Sources

Another major challenge in the research is the availability and usability of data, owing to its defence related security classifications and other ramifications. Notwithstanding, maximum data as available in the open source was used. Also Convenient Sampling techniques were used for the same reasons. The details of primary and secondary data are described below.

4.7.1 Primary Data

Quite natural for the subject chosen, there were not many primary sources accessible in quantitative terms. The research had to be probed explanatively through explorative interactions with experts at various levels. Since metrics of many of these variables were not readily available, they were evolved transitively. Subjective interpretation and analysis, although was unavoidable, were kept to bare minimum.
The primary information was collected through questionnaires. Subjective information was also obtained through interactions with experts in the field.

Convenience Sampling techniques were used with due concern for variety and exclusion of inconsistencies through subjective validation through information obtained through experts interactions.

An opinion survey was initially carried out to estimate the need and areas of focus. To this effect, customized questionnaires were mailed to 100 candidates, of which 30 personnel could respond, of which 10 were user officers and 20 were logistic officers respectively. It may also be noted that, being a defence related research, not much of direct information could be gathered or used. Respondents as available had to be content with. The sample size is out of a population of approximately 300 user officers and 400 logistic officers.

Thereafter during initial stages, for felt need analysis and environment scan, out of estimated population of 1000 logisticians spanning all services, 40 respondents were chosen through Random Sampling. Customised questionnaire was used for this purpose.

Towards finer estimation of skills and measurement, out of an estimated population of approximately 4000 technicians, 36 respondents from various trades as available during a training were chosen as Convenient Sampling and were assessed.
The primary data generated through them include the following:-

- Self Assessment Data
- Supervisors Assessment
- Panel Assessment

4.7.2 Secondary Data

There is a strong interconnect between primary and secondary data in this research for very reasons cited above. The data collection started with Secondary Data followed by Experts Analysis that helped identifying area and focus of primary data. The primary data induced collection of more secondary data. This activity went on like a reinforcing loop till adequate confidence levels on inferences are achieved.

Since the learning curve is not very steep in military logistics, the observations on skill development owing to other independent variables have to be based on the following secondary data extracted from database of last 30 to 40 years:-

- Posting Records.
- Super Specialisation Records.
- Posting profiles of a technicians.
- Equipment association.
- Grading as per records.
- Employability as per records.
However, the interpretation of these statistical inferences ought to be necessarily corroborated with the analysis/view points of experts in the fields. Thus, the primary-secondary data connect in the study is seen as Strong and was pursued with due importance.

4.8 Methodology and Techniques Data Analysis

Being an explorative research operating in qualitative realms, multiple iterations of data collection and analysis, was mandated. In between, subjective interventions by the experts were also required. In all the data collection and analysis was carried out in four distinct phases that are summarized below and explained in succeeding paras.

In Phase 1, a Felt Need analysis was carried out through an environmental scan. Questionnaires targeting various stakeholders were used. Based on the findings, the felt need was analysed and confirmed. Chi Square test was applied on the findings, to confirm two major components of the hypotheses emerging at this stage.

Based on the findings of previous phase, the hypotheses was formulated and pursued in Phase 2. Data collection and analysis thereafter were driven by the same. Hypotheses warranted comparison of effectiveness of existing model with that of proposed models, for which necessary factors were identified and measures evolved. For objective differentiation and measurement of factors, skill indices were formulated.

In Phase 3 manpower validation in terms of skill was carried out. Towards this, an organic army logistic unit was assessed for its skill potential. The same was compared with the skill requirement generated by
a skill specific model. Based on these two findings, skill adequacy was analysed. Due to security implications, these information and analysis were reserved. However, major inferences in terms of broad patterns were suitably incorporated in subsequent analysis. Phase 3 concluded with an inference that **skill requirement is relevant and essential for effective deployment.**

In Phase 4, skill pervasiveness and development prospects were analysed from implementation perspectives. In this phase, the constituents of skill, were culled out and their presence, development and potential for an objective measure for deployment were analysed. The findings were further corroborated with preferences of experts duly processed by AHP method. Towards validation of the hypothesis, skill factors, skill indices, self assessment of skills, supervisor assessment of skills, skill requirements in forward echelons and skill presence, were tested in detail for internal and mutual congruence / dependencies. Major findings from this phase were used in final validation of hypothesis and recommended implementation strategy.

