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SWOT Analysis: A Theoretical Study of ADRDE DRDO Performance Appraisal

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Abstract-Today's commercial success and stability depend heavily on innovation and knowledge creation in research and development (R&D). Companies are shifting toward quality-focused improvements due to tightening client requirements and increased worldwide competition. The performance evaluation of government funded venture research institutions is crucial in boosting the efficiency and cost-effectiveness of public resources. Integrates basic and applied research with the development, testing, and experimental production of crucial national systems and subsystems to satisfy the armed forces' requirements. Today as per the organization's mandate, R&D organizations have to engage in strategic planning. This study focuses on performance appraisal of government funded defense establishment ADRDE, Ministry of Defense, Government of India, by SWOT Analysis. The present study offers vital contributions to both theory and practice. To the authors' knowledge, this review is the first to assess, analyze, and synthesize the SWOT in Research and Development establishment, providing new theoretical perspectives on SWOT analysis.

Keywords: venture, cost-effectiveness, ADRDE, SWOT, Integrates

1. Introduction

Industries are facing numerous challenges to remain in the market for a long time; Innovation is the only technique to compete in the continuous changing market. Industries are extending their expertise and developing innovative technologies. Although working with outside parties to develop and promote innovative products and services has become more common place for businesses, this process is still very difficult. It has not garnered enough attention from academic studies.

In order to properly serve their consumers' needs for quality, price, and delivery time, businesses are thriving to define, monitor, and control their processes. In order to manage future success, businesses are putting more emphasis on process management to ensure quality. Management roles and duties are shifting. The challenge for businesses is to adopt quality assurance and systems that truly fit their industry and unique operational procedures.

Research involves the application of both concrete (scientific tools, systems, processes, subsystems, materials, etc.) and intangible (learned knowledge) resources produced by human intelligence. As a result, "new knowledge or innovation" has a complex nature and comprises both concrete and abstract components (publication, patent, database, paper presentations, new products, etc.). (Tacit knowledge, experience gained, etc.). Research is, therefore, a multi-input, multi-output process.

Defense Research

Defense research and development is a mission-focused activity. Additionally, improving and modernizing present systems and their components is meant by the word. Since gaining independence, Indian officials have prioritized meeting all of their own defense needs. As a result, a vast investment of hundreds of organizations in public-private sectors was created to develop cutting-edge systems for the nation's armed forces.

Portfolio management enables executives to choose where to invest in R&D (Cooper, 2013; Fragola, 2010); client preferences and market trends must be considered in order to meet the organization's long-term goals. According to R. Cooper, initiatives that result in new knowledge, new technologies, new skills, or a technical platform may be incorporated into the portfolio of applied research projects (Cooper et al., 2007). However, the government's capacity to Import of new systems has been caused by poorly supported R&D institutions to innovate new systems.

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Performance Evaluation by SWOT Analysis

Performance evaluation of defense R&D is still largely unexplored in the literature due to the paucity of information on the topic. A number of metrics, such as commercialized technologies, products incorporated into services, revenue generated, collaborations among the industries and academia, Transfer of Technology (ToT), technical human resources generation, import, and research papers publication, show how directly DRDO R&D activities affect the nation's economic growth. R&D is seen as a key indicator of techno-economic growth because it is responsible for India's vast variations in technology and industrial advancements.

SWOT is a strategic management tool. Strategic planning is a key to successful strategic management. Strategic management is the continuous process of creating, implementing, and evaluating decisions that enable an organization to achieve its objectives. It allows an organization to be more proactive than reactive in shaping its future; Strategic management consists of the analysis, decisions, and actions an organization undertakes to create and sustain competitive advantages.

It begins with a vision. Vision is a picture of the future position (where you would like to be in the future). The next step is mission. The mission is what the organization is, its long-term purpose. Charter is the domain expertise of the organization are the third step of the strategic management process. The next phase is external and internal analysis, also called SWOT Analysis. While external analysis focuses on the environmental threats and opportunities facing an organization, internal analysis helps it identify its strengths and weaknesses.

Based on SWOT Analysis, organizations can choose the appropriate strategy. The next is the implementation of the strategy. Selecting a strategy means nothing if that strategy is not implemented. Strategy implementation occurs when an organization adopts organizational policies and practices consistent with its strategy. And the final step of this process is to obtain a competitive advantage.

SWOT Analysis is a tool used for strategic planning and strategic management. Examining the internal factors within the establishment and the external factor associated with the establishment and influencing its function is termed SWOT Analysis, as shown in Table1. According to Hill and Westbrook (1997), SWOT Analysis is a technique that started to be used in 1960s. SWOT Analysis is a simple but powerful tool for sizing up an organization's resource capabilities and deficiencies, market opportunities, and the external threats to its future. SWOT stands for 'strengths,' 'weakness,' 'opportunities,' and 'threats. Strengths and weaknesses are internal factors and attributes of the organization, opportunities and threats are external factors and characteristics of the environment.

