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Research Article

Business Oriented R&D Model for Public Funded R&D Organizations

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Abstract

Over the past few decades, it has become evident that research and development (R&D) serves as a source of competitive advantage for both public (nations) and business organizations. Consequently, there has been a significant emphasis on R&D, involving a deep understanding of the R&D process and the efficient management of R&D organizations. Many researchers highlighted the pivotal role of the underlying management process to achieve more effective R&D outcomes. In the rapidly evolving landscape, the management of R&D organizations has become a continuously evolving process, requiring ongoing understanding of R&D organisations to maintain a competitive edge. R&D organizations encounter a major challenge in successfully delivering innovations, stemming from the inherent difficulty of maintaining focused and efficient activities throughout the entire R&D life cycle. This challenge is attributed to two main reasons. The first challenge arises from the difficulty for a single R&D organization to encompass all activities of the R&D life cycle under one umbrella. These activities, distinct in nature, require diverse types of manpower and different organizational environments for efficient execution. Consequently, the focus on innovation is lost during various stages of the R&D cycle as different organizations prioritize different activities. Secondly, R&D organizations differ from business organizations in two key aspects. Firstly, they lack direct interaction with the final customer until the end of the R&D cycle when the innovation reaches the end user. This absence of constant customer engagement results in a diminished customer focus, crucial for the efficient delivery of innovations. In contrast, business organizations continuously interact with and are evaluated by customers, who keep them strongly oriented toward customer needs and preferences. In this paper, the author advocates for the incorporation of the above two key characteristics of business organizations into public R&D entities, contending that such integration would significantly enhance the efficiency and speed of innovation delivery. To achieve this objective, the author introduces a novel concept termed as 'Business-oriented R&D Model for public funded R&D organisations'. Drawing upon extensive work experience within the Indian Ministry of Defence; Defence Research and Development Organization (DRDO), New Delhi, India, the model is elucidated through the lens of the author's specific experiences with DRDO.

Keywords

Organisation Structure, R&D Organizations, Business Organizations, Public Funded R&D Organisations, Customer Focus

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1. Introduction

Organizational structure is a powerful determinant of organizational behavior and organizational performance. As per Minterzberg [1], Organizational structure is the framework of the relations of jobs, systems, operating process, people, and groups making collaborative efforts to achieve common goals. Duncan [2] further defines organizational structure as "a pattern of interactions and coordination that links technology, tasks, and human components of the organization to ensure that the organization accomplishes its purpose." Monavarian, Asgari, and Ashna [3] describe it as a set of methods for dividing tasks, determining duties, and coordinating them.

A well-designed organizational structure is expected to facilitate decision-making, enable a proper response to the environment, and resolve conflicts between different units. Muo & Muo [4], citing Robert, highlighted that the conceptualization of organizational structure is a manifestation of systematic thinking. An organization comprises tangible "hard elements" such as groups and hierarchies within organizational units, and intangible "soft elements" in the form of relations between these units and groups. Scholars distinguish two types of structures: physical structures and social structures. Physical structure pertains to the relationships between the physical elements of organizations, such as buildings and geographical units, while social structure involves the relations between social elements like people, positions, and organizational units.

The configuration of an organizational structure is influenced by several factors, including size, environment, strategy, and technology. Whether a specific structure proves advantageous or disadvantageous for an organization hinge on the nature of the business, its strategy, target market, and the management style employed. Researchers and practitioners in the field of organizational structure commonly emphasize productivity as a paramount consideration. According to Chegini et al. [5], productivity holds significant importance for organizations, and the primary objective of every organization is to ensure the highest possible level of productivity.

Much of the existing research on organizational structure treats R&D organizations like business organizations, primarily focusing on differences in strategy and technology readiness. The predominant research themes had been the design of product development organizations [6, 7] and the examination of centralization versus decentralization in R&D organizations [8, 9]. However, these studies often overlook the fundamental distinctions between publicly funded R&D institutions and R&D conducted by strategic business units (SBUs) within large business organizations.

R&D posses unique characteristics, involving not only project management but also the technical management of R&D activities themselves [10]. The importance of publicly funded R&D organizations cannot be understated as they play a crucial role in developing a robust scientific foundation in countries, particularly in strategic areas or those neglected by private initiatives [9, 11, 12].

In this paper, the author highlights the fundamental reasons for disparities between R&D organizations and business organizations, as well as differences between publicly funded R&D and privately (business) funded R&D organizations. The aim is to underscore the significant impact these distinctions have on the design of organizational structures for publicly funded R&D institutions.

In Section 2.0, the author provides a concise overview of Nadler's Congruence Model of organization [13], as proposed by David Nadler and Associates in 1998. Additionally, the author introduces a modified version of Nadler's model, offering insights or adaptations as suggested by the author.

Moving on to Section 3.0, the author summarizes the fundamental distinctions between a business organization and an R&D organization. This analysis is based on the six components of the modified Nadler's Congruence Model of organization, shedding light on the nuanced differences in these key areas.