### 4.8.1 Data Collection and Analysis Techniques in Phase 1

The methodology and techniques followed for data collection and analysis in Phase 1 is shown at Figure 4.2.

As can be seen, the Phase 1 started with collection of initial impressions from a set of respondents using the equipment and another set of respondents involved in logistics support through customized questionnaires.
These questionnaires included two major facets that later formed the core of hypothesis, that are as under:-

- Do you think, skill specific deployment of technicians will automatically enable / enhance skill development?
- Will continuous equipment association, automatically enhance skill levels of the technicians?

Responses to ibid questions were further processed through a Chi Square test for consistency. Based on the broad spectrum of requirement an environment scan with 40 respondents, was conducted with a customised questionnaire that covered users and logisticians at officer’s level. It was conducted to gain an insight on the shared perceptions on various facets of skill based management of HR.
Simultaneously, another customized questionnaire was used to collect information and analysis from Senior General Officers, to corroborate the earlier findings. These responses remained subjective and were applied to confirm research findings. In all, there were seven senior officers chosen based on convenience and relevant expertise, have been interacted with.

Findings of Phase 1 are as under:-

- There is a Felt Need in the environment for Skill Based Deployment of technicians in forward repair echelons.
- Skill based deployment will enhance skill development.
- Equipment association is vital for skill development.

4.8.2 Data Collection and Analysis Techniques in Phase 2

The methodology and techniques followed for data collection and analysis in Phase 2 is shown at Figure 4.3.

Phase 2 warranted comparison of current deployment scheme with that of the proposed scheme based on skill index. To this effect, it was essential to evolve skill indices. While literature review on skill measurement and competency measurement could throw some light on the same, it was essential to concretize the skill constituents relevant to current research. The components of skills earlier identified through customized questionnaire were used as the basis. With the responses to these questionnaires, the essential constituents of skill in our context were derived.
However, these constituents have to be further prioritised and weightings assigned. To this effect, rank ordering of skill constituents was resorted to, with 40 respondents through a customised questionnaire. Random Sampling Techniques were used at this stage.

As the ibid aspect is quite vital in the research, AHP was also applied to further corroborate the findings and assign inter-se weightings. To this effect, three experts in the field, dealing with the subject, for over last three decades were asked to make pair wise comparisons. They were selected based on their expertise and availability.
4.8.3 Data Collection and Analysis Techniques in Phase 3

The methodology and techniques followed for data collection and analysis in Phase 2 is shown at Figure 4.4. This phase was carried out in two sub-phases concurrently as under, those are explained in succeeding paras.

- Skill Availability Determination.
- Skill Requirement Determination.

4.8.3.1 Skill Availability Determination

The skill availability in a Light Repair Detachment (LRD) responsible for providing combat engineering support at Organizational Level (O Level) is to be calculated. To this effect, first hand information of all personnel available in three LRDs from different formations was captured. The data was further validated based on skill indices and the weightings derived earlier.

4.8.3.2 Skill Requirement Determination

To this effect, a job analysis of organic repair detachments of primary echelons was carried out. The job requirement was worked out in skill sets as close as possible with available skills. Questionnaire 6 was used for rank ordering of these aspects. There were 113 respondents used in this survey.
Although it is one of the major phases dealing with manpower validation, the findings and inferences are reserved for security reasons. The major inferences in terms of broad patterns have been suitably dovetailed in Phase 4. Thus, Phase 3 was fore closed with an open inference that skill requirement is relevant and essential for deployment.
4.8.4 Data Collection and Analysis Techniques in Phase 4

The abstract model followed for data collection and analysis in Phase 4 is shown at Figure 4.5.