S. NO.	PARTICULARS	ASPECTS
1.	Strength	Advantage over others
2.	Weakness	Disadvantages relative to others
3.	Opportunity	External elements that give the benefit
4.	Threat	An external element that causes trouble

Table 1: Variables in a SWOT analysis

SWOT Analysis helps identify Strengths and favorable and helpful opportunities in achieving the objectives. Also, Weaknesses and threats that are unfavorable and harmful cause difficulty in achieving the organizational objectives.

Advantages of SWOT Analysis

SWOT Analysis is a prevalent and tested method used for strategic management. The characteristics that can be evaluated as advantages are listed below:

- General perspective and presents general solutions.
- Macro evaluation (broader picture).
- Help managements to uncover opportunities.
- SWOT Analysis can be combined with other methods such as PESTLE, five force model, etc., to give a more accurate analysis.
- Promotes group discussion, brainstorming, meetings, etc., about strategic issues.
- Promotes focus on future goals and targets.

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- SWOT Analysis can be applied at different analytical levels -individual, organizational, national, and international. It can be used by educational institutes, non-profit organizations, countries, governments, projects on multiculturalism, etc.

Disadvantages and limitations of SWOT Analysis

The disadvantages of SWOT Analysis can be listed as follows:

- SWOT analysis is to focus on opportunities and threats. External factors beyond the control must be managed using the organization's strengths and weaknesses.
- Details and specific issues are not the focus of analysis. It is limited to general perspective as an approach and presents general solutions.
- SWOT Analysis is poorly formulated. It requires experience and training for systematic construction and use.
- SWOT is restricted to analysis needed to perform more in-depth strategic analysis to get more relevant results
- SWOT cannot show them how to achieve a competitive advantage. It temporarily raises awareness about important issues.
- Strengths may not lead to an advantage. No matter how unique or impressive, an organization's strengths and capabilities may not enable it to achieve a competitive advantage in the marketplace.
- SWOT Analysis focuses on the external environment, which is too narrow.
- SWOT Analysis is like studying a single frame of a complete picture.
- SWOT Analysis is situation analysis, and it can also be the starting point for a more comprehensive review.

Indian Defense Research & Development Organization (DRDO) – An Overview

Defense Research and Development Organization (DRDO) under the Ministry of Defense Govt of India focused on the modernization of Armed forces has a direct impact on the country's economic growth, which is reflected through several parameters such as commercialized technologies, products inducted into services, revenue generated through exports, collaborations, Transfer of Technology (ToT), technical human resources generation, equipment or systems imported by Armed forces and research papers publications. India has shown tremendous variations in technological and industrial developments in the last decade. A solid and sustainable R&D is credited; therefore, it is recognized as a vital indicator for techno-economic growth. Such hands play a significant role in analyzing the performance, whether at the micro-and macro-level (Kumar et al., 2017).

The reports were published in numerous leading magazines related to Defense and Security and statics data from World Bank. India is the single second-largest importer of defense equipment in the world for the modernization of its Armed forces. This raises many questions about how to energize the domestic industrial base to make India increasingly self-reliant in defense production and maintenance.

To become the world superpower and coupled export, Challenges of technology denial can be overcome by focused promotion on indigenous R&D; India, a developing nation, fulfills the need for the Armed force's modernization through defense system acquisition from other countries and induction of products developed by DRDO.

India is equipped with a sizeable scientific pool with organizations such as the Department for Scientific and Industrial Research (DSIR), Department of Atomic Energy (DAE), Indian Space Research Organization (ISRO), Council of Scientific and Industrial Research (CSIR) and Indian Council of Agricultural Research (ICAR) and other departments under Ministry of Science and Technology, GOI. Defense Research and Development Organization is recognized for its cutting-edge technology base; its wide range of technologies, processes, and systems encompassing all defense requirements is a force behind self-reliance on critical defense equipment. The Indian Govt. is also promoting the indigenization of Defense R&D through many programs.

Today, the ADRDE is over six decades old. It has grown into multi-dimensionally into a technology leader in the area of defense systems from an inspection agency and is comparable with the best in the world. The organization encompasses a cluster of laboratories that accelerates the country's economy through indigenized products and technologies for the armed forces to work under two environments, i.e., external and internal, which have to be evaluated to sustain. SWOT (strengths, weaknesses, opportunities, and threats) analysis is one of the best measures to evaluate the environment and deliver suggestive points that help take corrective action to meet the requirement of armed forces at par with global standards.

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2.Literature Review

A strength, weaknesses, opportunities, and threats (SWOT) analysis has become a fundamental tool to evaluate position among the other establishment and globally. It is widely used to analyze the internal and external environments. It also assists the researchers/policymakers identify and prioritize the operational goals and frame the approach to achieve them. It also gives insight into current and past issues, thus finding possible solutions for existing operations/research or a new entity (USDARMA, 2008).