In Section 4.0, the author delves into the disparities between R&D funded by large business organizations and publicly funded R&D. The analysis is grounded in the knowledge manipulation characteristics outlined by the model of Organization Value Chain, as suggested by Sen Atul [14]. The author posits that the presence of a customer in a business organization stands out as the pivotal factor contributing to its superior performance. With the aim of enhancing the performance of publicly funded R&D organizations, the author proposes the incorporation of the concept of a customer into these institutions.

Building on this argument, Section 5.0 introduces the concept of 'Business-oriented Public Funded R&D Organizations.' The discussion revolves around the potential impact of infusing a business-oriented approach into publicly funded R&D institutions, with the anticipation of achieving a significant leap in their performance.

Finally, the proposed model is evaluated on different performance parameters for R&D organizations.

2. Nadler and Associates' Congruence Model

Figure 1 illustrates the organizational model proposed by David A. Nadler, D. A. and Associates [13], which they recommended for diagnosing organizational behavior. Nadler identified four major components within an organization, depicted in the figure 1, through which inputs are transformed into outputs. The first two components include the nature of the work and the skills required for tasks, individual people, teams and groups along with their skills and motivation. The conversion of input to output occurs partly

through the formal organization and partly through an informal structure, the other two components.

Nadler introduced the concept of congruence, emphasizing the alignment between different pairs of these components. He argued that the overall performance of an organization hinges on the total fit between these pairs. Table 1 provides examples of congruence between these components for further clarification.

Expanding on this model in Figure 2, the author incorporated the Vision and Mission of the organization, influencing the organizational strategy and, consequently, all four components proposed by Nadler. As a result, the organizational framework now encompasses five key components that collaborate to generate output.