Phase 4 being the culminating phase, it commenced with four concurrent activities as under:-

- Skill Estimation using Skill Indices
- Objective Assessment of Skills
- Experts choice for Training and Deployment Preferences.

In addition, self assessment and supervisor’s assessment of skills on sample respondents were resorted to validate viable implementation techniques in future.

A convenient sample of 36 technicians from various formations, dealing with different equipment, age profile, service profile, trade and rank were picked.
4.8.5 Validation Approach

The schema used for validation is shown in Fig 4.6 and is explained in succeeding paragraphs.
The skill factors, identified earlier in Phase 3, were subjected to a test of correlation. It could be observed that 68 percent cases have dependencies less than 35 percent. Minimum interdependencies are preferred options during multifactor correlation to avoid multi-collinearity.
The skill requirements were identified earlier in Phase 3 were subjected to a test of correlation. It could be observed that 72 percent cases had dependencies stronger than 50 percent. While minimum interdependencies are preferred options during multifactor correlation to avoid multi-collinearity, such strong correlation amongst requirement indicates consistency in requirement in forward echelons.

The sample respondents were asked to fill in their portfolio. The same was applied with skill indices earlier determined and skill presence in each of them was estimated. Due weightings for each of these skill factors, were applied as determined earlier in Phase 3.

The requirement in forward echelons have been determined a prior. A panel of experts conducted following tests on the sample respondents that were primarily centric on requirements in forward echelons:-

- Theoretical Test.
- Repair Exercises.
- Practical Tests on Equipment.
- Oral Discussions.

The results were further processed along with weightings of each requirement as determined for skill factors and skill requirements.
4.8.5.1 Self Assessment of Skill

All individuals were asked to make a self assessment. These results were processed for congruence with actual estimates. This aspect ought to be considered while evolving implementation models post research.

4.8.5.2 Supervisors Assessment of Skill

All individuals were assessed by the supervisors subjectively through interaction during classes. These results were processed for congruence with actual estimates. This aspect ought to be considered while evolving implementation models post research.

It should also be read in conjunction with the previous findings and it can be opined that subjective estimation by supervisors are less reliable with respect to Self Assessment.

4.8.5.3 Skill Presence Vs Skill Development Factor

A multivariate analysis was carried out on the skill presence (dependent variable) with skill development factors. A more detailed analysis of dependency with Total Service is recommended during implementation stage.

4.8.5.4 Estimated Skill Vs Skill Requirement in Forward Echelons

A multivariate analysis was carried out on the Estimated Skill (dependent variable) with skill requirement factors.
4.8.5.5 Regression between Estimated Skill and Skill Presence

The crux of the study is in establishing the relationship between the estimated skill requirements vis-a-vis measurable skill presence in the forward echelons. To this effect, a regression analysis between these factors was carried. While ibid tests are adequate to confirm the research findings, experts choice for deployment preferences and training preferences were resorted to, purely for implementation requirements and are covered in succeeding paras.

4.8.5.6 Expert’s choice for deployment preferences

Preferences of experts over various types of deployment methods was captured through pair wise comparison and validated. The same was further processed through AHP.

4.8.5.7 Expert’s choice for Training preferences

Preferences of experts over various types of training methods were captured through pair wise comparison and validated. The same was further processed through AHP.

4.8.5.8 Interview with Experts

Towards concluding the phase, a set of focused interviews were carried out with three senior General Officers through a customized questionnaire. The results were processed subjectively in concretizing the findings and hypothesis validation.
4.9 Tools for Analysis

Primarily the research is centric about identifying factors that are relevant measurable and recordable at two distinct, domains, namely; its manifestations and requirement. Thereafter their intra-dependencies of factors and interdependencies of the domains were to validated to prove the change in effectiveness. To this effect, only standard tools commonly available for Factor Analysis, Correlation and Regression, were used. The tools used in the study are discussed in succeeding paras.