SWOT is a convenient tool at the evaluation stage to gain an initial idea of possible future consequences. The SWOT analysis is a simple analysis method that can provide a realistic interpretation of the strengths and weaknesses of a business. SWOT to effectively overcome their businesses' threats and quickly identify the businesses' core competencies. SWOT analysis with other techniques such as analytic hierarchy process (AHP), PESTEL (political, economic, sociological, technological, legal, and environmental) framework, and five forces model can bring more beneficial results to businesses.

Table 2 summarizes key research papers using SWOT analysis in different contexts.

S. NO.	AREA	ARTICLE	SOURCE
1.	General Management	The TOWS matrix- A tool for situational analysis	Weihrich, H. (1982).
		The use of strategic planning tools and techniques in Saudi Arabia: An empirical study.	Ghamdi, S. M. (2005).
2.	Education	Trends and policy issues for the e-learning implementation in Libyan universities	Kenan, T., Pislaru, C. &Elzawi, A. (2014).
		ICT in universities of the Western Himalayan Region of India II: A comparative SWOT analysis	Sharma, D., Kumar, V. & Singh, V. (2010).
		Islamic Azad University function analysis with using the SWOT model in order to provide strategic guidelines (Case study: Faculty of Humanities)	Sharifi, A. (2012).
		Strayer education incorporated: An equity valuation	Ghamdi, S. M. (2005).
3.	Marketing	Dual-perspective SWOT: A synthesis of marketing intelligence and planning	Novicevic, M., Harvey, M., Autry, C. & Bond, E. (2004).
		Competitive intelligence process and tools for intelligence analysis	Bose, R. (2008).
		Internet market segmentation–an exploratory study of critical success factors	Lin, M-Y.,Luarn, P.& Lo, P. (2004).
4.	Health and Healthcare	Human health risk assessment under uncertain environment and its SWOT analysis	Dutta, P. (2018).
		A synthesis of swot analysis of public sector healthcare Knowledge management information systems in Pakistan	Arshad, A., Noordin, M.&Bint, R. (2017).

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		Applicability of SWOT analysis for measuring quality of public oral health services as perceived by adult patients in Finland	Toivanen, T., Lahti, S.&Leino-Kilpi, H. (2007).
5.	Agriculture	Optimization of water resources management using SWOT analysis: The case of Zakynthos Island, Ionian Sea, Greece	Diamantopoulou, P.(2008).
		Farm business and the development of alternative farm enterprises: An empirical analysis in Greece	Damianos, D. & Skuras, D. (1996).
		Institutional arrangement of agriculture development in Indonesia: Lesson learned from Korea through 6th order of industrial agriculture system	Wardhono, A. & Wibowo, R. (2020).

Table 2: Key issues using SWOT analysis in different contexts SWOT analysis of ADRDE Agra

Adrde-Drdo

Aerial Delivery Research & Development Establishment (ADRDE), Agra, an ISO 9001:2015 certified organization, is a pioneer R&D establishment under DRDO Ministry of Defense, engaged in the design and development of Parachute Systems, Aerial Delivery Systems, Aircraft Arrester Barrier Systems, Controlled Aerial Delivery System, Lighter than Air (LTA) systems, Recovery Systems, and Floatation Systems, ADRDE has developed a wide range of products in the field of parachutes and Lighter than Air systems for various applications; the R&D lab has indigenously designed, developed, and installed Aircraft Arrester Barrier Systems and Inflatable RADOME at various locations of different capacities and provided in hand technical support to the Armed forces for existing inducted system on a requirement basis. ADRDE contributed to the space program of national importance by developing a state-of-the-art deceleration system for the various mission programs of the ISRO.

The SWOT analysis called TOWS analysis, comprises analysis, also strength and weakness as internal and opportunity and threat as external factors. The strength of the establishment is used to maximize the opportunities and minimize the threats identified. The opportunities will also assist in developing strategies that reduce the weakness or avoid threats.

Strengths (Internal, Positive)

Strengths describe the positive attributes of an establishment and its advantage over the other competitors. Key indicators of strength are described below.

(i) Technical expertise /intellectual capital: ADRDE encompasses scientist's alumni of IIT, NIT's best technical brain in India, supported by technical officers, service personnel, research scholar, and strategic administration. This intellectual strength of 308 comprises 78 Scientists (DRDS); 150 Technical Cadre (DRTC); 04 service officers; 16 service personnel as regular employees; and Research scholars as temporary employees. This diverse technical strength of ADRDE is engaged in several areas of design and development of an eclectic range of Parachute systems and its allied technology.

(ii) Wide Product Portfolio: ADRDE has developed a wide range of products, as shown in Table 4, in the field of parachutes and Lighter than Air systems for various applications; the R&D lab has indigenously designed, developed, and installed Aircraft Arrester Barrier Systems and Inflatable RADOME at various locations of different capacities and provided in hand technical support to the Armed forces for existing inducted system on a requirement basis. ADRDE contributed to the space program of national importance by developing a state-of-the-art deacceleration system for the various mission programs of the ISRO.