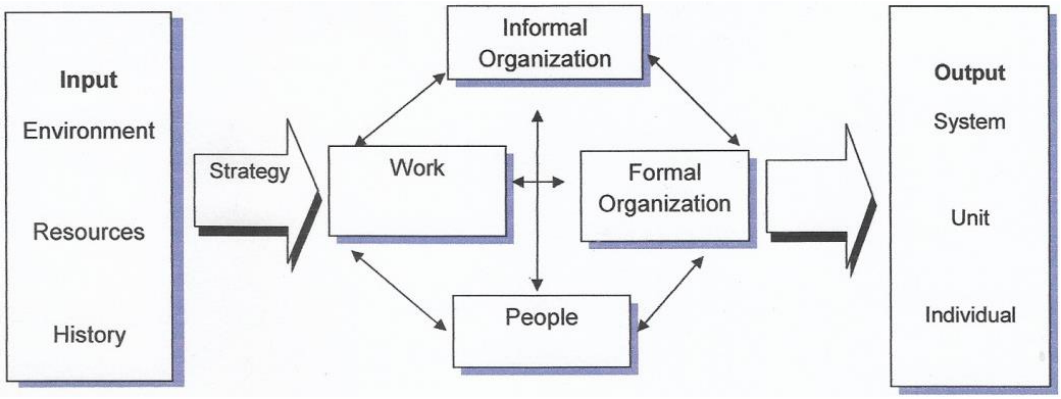

Figure 1. *Nadler and Associates' Congruence Model for Organization, [13].*

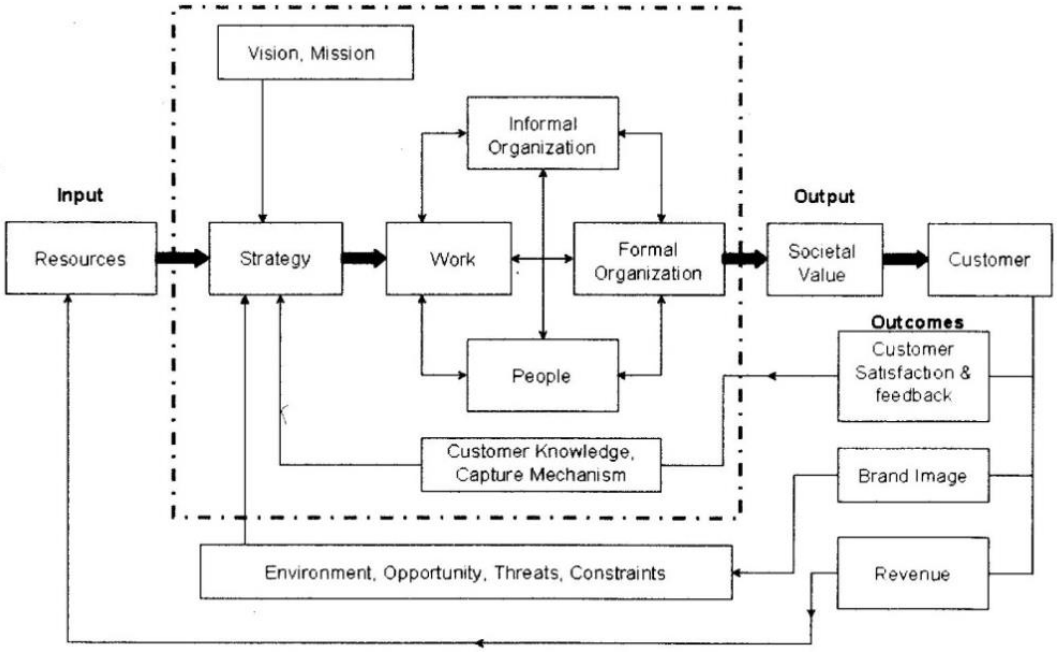

Figure 2. *Modified model of organization.*

In business organizations, well-defined goals, standards, and a homogeneous workforce contribute to a robust formal organization, ensuring the effective delivery of desired outputs. Conversely, in Research and Development (R&D) organizations, tasks, goals, and roles are often less clearly defined. The workforce is characterized by a high degree of heterogeneity, with variations in qualifications, expertise, discipline, experience, emotional intelligence, and individual contributions to the organization's value creation process. As a result, the formal organization may struggle to achieve the desired results.

Despite the existence of formal organizational structures in R&D organizations, another set of implicit and unwritten arrangements tends to evolve over time. These informal structures play a significant role in influencing organizational performance. They serve as complementary mechanisms to the formal organization, particularly in new or undefined task situations. In some cases, these informal structures emerge in

response to the limitations of the formal structure. The strength of informal organizations is particularly pronounced in R&D environments due to the newness of technology and the prevalence of undefined or ill-defined tasks.

Conventional business organizations typically engage in the production and distribution of products/services, operating with well-defined goals, processes and standards across all levels. These organizations have a clear vision and mission, often expressed in terms of revenue objectives. On the contrary, Research and Development (R&D) organizations are focused on generating knowledge and developing technologies, activities that may not be easily envisioned in clear terms. The absence of well-defined customers in the R&D context makes it challenging to even establish precise performance standards.

Table 1. Examples of fit.

Fit	Issues
People/ Formal Organization	How do organizational arrangements address individual needs? Do individuals possess accurate or distorted perceptions of organizational structures? Is there alignment between individual and organizational goals?
People /Task	How do tasks fulfil individual needs? Do individuals possess the necessary skills and abilities to meet the demands of the tasks?
People /Informal Organization	How do individual needs find fulfilment within the informal organization? In what ways does the informal organization leverage individual resources in alignment with its informal goals?
Task/ Formal Organization	Do organizational arrangements sufficiently address the demands of the task at hand? Do organizational arrangements motivate behaviour that's consistent with task demands?
Task/Informal Organization	Does the informal organizational structure enhance or impede task performance? Does it contribute positively or negatively to meeting the demands of the task?
Formal Org./ informal Organization	Are the goals, rewards, and structures of the informal organization consistent with those of the formal organization?

3. Analyzing R&D Organizations Based on Nadler's Congruence Model

While analyzing the Nadler's Model for R&D Organizations, it is observed that all the five components of the R&D organizations differ significantly from conventional business organizations.

Table 2 shows the major differences between business organization and R&D organization in terms of the six components of the organization model.

Table 2. Major differences in Business Organizations and R&D Organizations based on Nadler's Congruence Model.

S.No.	Elements	Business Organizations	R&D Organizations
1.	Vision/ Mission	In terms of Sales and Revenue/ Market share	In terms of knowledge and technology.
2.	Strategy	Well defined strategies	Strategies may change mid-course.
3.	Work packages / Task	Well defined work packages with definite goals, objectives, and resources	Tasks are interdependent on uncertain objectives. Tasks and their performance criteria are not very well defined. Knowledge work does not follow any structure. All tasks are not perceived equal. Some tasks are done best by certain individuals.
4.	People	Medium educated, strong	Highly educated and creative knowledge worker.

S.No.	Elements	Business Organizations	R&D Organizations
		implementation	To cope with uncertainties, empowerment at all levels is a must. Knowledge workers do not take up all type of tasks.
5.	Formal Organization	Strong, well defined and process oriented	Week and people oriented. Reward system plays very important role.
6.	Informal Organization	Weak	When clear goals and expectations are lacking, congruence diminishes, and individuals may prioritize personal agendas over organizational goals. This scenario often fosters the use of informal methods. Lack of clear goals encourages informal and flexible work procedures
7.	Communication	Controlled and hierarchal	Open and fast

4. Business Funded R&D vs. Public Funded R&D

According to Wikipedia, the term "Business" is described as the activity of earning a living or making money through the production, purchase, and sale of products, such as goods and services. Pandey Vishal and Tulsian P.C. [15], in their book "Business Organization and Management," provide an alternative definition based on five characteristics of business organizations. These include dealing in goods or services, engaging in production or purchasing and transferring, involving continuity and regularity, having profit motives as goals, and encompassing an element of risk.