Appropriate statistical tools were used in environmental scan to arrive at weighted preferences through MS Excel. Use of simple statistical analysis like Mean, Median, Mode, Standard Deviation, etc, was resorted to, in the treatment of first level secondary data to indentify the research problems correctly and also define the scope of research. MS Excel was extensively used throughout the research for Chi Square Test, ANOVA and AHP. Final processing of skill presence and requirement was extensively processed using standard statistical tools

One way Analysis of Variance technique has been used for testing the inter-se variances of preferences captured through questionnaires.

Chi-square is a statistical test commonly used to compare observed data with data we would expect to obtain according to a specific hypothesis. It has been used in this study to verify and exclude the presence of inconsistencies, if any.

One of the widely used tool in this research was AHP, that facilitated resolving many subjective decisions from inconsistencies. It was used in verifying the first level inferences drawn from secondary data. The
views and impressions generated by the experts were also processed through Experts Choice software to remove inconsistencies. Experts Choice® software for AHP was used initially. Thereafter, a customized MS Excel Template was evolved for the research and used.

Towards the final findings, multivariate regression techniques were used to along with simple linear regression models in verifying causal relationships and the strength of regression.

Correlation analysis of factors to identify and control interdependencies of independent variables was resorted to before applying multivariate Regression Analysis.

4.10 Limitations and Extensions

The broad and specific confines within which the research was endeavoured and also the potential extensions, are outlined below.

4.10.1 Limitations

- This study was carried out in an explorative and non-intrusive manner due to security reasons. Specifics of Indian Army were not used at all in any form. As such, the findings can be used only after careful adaptation.
- The research information used is primarily from open source and pertaining to that of US Army, Canadian Army and Australian Army. These Armies can be considered as fore-runners in the fields of technology as well as HR management of military personnel.
However, their templates may not suit our context fully, but essentials can always be learnt and adopted in our systems.

- Being an explorative study, not all objectives set forth in the beginning could be reached as such. The research was progressed iteratively and the hypotheses and research objectives had to be realigned with interim findings. Notwithstanding, towards the end, the objectives could well firm up and yield desired results.

- Since the study deals with Armed Forces, that have security ramifications, the research was pursued in non-obtrusive manner without intervening in any of the functioning of Armed Forces agencies. Thus, no active empirical study was carried out.

- For verification of research, current research may be extended as an Applied Research in the select domains of Armed Forces by them internally.

- Confidentiality of information and sensitivity of data involved had to be kept in mind all the time.

- Limited data availability in public domain was a restricting factor. However adequate data for the research could be accessed.

- Understanding military logistics by the reader has known limitations. It is not possible to expect the reader to understand all the nuances that define the context.

- Methods ought to be non-intrusive due to sensitivity of area.

- Multi-faceted skills that are context specific had to be validated subjectively.

- Modalities for implementation are vague and ridden with many unknowns. Reasoned assumptions had to be made at many places.
4.10.2 Extensions

- An implementation model based on the findings was worked out and shared with Indian Army authorities for their necessary pursuit, if deemed fit.
- Current research shall be pursued further by Army authorities towards making a deployment template and study its effectiveness.
- Skill Inventory Models can be explored for feasibility in Industrial and Service Sectors. Such models are very easy to implement in Virtual Educational Institutions.
- Skill Inventory concepts should be explored for automatic generation of templates, based on stated requirement. This should have due complementary efforts from Knowledge Management domain.
- Skill Inventory models can be subjected for a comparative analysis with Configuration Management techniques to develop common system attributes.

4.11 Chapter Summary

This chapter described the details of methodology for research and techniques adopted at various stages. It explained the types of data used, their sources, methods adopted for collection and analysis. It also outlined various statistical tools used for data analysis. It described the methods adopted for validation of hypothesis. Finally, it indicated the confines within which the research was carried out and possible extensions in other domains.