(iii) Various research areas: ADRDE is the only establishment of DRDO that is fulfilling diverse mandates of the Indian Armed forces. The establishment has proven its capability through its Design & development of state-of-the-art systems, platforms & allied equipment in defense domains of land, air, sea & space & cyber. Table 3 represents the wide range of technological areas of research by ADRDE.

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Table 3: Indicative areas of research

S. NO.	RESEARCH AREA	SYSTEMS
1.	Parachute	Personnel parachute
		Recovery parachute includes space recovery.
		Brake parachute
		Ejection Seat Parachute
		Arms & ammunition parachutes
		Cargo delivery system
2.	Aerial delivery system	Controlled aerial delivery system
		Unmanned aerial delivery
3.	Lighter than air system	Airship
		Aerostat
4.	Inflatables	RADOME
5.	Aircraft arrestor	Aircraft arrestor barrier

(iv) Development of production partners: For the development and production of various systems, ADRDE works in association with Ordnance Factories (OFs) now PSU, Defence Public Sector Undertakings (DPSUs), large scale private industries, Micro, Small & Medium Enterprises (MSMEs), and academia to develop products and enabling the designed products to be inducted into the Services.

(v) Induction into services: ADRDE designed and developed products had many success stories; most of the products developed by ADRDE are inducted into the services to fulfill the requirement of the armed forces. Products inducted in services in the last 10 years are shown in the Table 4.

S NO.	NAME OF ITEMS/SYSTEM	PRODUCTION AGENCY	USER
1.	Paratrooper parachute system	OPF (K)	Army
2.	Brake parachutes	OPF (K)	IAF
3.	Heavy drop system for AN-32 a/c	OFB	Army
4.	Combat Free Fall System	OPF (K)	Army
5.	P-7 Heavy drop parachute system	OFB	Army
6.	Heavy drop platform (P-7) system for IL-76 Aircraft	M/s L&T Mumbai	Army
7.	Heavy drop system-16T(HDS-16T) (Platform & parachute sub-systems)	ADRDE	Army
8.	Aircrew parachute system	OPF (K)	IAF
9.	Target banner sleeve	OPF (K)	IAF

Table 4: Developed products inducted into services

(vi) Infrastructure: ADRDE designed and developed many products successfully within the establishment with state-of-the-art infrastructure, which stands firm for efficient performance. To promote R&D, ADRDE offers technical support and consultancy to armed forces, offering Test facilities to other govt. agencies and private players, and Prototype Development supports to other S&T organizations. ADRDE's own advance environmental testing facility, prototype fabrication facility, textile testing facility, chemical test facility for fabric, metal test, Bursting Tester, and Seam Fatigue Tester contribute to the successful testing of raw material during the design and development of products.

(vii) Robust human resource development: Human resource development of ADRDE integrate training, organization, and career development efforts to improve individual, group, and organizational effectiveness. HRD develops the key competencies that enable individuals in organizations to perform current and future jobs efficiently and effectively. Human Resource Development (HRD) in ADRDE helps intellectuals build their personal and organizational skills, knowledge, and abilities by providing training, career development, performance management, and development through higher education, coaching, mentoring, succession planning, assistance, and organization development. The focus of all aspects is developing the most superior workforce so that the organization and individual can accomplish their work goals in service to Users.

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(viii) Training: ADRDE conducts targeted training modules and sponsor/conduct training programs associated with national and international bodies that scale up the management and technical skills required for better working and managerial skills for the human resources to enhance employee efficiency and thought process as per domain and availability. Opportunities are also given for foreign deputations for training/presentation of papers/specific assignments.

(ix) Vital research & global recognition: Some of the cutting-edge research deliverables by ADRDE, which made the nation proud.

(x) Academia's participation in R&D: Academia contributes by providing guidance as a member of the various review board and enhancing the theoretical technical knowledge base of the ADRDE intellectual with the involvement in various R&D activities. Also, facilitate scientists to perform research in the ongoing R&D project in consultation with academia to award the contract through the Contract for the Acquisition of research Services (CARS) and invite the research scholar from Academic institutes to conduct studies on ongoing R&D activities through Govt. of India promotional event

Azadi Ka Amrit Mahotshav.

(xi) Digital information and resource medium: ADRDE had a secured LAN platform developed in-house. This platform has user-friendly modules covering human resources, R&D, finance and accounts, project management, notice board, and secured communication within the laboratory. Its utility gave each employee insight into where they can communicate via an electronic medium, thus creating a paperless environment. This has led to a single-window information database.

(xii) Defense export: Export of indigenously developed international standard defense products provides a country's economic, security, and political advantage. ADRDE designed and developed parachute systems are imported by the Ordnance Factory (Now converted to PSU). Several other successful developed defense products have created interest from several Nations and have been exported.