Sen, Atul [14] differentiated between 'R&D activities' and 'Business activities' based on the difference in manipulation of organizational knowledge. He argues that R&D activities focus on value creation, while business activities primarily involve value transaction. The value created by a business organization is considered a liability until it is transacted to customers; for instance, producing 1000 units of a product is of zero value if those units are not sold and are shown as a liability in the balance sheet. Sen emphasizes that the value created by R&D, in the form of knowledge, doesn't have the same condition. There's no obligatory transfer of value to a defined customer, and evaluation is often conducted by peer groups with expertise in specific knowledge areas. The concept of a customer only partially becomes relevant during the product development stage of R&D [14]. For business organizations, the customer plays a crucial role as an independent evaluation agency. Customers evaluate product performance before making purchase decisions and, through purchase decisions, influence the organization's structure in a big way. The power of customers is evident in their ability to bring about changes in the organization through annual general body meetings, especially in cases of product failure. Business-funded R&D tends to be limited to product development and incremental innovations for well-defined customers. Thus, the existence of customer creates main difference between business funded R&D and public funded R&D. Apart from the above, public funded R&D organizations suffer with several other organizational challenges because they work in broader research areas i.e. from basic research to product/system development phase. This creates confusion in the organization's mission, vision and human resource management.

In this paper, the author presents the concept of a 'Business oriented Public Funded R&D organization model' by advocating the integration of the customer concept at every stage of the R&D process. The author contends that incorporating this approach could potentially lead to a quantum leap in the productivity of public-funded R&D organizations.

The author, drawing on his experience as a senior missile scientist with the Defence Research & Development Organization (DRDO) under the Government of India, elucidates the proposed model using DRDO as an example. However, the author asserts that this model is applicable not only to DRDO but can also be implemented by various other public-funded R&D organizations globally.

Furthermore, the author suggests that the research conducted at top universities and other public-funded national research institutions engaged in basic research can also integrate with this model. The potential advantages include enhanced performance through robust networking and optimized utilization of resources.

5. Proposed Model for Business oriented Public Funded R&D Organizations

With the exception of a few pharmaceutical firms, the current scenario in India reveals that 95% of Research and Development (R&D) takes place in public-funded laboratories and institutions across various sectors. As highlighted in Paragraph 4.0, there exists considerable potential for enhancing the productivity of these laboratories by transforming them into business-oriented R&D organizations. In

this section, we illustrate this model using the Defence Research & Development Organization (DRDO) as a case example.

5.1. About Defence R&D Organisation (DRDO), Govt. of India

The Defence Research & Development Organization (DRDO) serves as the R&D wing of the Ministry of Defence, Government of India. Its overarching vision is to empower India with cutting-edge defense technologies, while the mission is to achieve self-reliance in critical defense technologies and systems. DRDO is committed to equipping the armed forces with state-of-the-art weapon systems and equipment in accordance with the requirements laid down by the three-armed force divisions.

With a focus on self-reliance through indigenous development and production, DRDO operates through its 50+ laboratories spread across the country. The organization comprises a network of laboratories housing over 7000 scientists engaged in the development of defense technologies spanning various disciplines, including aeronautics, armaments, electronics, combat vehicles, engineering systems, instrumentation, missiles, advanced computing and simulation, special materials, naval systems, life sciences, training, information systems, and agriculture.

DRDO's activities are categorized into seven technology clusters: Aeronautical systems, Naval systems and materials, Armament and combat engineering systems, Missile and strategic systems, Electronics and communication systems, Microelectronic devices, computer and cyber systems, and life sciences. These technology clusters encompass a wide spectrum of projects, ranging from basic research to device development and large system development, such as missiles and aircraft (downloaded from internet, Dec' 2023; https//drdo.gov.in).

5.2. Business Oriented R&D Model for Public Funded Organizations

The concept of the sixth generation of R&D [16] emphasizes the delivery of systems through comprehensive supply chain management. This approach views R&D as a business process and advocates managing innovation through global collaboration. Successful collaboration becomes feasible when each participating organization possesses core strengths in one or more technology areas. To establish these core strength areas, R&D organizations must concentrate on the entirety of the knowledge value chain activities [14]. This encompasses the entire spectrum, starting from basic research, progressing through technological development, and culminating in product development and the production of the final product/system.