(xiii) Technical support to armed forces: ADRDE provides full support to the Armed forces, such as technical support, assistance, technical know-how, and solutions in parachutes to the Armed forces to optimize combat effectiveness through fundamental and applied research.

(xiv) Transfer of technology: Category 'A' technologies are military technologies referred to as "MILTECH." And these are the technologies for which Indian Armed Forces/ MHA/ other Govt. agencies (both central & state) are the only end-users. Export of Cat 'A' technologies is subjected to the approval process of DRDO and MoD, Govt of India. TOT to the industry is done directly by ADRDE through DRDO for all Category 'A' technologies. Table VIII provides the list of Technologies transferred by ADRDE to private industries for production to meet the requirement of the armed forces.

(xv) Support to Private Industry Base: ADRDE has substantially enhanced the technological capabilities of Indian industry through continuous initiatives, sustained engagements, and intense technology transfers.

(a) Development and Production Partner: ADRDE engages the industry as Development Cum Production Partner (DcPP)/ Development Partners (DP)/ Production Agency (PA) during the execution of its projects and programs. The selection of industries is carried out based on procurement rules and procedures.

(b) Testing Support: ADRDE supports the Indian industry during their technology and product development by extending Test Facilities.

(xvi) Manufacturing and operation: ADRDE successfully developed a large variety of Parachute and its allied System over the last 05 decades to meet the requirement of the Armed Forces. ADRDE-developed parachute Systems are widely accepted by the Armed Forces and inducted into the system.

(xvii) Organizational structure: Organizational Structure is as per the Organization Chart as shown in Figure 1.

Figure 1: Organization Chart

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(xviii) Availability of user: ADRDE is known for its achievement in developing an indigenous parachute system as per the requirement of the Armed Forces. Most of the Parachute System developed by ADRDE is as per General Staff Qualitative Requirement (GSQR) or PSQR provided by the User (Armed Forces). ADRDE has a good track record for induction of Systems into the services.

(xix) Expandability (user-oriented system): ADRDE developed system is very well accepted by the User and most of the system; the user has also witnessed its applicability during the product development trials.

(xx) Experience: Scientist & Technical Staff working on various system development has very vast experience in the design & development of the system.

(xxi) Production capacity: ADRDE has state of the art manufacturing facility for production of the prototype for testing and evaluation purposes.

Weakness (Internal, Negative)

Weaknesses (internal, negative factors): Weaknesses are aspects of an organization that detracts from achieving its objectives. To compete among the other laboratory and globally, overcoming the challenges of technology denial regimes, limited industrial capability, and complex technology. ADRDE has grown multi-dimensionally to become a system-developing laboratory from the inspection agency in Parachute, lighter than air system and its allied technologies and comparable with the world; however, a few slits are also found which are hindering its progress. These weaknesses, if mediated, would get converted into strength; otherwise, they are a potential threat.

(i) Research and global recognition: Scimago Institutions Rankings (www. scimagoir. com) is globally recognized as a composite indicator for evaluating the performance in research based on the research performance, innovation outputs, and impact on society. The innovation ranking is calculated on the number of patent applications of the institution and the citations that its research output receives from patents.

(ii) Adequate utilization of laboratory resources: The scientists demand and expertise must be assessed per the laboratory and project requirements. It is needing effective utilization of the human and available resources/infrastructure make a productive organization. With such strength and diverse mandates in last five decades, ADRDE is developed numerous successful products to become a technology leader compared to the other country on a global platform. There is a significant scope to either by reallocation technically specialized human resources, infrastructure, and laboratory resources to develop futuristic cutting edge technologies. Moreover, to overcome this issue further options for consulting, collaborative research to overcome new business opportunities.

(iii) Prioritize the research: ADRDE was established initially with a unique mandate to support the Armed forces, later with cutting-edge technologies and products requirement growing. There is need to focus work on new concepts and research scope, covering global challenges, which further get translated into a technology/product. ADRDE has delivered many technologies, the Armed Forces still import many products and technologies and then consume them, leading to high costs and taxes on the public. ADRDE would priorities focus on high-quality research and strategic program as import substitution relevant to the armed forces and resulted application-oriented research geared toward commercialization.

(iv) Inadequate provision of incentivizing and gratifying innovators: The establishment has no provision of any innovation award(s) in the form of an incentive scheme regarding the generation of innovations, high-impact research, publications, product generation, etc. The scheme of awarding the outstanding work every year in Lab Level award will suffix the purpose of motivating the researcher. If this policy is inducted, incentives will represent a great source of motivation for the scientists and teams who have worked hard to generate novel technologies and products.

(v) Low commercialization of patents on a global scale: The number of Patents filed/granted reflects R&D efforts made by the establishment and brings global recognition. ADRDE has developed numerous products related to parachutes and its allied technology for over 5 decades, and very few patents have been filed/granted. Thus scientist will be motivated to file more patent and gets commercialized, thus feeding crores of money in generating a technology/ product will find a suitable licensee would be justifiable.

(vi) Policy assessment:ADRDE must also derive equations by checking the dynamicity of the existing policies. Being an R&D establishment in defense technologies, ADRDE should suggest review policies on 360° through scientific and industry mentors where issues such as incentivizing, technology development and transfer, public-private partnership, industry-academia linkages, and technopreneurship should be kept on high priority. The establishment promote policies and promotion strategies for induction of newly developed products into services, commercialization, and industry establishments (under joint venture-ship) for the products/technologies generated from the laboratory.

(vii) Accountability of research activities: The establishment should take up research activity with due care after conducting rigorous pre-project activities such as feasibility study, comparing the proposed technology globally. As developed system shall be coupled with induction into services for use, if in any case projects which are said to be completed have no takers is a loss of effort and prestigious time. In order to avoid due care should be taken for taking up projects with focus and priority.

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(viii) Development cum production: Focus on proof-of-concept demonstrations of prototypes of indigenous products with no thought for the mass production and adoption by the clientele for whom it has been designed is to be investigated. The establishment must devise an initiative to check the effectiveness of the developing product, the Armed forces (User) benefitted, and its productivity. Many develop products face problem in terms of acceptable to the Armed forces opting for that technique on the ground.

(ix) Conquered trust deficit between User and R&D: Conquered trust deficit between ADRDE and the user observed on inordinate delays, quality, not meeting the desired specification, and other issues. Due care to be taken between R&D and User in agreement for changes in scope and requirements, support in development activity, indigenous development as import substitute, and User shall work hand in hand with R&D to avoid time delays and developing prototype as per scope.

(x) Government policies on R&D expenditure (procurement): R&D activityunder DRDO is govt. funded and expenditure, is the reflection of work done. Expenditure is to be made as per laid down policies and procedures, where most financial proposals, projects, Policies, and schemes except a few to be consonance by Finance member under IFA system. Many initiatives have been adopted to fast pace the consonance process. Still, the long channel of correspondence severely affects the project schedule. Also, various other procurement methods are proposed by Govt. recently procurement to fast-pace the procurement process. However, it is still under the continuous improvement stage.

(xi) Financial management: At the beginning of every financial year, the fund requirement was planned to meet the expenditure on various R&D activities and reflection of expenditure at the end of year is considered as R&D activity of the establishment. R&D will always be coupled with planned expenditure.

Opportunities (External, Positive)

Opportunities (external, positive factors): Opportunities are attractive external factors that represent reasons for your organisation to exist and prosper.

(i) Global R&D collaboration: ADRDE to choose its international partners worldwide for cooperation in the areas of research to become globally competitive with complementary work share. Thus, the combination of the capabilities and competencies of both gave birth to a world-class product in a short time and able to fulfil the requirement of the User in the shortest possible time.

(ii) Re-organize scientific human resources vis-à-vis mandate. ADRDE is credited with having a vast scientific pool of diverse expertise. They can collaborate and initiate scientific manpower exchange among the laboratory-based on projects requirement and new product development, as followed by many multinational companies offering various products and services. This opportunity initiative can lead to global competitiveness, thus making them a leader in scientific product and technology developers.

(iii) Inter- and intra- laboratory collaborations. ADRDE, being a diverse mandate organization, should promote a focus on leveraging the benefits from inter-and intra- laboratory and inter-and intra- organization collaborations. Such linkages would work on multidisciplinary research projects, leading to the generation of high-throughput scientific technologies, which would attract friendly global partners to translate the research benefit for the modernization of Armed forces, overcome technology denial, and reduce dependency on arms imports.

(iv) The fast pace of commercialization of intellectual property: All the products indigenously developed by ADRDE himself or in collaboration with private industries for any R&D project are considered IPR of DRDO. Identifying the weakness, i.e., "low commercialization of patents on a global scale," ADRDE may take initiatives to screen the intellectual property (IP) before filing, i.e., assessing the viability of IP. In this way, the funds will economize, and IP generated will further generate revenues.

(v) Techno globalism. Techno-globalism is defined as an interaction between the internationalization of technology and the globalization of the economy. This is bringing a significant transformation in India, putting the country as the most preferred destination for outsourced R&D and foreign direct investment. This motto of the scientific business should help capture the market segment and cash in upon this opportunity provided by the dynamism of global R&D to create more highly paid employment opportunities and build new industries (Kumar, 2007).

(vi) Self-reliance in defence: India aims to cut its import dependence and increase self-sustenance for R&D as the country is the second-largest importer of arms globally. Govt of India has planned to spend a considerable amount [The Economics Times] on military modernization in the next five years. The government has also allowed private companies to participate in defence manufacturing to provide impetus to indigenous manufacturing.

(vii) Research initiatives: ADRDE must research into the niche and emerging futuristic technologies to produce them on the scale and make them adaptable to the Armed Forces' warfighting methods.