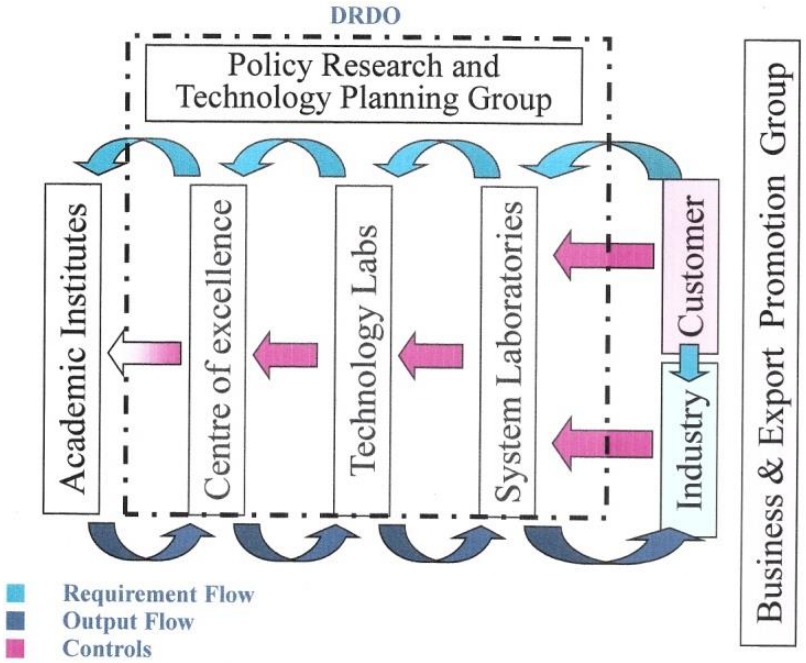

Figure 3. *Business oriented R&D model for public funded R&D Organizations.*

Engaging in such a broad spectrum of R&D activities under a single umbrella gives rise to various management challenges. These issues often stem from the absence of a clear mission and vision, difficulties in managing diverse man-

power, and navigating through organizational culture differences. Ultimately, this can lead to a loss of focus on the end product. The proposed model addresses these challenges. Figure 3 illustrates the model further elucidated with an example from DRDO.

5.2.1. Description of the Model

The proposed model is based on the assumption that all major public funded R&D organizations need to be involved in the research in certain basic research areas of science and technology in order to create core strength areas for the reasons discussed earlier. Main features of the model are discussed below.

According to the proposed model, the entire spectrum of R&D activities at DRDO can be categorized into three distinct highly empowered clusters of laboratories, based on the three established R&D stages. This is a departure from the current organization of seven clusters, which is based on subject discipline. The proposed clusters are as follows:

1. Product/System Development Laboratories cluster
2. Technology/Subsystem Development Laboratories cluster
3. Centers of Excellence (COE) for Basic and Applied Research: These centers serve as hubs for both basic and applied research, fostering core strengths and innovation in specific technology areas.

This restructuring is designed to streamline R&D activities and enhance organizational focus on the distinct stages of the research and development process.

Product/ system development laboratories focus on the development of final products or systems keeping the customer interactions ongoing with the industry. Industry and end users are defined as customers for these laboratories.

The Technology/Subsystem Development laboratories, according to the proposed model, will primarily engage in the development of subsystems and technologies. Their main role is to provide essential R&D services required by the Product/System Development Laboratories, which are their primary customers. Additionally, these labs have the flexibility to undertake projects from external customers, contributing to the development of cutting-edge futuristic technology devices and subsystems. This approach aims to foster collaboration and synergy between different stages of R&D while allowing for external partnerships and projects.

The proposed Center of Excellences (COEs) are envisioned to not only conduct basic and applied research in areas aligned with the interests of technology labs but also house high-end testing facilities. These COEs will offer R&D services to their customer laboratories and other research institutions, which could be internal or external to the R&D organization. It is essential for these COEs to establish integration with academic institutions and other R&D organizations, serving as both external customers and providers of facilities. The government must exercise caution to avoid duplicating COEs for the same technology under different R&D organizations unless the existing facilities are not optimally utilized. This approach ensures efficient use of resources and expertise in specialized areas.

As defined earlier, customer labs must have a role in funding and evaluating the performance of their vendor laboratories (explained in section 5.2.2).

For example, tentatively DRDO laboratories can be clubbed under three different highly empowered clusters represented by the three respective DGs as following

Product/System Development laboratories

1. Avionics
2. Missile and Rockets Systems
3. Radar Systems
4. Electronic Warfare and Counter Measures
5. Laser Systems
6. Ground Systems
7. Under water and Naval Systems

Technology/Subsystem Development Laboratories

1. System Studies and Simulation
2. Aerodynamic Studies
3. Propulsion Technology
4. Seeker Systems
5. Control System
6. War head laboratory
7. Mechanisms
8. C4IRS Systems
9. Power Systems
10. Special purpose Computers and Micro-Systems

Centre of Excellences (COE) for basic & applied research

1. Materials
2. High Temperature & High Energy Materials
3. Semiconductor, Electro-optical devices and sensors
4. Environmental studies and testing
5. Fabrication Technology
6. Life Sciences

As part of the proposed model, the establishment of a Policy Research and Technology Planning (PR&TP) group at the headquarters is recommended. This group, headed by a DG (PR&TP) could consist of three Directors; Director (PR&TP), Director (Human Resource Management), and Director (Resources). This group would play a key role in strategic planning, policy formulation, and technology planning to guide the overall direction of the R&D organization

Additionally, the model suggests outsourcing export promotion activities to a new independent Public Sector Undertaking (PSU). This approach aims to streamline and enhance the efficiency of export-related initiatives, possibly benefiting from specialized expertise and focus provided by the independent PSU.