(viii) Enhance industries' capabilities for defence manufacturing: India's defence industry can learn and benefit from the experiences of the major developed countries in building up a comprehensive defence manufacturing capability. Arms imports by India fell by 33 percent between 2011-15 and 2016-20. The focus of govt. Is to cut down the imports and boast

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defence manufacturing in India through direct tax benefit to the industry, make in India initiatives, etc. ADRDE is among the few laboratories of DRDO that engages in the export of products developed successfully through the production partner Ordnance Factory Board (OFB) (Now PSU). Many of the developed product is exported by OFB. Now ADRDE has offered ToT to private industries for production and export with the permission of Govt. of India.

(ix) Reduced tolerance towards time and cost overrun: In R&D, the project's objectives become the benchmark to assess the project's success when the product realization plan has not been adhered to. Then there is the issue of time overrun as well as cost overrun. ADRDE should devise the mechanism through a stringent review mechanism during the planning and the execution that the development of the product should be as per the planned schedule to avoid any time and cost overrun.

(x) Encourage unconventionality: Be it defence, technology, or governance, it has been well demonstrated by DARPA that innovation happens only in an enabling environment. The approach of 'fault-finding,' instead of the cause-finding of every failure, is the most significant disincentive to innovation. DRDO is advanced in the way to escape this challenge is to create organizations with a unique administrative culture that harps on taking high risks, collaborating with the private sector, and incentivizing disruption.

(xi) Encourage publication in international journals: Scientists working in ADRDE should be encouraged to publish their research in the international journals as well as the Defence Science journal of DRDO to get the global recognition as DRDO Defence Science Journal is a peer-reviewed, multidisciplinary research journal in the area of defence science and technology.

(xii) Encourage defence export: The government has formulated policies to boost defence exports and plans to achieve a defence export target of USD 5 billion in the next five years. ADRDE developed products have been exported through Ordnance Factory Board to friendly nations. Many successful designs and developed products have export potential under production in private industries and Ordnance Factories through the Transfer of Technologies.

Threat (External, Negative)

Threats (external, negative factors): Threats are external factors beyond your control that could put your organisation at risk. Organizations may benefit from having contingency plans for them.

(i) Intellectual vacuum: Intellectual vacuum (brain drain) is a significant known fact that is hampering the strength of the scientific industry. Various measures have been taken to control the intellectual vacuum. They could be of great help and thus would create a sustainable intellectual power for Indian R&D. In the last 5 years approx. 150 scientists had left the DRDO to join the other organisation. Policy may be introduced by the Govt. focus on the issues related to scientist retreats in the future to deliver the highest standard of results

(ii) Career stability: Career instability leads to personality clashes, affecting research progress. It has been observed that though the majority of scientists and technical human resources are enthusiastic toward new projects or technology development, a significant contribution has been made to deliver the globally competitive system. Scientist and technical human resources must be routine monitoring and made accountable. Due care to be taken link the career progressions with performance. There must be routine monitoring or an accountability and performance check to sustain.

(iii) Scientist retreat: DRDO is known for its best talent in the country, working for self-reliance in critical defence technologies. In pursuit of self-reliance in critical technologies relevant to national security, formulates and executes scientific research programs, design, development, testing, and evaluation of various systems, subsystems, and products. Employees are highly qualified and competent scientists. Govt to consider DRDO should consider a performance-based incentive scheme, "PRIS," to motivate the scientist, in line with other scientific organisation like ISRO and BARC.

(iv) Judicious use of resources: Underutilized and misappropriation resulted in a loss in infrastructure commissioning, unfruitful facilities expenditures, regular audits, etc. Such checks in procurement, operation, and monitoring of projects and infrastructure, deliver better results.

(v) Commercialization of patented technologies. Patents lead to motivation amongst colleagues and ignite a fire for innovation. Although, a few patents are granted/filed. However, if the granted patents are not commercialized, it leads to monetary loss, a sheer waste of time. Thus, the focus approach shall be made on the patent's commercialization for the organization's benefit to earn revenue as loyalty.

(vi) Technological challenges: The growing need for the armed forces, promoting imports, and frequent work scope changes hampered the development activities. R&D organisation in consultation with User, Government of India shall formulate policy and later devise a mechanism so that designers, developers, and users work together and realize the products at the earliest in the planned timelines.

(vii) Appropriate innovation and disruption: In today's world, a lack of technological innovation could wipe out market leaders overnight. The technological upper hand is vital for national security, business, and quality of life. USA has planned to create 'high-risk, high-reward" agencies to tackle problems in health and climate modelled on DARPA. Similarly, Britain announced the creation of Advanced Research Projects Agency-Health (ARPA-H), focusing on innovative treatments

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for cancer, diabetes, and Alzheimer's. Similar DARPA-inspired programs have been launched by Japan and Germany as well. Studying DARPA and its successful clones, R&D organisation shall focus on innovation and establishment psychology rather than merely launching an establishment and funding it heavily. Innovation involves the practical implementation of an invention, making a meaningful impact on the User [Armed Forces].

(viii) Permanence bane: Comptroller and Auditor General of India (CAG) report had noted and observed that almost 50 percent of the lab's budget was spent on salaries, with a ratio of 11 non-scientists for every scientist. In comparison, DARPA of the USA, on the other hand, is a lean organization of just 100 program managers borrowed for stints of 3–5 years from academia or industry and oversees about 250 research and development programs. Bureaucracy, permanent staffing, and permanence are simply the antithesis of creativity. The observation raised by the highest govt. fund monitoring shall be taken care in the lateral spirit for the organisation.

(ix) Performance audit: The establishment has successfully developed more than 100 products in the last five decades. Few critical projects are way behind schedule and failure to deliver. The inability to deliver in time has caused a crisis of confidence and constant dissatisfaction. To ensure smooth progress a rigorous periodic performance audit of product under development projects will be reinforce so as collaborate the efforts in areas of success and weed out unproductive activities.

Summary of SWOT Analysis

Summary of all the indicators has been listed below:

STRENGTHS (Internal, Positive)	**WEAKNESSES (Internal, Negative)**
Technical expertise Wide product portfolio Various research areas Development of production partners Induction into products in services Possession of critical infrastructure Robust human resource development programs Strong research & global recognition Academia's participation in R&D Digital information and resource medium Export of products Technical support to armed forces Transfer of technology Support to private industry base Manufacturing and operations capability Defined organizational structure Availability of user Expandability (user-oriented system) Experience Production capacity	Research and Global recognition Government funding Adequate-utilization of laboratory resources. Prioritise the research Low provision of incentivizing and gratifying innovators Joint commercialization of patents on a global scale. Policy assessment Accountability of research activities Development cum Production Conquered deficit between User & R&D Government policies on R&D expenditure (procurement) Financial management

Table 5: Strengths and Weaknesses

OPPORTUNITIES(External, Positive)	**THREATS (External, Negative)**
Global R&D collaboration Advanced state-of-the-art test facility Re-organize scientific human resources vis-à-vis mandate Inter- and intra- laboratory collaborations Fast pace of commercialization of intellectual property Techno globalism Self-reliance in defense Research initiatives Enhance industries' capabilities for defense manufacturing Reduced tolerance towards time and cost overrun Encourage unconventionality Encourage publication in international journals	Intellectual vacuum Career stability Scientist retreat affecting research progress. Judicious use of resources Commercialization of patented technologies Technological challenges Government compliance & bureaucratic Appropriate Innovation and Disruption Permanence bane Performance audit

Table 6: Opportunities and Threats

3. Conclusion

The creation of ground-breaking goods and specialized knowledge is accompanied by uncertainty and significant costs, and controlling these costs is one of the biggest problems facing R&D organizations. Strategic planning through SWOT Analysis

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is a way to help an organization be more productive by supporting and administrate management in allocation of resources to achieve goals.This study fills the knowledge gap in the strategic planning context by comprehensively reviewing the SWOT literature conducted over the last couple of years in R&D organization. It provides a strategic framework for defense establishments to formulate futuristic agendas beneficial for strategizing procedures.

4. Theoretical And Managerial Implications

The present study thus contributes to the literature in two important ways. First, it presents an entirely new collective perspective of SWOT analysis as a strategic tool, assessing the four aspects of defense R&D enterprises (strengths, weaknesses, opportunities, and threats) as it critically discussed the use of SWOT in defense R&D arenas. Furthermore, this study suggests several meaningful implications for techno manages and decision makes that can help improve their strategic decisions in R&D activity. Initially, with regard to the general managerial implications, the study demonstrates that SWOT analysis is an effective tool for strategic planning, and can be used in different contexts in which strengths, weaknesses, opportunities, and threats can be effectively evaluated.

Second, this study shows that SWOT analysis can be productively integrated with other techniques. Managers, therefore, can incorporate the SWOT model with other methods such as AHP, the PESTEL framework, the five forces model and fuzzy ANP, by which more accurate and beneficial results can be obtained. Besides, the results obtained from different contexts revealed that SWOT analysis is an important source of information. Hence, establishment may regularly conduct SWOT analysis, providing a continuous flow of information or strategic planning.

5. Limitations And Future Research

Even though this study provided a new integrative, comprehensive, and synthesized view of the SWOT model, it has limitations. As the aim of this study was to provide an overview of the SWOT knowledge base and combine insights and perspectives from defense R&D arenas, an integrative review approach was believed to be appropriate, and was accordingly adopted. Future studies may employ other approaches assessing the SWOT literature, for instance, with systematic and semi-systematic review approaches. Also, the concern of this study was the use of SWOT in various major activities of defense R&D. However, other contexts are no less important; therefore, future research might choose to investigate the use of SWOT models in other contexts. Finally, future research might also examine the inclusion of other variables and techniques with the SWOT model.

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