The proposed model suggests a governance structure for each laboratory, including the appointment of an 'Executive Director' (ED) as the head of the lab. Additionally, a 'Board of Directors' (BOD) is recommended to periodically review the lab's performance. The tenure of the ED could be two or three years, with the possibility of extension for one more

tenure based on performance evaluations by the BOD. The BOD is envisioned to have members from various stakeholders, including customers, customer labs, industry partners, and top management of the respective laboratory. Representation to BOD, from customers who contribute orders exceeding 10% of the laboratory budget is emphasized. Furthermore, top industry leaders and R&D scientists from the country can be invited as members of the BOD. Following the completion of their tenure, EDs could be inducted into the BOD of the respective lab, fostering continuity and knowledge transfer.

Following documentation must be taken care off while managing research projects

1. In accordance with the proposed model, collaboration among the Customer, Industry, and System Labs is encouraged to formulate a comprehensive 'Business Plan' for the design, development, and production of a Weapon System. This collaborative effort involves significant financial investments from both the Customer and Industry stakeholders.
2. 'Design and Development Contracts' to be placed on DRDO/System Labs with very specific deliverables, performance parameters, time schedules along with other financial and commercial terms.
3. For each Technology Work Package from System Labs to Technology Labs, 'Technical Assignment Contracts' to be signed between the respective Technology Lab and the System Lab on mutually agreed funding arrangements.
4. Technology Labs to sign 'Technical Knowledge Service Contracts' with the Center of Excellence(COE) for basic and applied research and expert knowledge services
5. Center of Excellence (COE) to sign MOU with Academic Institutions and fund Research in frontier technology areas of interest to DRDO and for providing state of art facilities to academic and research institutions.
6. Annual BOD meetings should be conducted by DG (PR&TP) for each lab to evaluate the performance of the Labs and Lab's Executive directors (ED) based on balance score card method [17].

5.2.2. Financial Arrangements

Figure 4 illustrates the financial frameworks governing public-funded Research and Development (R&D) organizations where X, Y and Z are the total budget of the respective labs. Although the numbers depicted in the diagram are provisional, the proposal suggests that System Labs aim to secure 60% of their budget from customer-funded projects and 20% from royalty earnings within a three to five-year time frame. At this juncture, the Defense Research and Development Organization (DRDO) is suggested to contribute only 20% of the System Lab's budget for new system development.

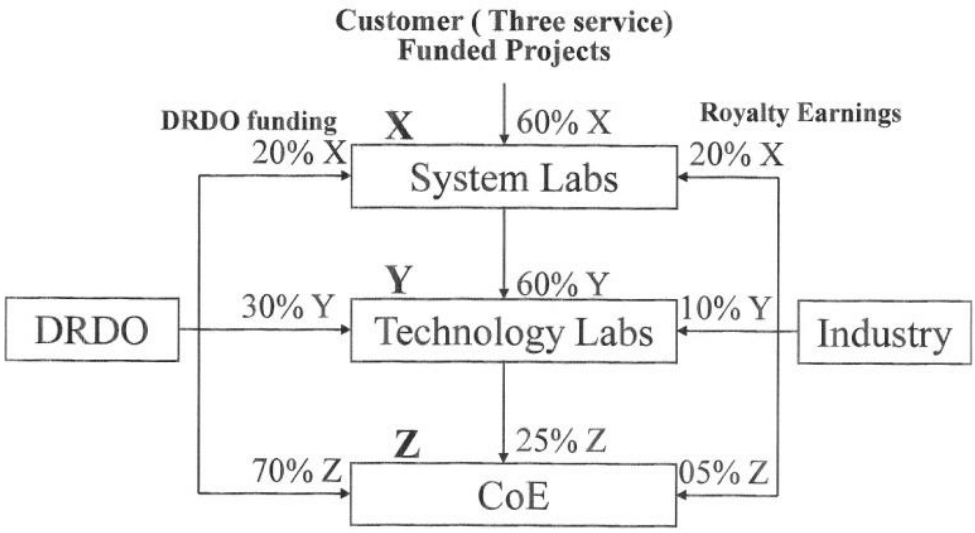

Figure 4. *Funding arrangements andtentative financial targets to be achieved by different clusters in 3 to 5 years.*

Likewise, Technology Labs are encouraged to reach a goal of obtaining 60% of their budget from System Labs for technology development and 10% from industry through royalty. The remaining 30% may be provided by DRDO to support the advancement of cutting-edge technologies. Centers of Excellence (COEs) are anticipated to receive a significant 70% of their budget from DRDO to facilitate fundamental research in collaboration with academic and R&D institutions. COEs should also generate 25% of their budget from Technology Labs, industry, and other institutions in exchange for the R&D services they offer. The remaining 5% should be aimed at royalty payments from industry.

5.2.3. Human Resource Management

The model proposes that scientists should commence their journey within the organization by joining one of the Centers of Excellence (COEs) to immerse themselves in basic sciences and research, fostering the development of a scientific temperament. Following five years of intensive training at a COE, scientists should be evaluated for potential transfer to Technology labs, taking into account their aptitude and performance. Subsequently, after accumulating 10 to 15 years of experience at technology labs, scientists may be considered for transfer to System laboratories, once again based on their aptitude and performance.

During their tenure at COEs, the focus of scientist training should be limited to technical aspects and higher education. At Technology labs, managerial trainings may be introduced to complement their technical expertise. Finally, at System labs, greater emphasis may be placed on leadership and business-related trainings to prepare scientists for roles requiring advanced strategic and managerial skills.

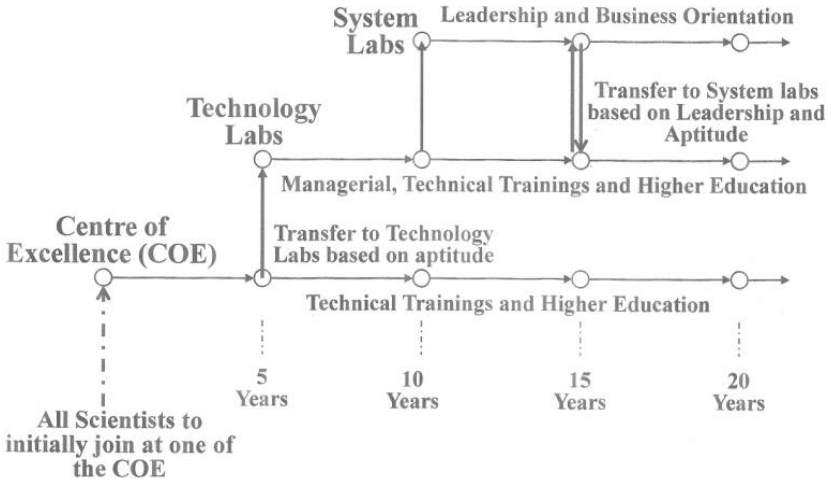

Figure 5. *Career Planning, Career Growth, and Leadership Development.*

6. Justifications and Discussions

In an optimal Research and Development (R&D) organization, well-defined responsibilities, and transparent interfaces among teams, both internal and external, are crucial. While these requirements have always held significance, their importance has been accentuated recently, especially with the prevalence of remote work setups. R&D organizations that successfully adhere to these principles are better equipped to meet additional demands, such as actively and efficiently managing complexity, maintaining a focus on the future, and retaining the tools and capabilities needed to adapt to change.

The performance of any R&D Organisation can be judged based on the following performance parameters [16, 18, 19].

1. Better R&D portfolio management
2. Higher success rate of innovation projects.
3. Development of core strength areas for collaboration for cutting edge technologies without losing the focus on product delivery
4. Efficient networking with Industry, Academy, and customer
5. Clear ownership and accountability at all levels
6. Career growth and career planning of manpower and continuous development of leadership
7. Adaptability to change.

Let us evaluate the proposed model based on the above parameters.

The primary challenge with public-funded Research and Development (R&D) organizations lies in the fragmented nature of basic and applied research. These organizations often engage in such research across various independent academic and R&D institutions, each driven solely by objectives like publishing research papers and obtaining doctorate degrees. In pursuit of these goals, these institutions tend to focus on research areas that are convenient for them or align with trends in research publications, rather than addressing the broader R&D requirements of industry and customers. Integrating these independent research institutions into the broader innovation value chain of organizations can enhance R&D portfolio management. Currently, all laboratories within DRDO are engaged in R&D activities across all phases, spanning from basic research to product development and prototype production. This comprehensive involvement makes R&D portfolio management challenging for each lab, resulting in confusion and, ultimately, leading to a loss of vision and project delays. Implementing a project division into three distinct clusters significantly improves R&D portfolio management. This approach not only streamlines the process but also enhances the success rate of innovation. By

directing all activities towards the delivery of the final innovation through product/system development laboratories, the organization can ensure a more focused and efficient innovation pipeline.

As mentioned above, the sixth generation of Research and Development (R&D) [16] envisions the delivery of systems through total supply chain management, treating R&D as a business process, and managing innovation through global collaboration. Successful collaboration is achievable when each participating organization possesses core strengths in one or more technology areas. To establish these core strengths, R&D organizations must focus on the entire knowledge value chain, encompassing activities from basic research to technology and product development, culminating in the production of the final product/system. In the proposed model, technology development labs and centers of excellence demonstrate core strength areas in their respective disciplines, essential for fruitful collaboration. Efficient networking with other academic and R&D labs on one end, and industry partners and customers on the other, not only reinforces expertise in core areas but also introduces new knowledge and best practices to the organization. Presently, DRDO networking with the academic institutions is not strong enough. By extending state-of-art fabrication and test facilities of COEs to academic institutions through collaborative projects will create a win-win situation for both academic institutions and DRDO laboratories.

This comprehensive approach ensures a robust foundation for successful collaboration and innovation.

For many researchers and practitioners in the field of organizational structure, productivity stands out as a paramount concern, with the overarching goal of every organization being the attainment of the highest possible productivity level [5]. As detailed in section 5.0, the primary objective of the proposed model is to elevate the productivity of public-funded Research and Development (R&D) organizations by instilling a customer-centric approach at every stage of the R&D process.

The principal motivator for individual output in the proposed model is the career growth of scientists based on their aptitude. Section 5.5 delineates the career planning and growth strategy for scientists. The model suggests an initial period of five to ten years for scientists within Centers of Excellence (COEs), fostering strong scientific foundations through interactions with academic institutions and other R&D labs. The strategic placement of scientists in other clusters, aligned with their aptitudes and supported by corresponding training, is a pivotal proposition in the model. This approach not only ensures ongoing leadership development but also position individuals to lead the organization effectively.

Crucially, the model underscores the significance of task ownership coupled with clear accountability and responsibility as the linchpin for organizational success. Through meticulous documentation and funding arrangements, this aspect is meticulously addressed and embedded in the proposed model. Last but not the least, the improved adoptability to change automatically comes from highly empowered R&D clusters with well trained leadership.

7. Conclusion

This paper introduces a modified version of Nadler's organizational model, uniquely outlining the fundamental distinctions between an R&D organization and a business organization. Using this model, the author further elucidates the key differences between publicly funded R&D and R&D within a large business organization, shedding light on the factors contributing to the lower productivity of publicly funded R&D. The paper advocates for a business-oriented R&D model at the corporate level tailored for public-funded R&D organizations, justifying its efficacy through well-established performance parameters. It is suggested that even at national level also, if all public funded R&D organizations are integrated in this manner the performance of public funded R&D can see a quantum jump.

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Author Contributions

Atul Sen is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

References

[1] Mintzberg, H. (1979), The structuring of organizations. Englewood cliffs, NJ: Prentice Hall.

[2] Duncan, R. (1979). What is the right organizational design? Organizational dynamics. Cross ref: Structure in 5's: a synthesis of the research on organization design, Management Science, Vol. 26, pp. 322-341.

[3] Monavarian, Asgari, & Ashna. (2007), Structural and content dimensions of knowledge-based organizations, The first national conference on Knowledge Management. Bahman.

[4] Muo, M. C. & Muo, I. K. (2014), Organizational Behavior: a concise introduction. Ibadan, Famous books

[5] Chegini M. G, Yousefi. S and Rastad. S, (2013). Competitive study of effects about dimensions of organizational structure on productivity, Journal of basic and applied scientific research, Text road publication, pp. 318-326, ISBN 2090-4304.

[6] Ashish Arora et.al. (2011), The organization of R&D in American Corporations: The determinants and consequences of decentralization, Working paper 17013 National bureau of economic research, 1050 Massachusetts Avenue, Cambridge, MA 02138, http:/www.nber.org/papers/w17013

[7] Argyres N. S. and Silverman, B. S. (2004), R&D, Organization structure, and the development of corporate Technological knowledge, Strategic Management Journal Vol. 7, no. 25, pp. 929-958.

[8] Chen, H.H. et al. (2014), The impacts of different R&D organizational structures on performance of firms: Perspective of absorptive capacity, Journal of High Technology Management Research Vol. 25. pp. 83–95.

[9] Gassmann, O. M. Õon Zedtwitzrm. (1999), New concepts and trends in international R&D organization, Research Policy Vol. 28 pp. 231–250.

[10] Cassanelli, A. N., Fernandez-sanchez, G., & Guiridlian, M. C. (2017). Principal researcher and project manager: who should drive R&D projects?. R&D Management, Vol. 47, pp. 277–287, http://dx.doi.org/10.1111/radm.12213

[11] Chen, J.H. & Chen, Y. (2016), The evolution of public industry R&D Institute–the case of ITRI. R&D Management, Vol. 46, pp. 49–61.

[12] Cristina Bayona Sáez, Teresa Garc´ıa Marco, Emilio Huerta Arribas, (2002), Collaboration in R&D with universities and research centres: an empirical study of Spanish firms, R&D Management, Vol. 32, No.4, pp. 321-341.

[13] Nadler, D. A. (1998), 'Champions of Change, Jossey – Bass Inc. Publishers, pp. 41.

[14] Sen, Atul. (2024), Organizational Knowledge and Knowledge Management- A New Framework, American Journal of management Science and Engineering, Vol. 24, No. 1, pp. 1-12

[15] Pandey Vishal and Tulsian P. C. (2008), Business organization and Management, Published by Pearson Education, ISBN 10: 8131716341 / ISBN 13: 9788131716342.

[16] Nobelius, D. (2004), Towards the sixth generation of R&D management, International Journal of Project Management, Vol. 22, pp. 369–375.

[17] RS Kaplan and DP Norton (2015). The Balanced Scorecard: Translating Strategy into Action, Harvard Business School Press.

[18] Thomas. M, Tirpak, Roger Miller, Larry S schwartz, and David Kashdan, (2006) R&D structure in a changing world, Research Technology Management, pp. 19-26.

[19] Zhang, J, Baden-fuller, C. and Mangematin, V., (2007), Technological knowledge base, R&D organization structure and alliance formation: evidence from the bio-pharmaceutical industry. Research policy, Vol. 36, no.4, pp. 515-528.