International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0291
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1989 - 2002

An Evaluation of Critical Success Factors of Research and Development Centers in Select Mechanical Engineering Companies of Karnataka

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Abstract
Several Engineering R&D centers are established in India by global multinational companies particularly in Mechanical Engineering domain, for leveraging cost efficiency, technical resource pool and capability available. However, these R&D centers struggle to move up to the value chain and transform from service-based thinking to product thinking. A well-developed business model would need to be established to enable this transformation improving productivity, competitiveness, enhance value to customers & attaining business growth. Using multi case study approach & interview technique, this study will identify R&D success factors. The study outcome will benefit the companies planning to set up R&D centers in Karnataka, India, Engineering R&D Ecosystem, leadership teams in various R&D centers, employees, business customers and society in general.

Keywords: *R&D Success factors, R&D Business model, R&D Typologies*

1. Introduction
Many global multinational company R&D centers were established in Karnataka, India, in the industrial machinery domain particularly focused on mechanical engineering design. These R&D centers generally start with basic engineering support as the main activity and slowly plan to grow in capability and to move up the value chain. Karnataka has firmly established itself as India's premier destination for captive Research & Development (R&D) centers, housing over 400 R&D facilities operated by Fortune 500 firms, including giants like Intel, GE, Samsung, and Texas Instruments. Bengaluru, often celebrated as the "Silicon Valley of India," contributes more than 50% of the country's R&D talent, and is home to the largest Samsung R&D Centre outside Korea. Supported by proactive state policies—such as the 2024–29 Global Capability Centre (GCC) policy aiming to add 500 centers by 2029 and generate 350,000 new jobs—Karnataka is rapidly becoming a global hub for captive innovation. Moreover, the state's recent decision to boost local R&D-to-manufacturing transitions with an additional 10% incentive and a Rs.50 billion infrastructure allocation represents a strategic push for value chain integration. Despite this momentum, captive R&D centers in Karnataka face unique challenges that determine their success. Access to a skill-ready talent pool remains critical, even as the state continuously invests to upskill professionals via partnerships with premier institutes and CoEs in biotech, AI, semiconductors, and more. Simultaneously, the alignment of state incentives—rental grants, capex subsidies, single-window regulatory support—with firm-level strategies like strong IP governance, agile project management, and local–global collaboration, shapes outcomes. Understanding which combination of external enablers and internal practices drive high-performing captive R&D operations is essential to unlocking Karnataka's full innovation potential and that is the focus of this study.

2. Conceptual Background
In the last decade, R&D centers generally start with basic engineering support as the main activity. The general approach followed during the initial stages of establishment is a "service centric business model". In this model, the companies take on projects as a service, often with clear scope and methodology defined. The workflow process would be well defined to arrive at desired results. Captive R&D centers, also known as Global Capability Centers (GCCs),

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represent a strategic extension of multinational corporations aimed at leveraging local talent and cost efficiencies to drive innovation. These canters are wholly owned subsidiaries, dedicated to conducting research, product development, and technological advancement. Unlike outsourced R&D, captive centers ensure tighter control over intellectual property, alignment with core business objectives, and long-term knowledge retention. The evolution of these canters from low-end back-office functions to high-value innovation hubs has been significant, especially in India, where the ecosystem supports such growth. In this context, Karnataka—particularly Bengaluru—emerges as a preferred destination due to its strong academic network, robust infrastructure, and favourable policy climate. The identification of critical success factors (CSFs) for captive R&D canters is essential for sustaining global competitiveness and innovation leadership. Elements such as leadership commitment, talent acquisition and retention, collaborative culture, effective knowledge management, and regulatory support play a pivotal role in determining the effectiveness of these centers [1-7]. This study is particularly significant for Karnataka, which is witnessing a surge in both existing expansions and new investments in R&D. By understanding these success drivers in the local context, the findings can help policymakers enhance the state's innovation framework and assist organizations in maximizing their R&D impact. The conceptual exploration thus bridges theoretical insights with practical imperatives for sustainable technological growth.

3. Review of Literature

There are various theoretical frameworks witnessed from the literature that can be considered while determining the success factors from an industrial machinery Mechanical Engineering R&D perspective. The literature studies conducted and the key takeaways from the respective references are described in below table 1.

Table 1 References

Reference	Key Takeaways
Lu, S. and Liu, A., 2016. Innovative Design Thinking for Breakthrough Product Development. Procedia CIRP, 53, pp.50-55.	Six theoretical building-blocks of Innovative Design Thinking: Reasoning, Representation, Operation, Complexity, Certainty, Process
Wiedenmann, M., Dreher, S., Humbeck, P., Schöllhammer, O. and Bauernhansl, T., 2020. How Current Trends in Mechanical Engineering Can Shape Inter organizational R&D. Procedia CIRP, 93, pp.736-741.	Success Factors in Inter organizational R&D: Strategy, Organization, Interfaces, Culture, Mindset
Conforto, E. and Amaral, D., 2016. Agile project management and stage-gate model—A hybrid framework for technology-based companies. Journal of Engineering and Technology Management, 40, pp.1-14.	Some of these critical factors may include team characteristics, people competencies, organizational culture, structure, and available resources, technology uncertainty, and market characteristics.
Koch, J. and Schermuly, C., 2020. Who is attracted and why? How agile project management influences employee's attraction and commitment. International Journal of Managing Projects in Business, 14(3), pp.699-720.	Team-building interventions may therefore introduce specific agile practices such as stand-up meetings, agile team roles or retrospectives that answer the organizational need at hand.

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Taran, Y., Boer, H. and Lindgren, P., 2015. A Business Model Innovation Typology. Decision Sciences, 46(2), pp.301-331.	The study suggests that the success of the innovation depends on, among others, the company's appreciation of the new business model's innovativeness and the extent to which the company achieves fit between the innovativeness (radicality, reach, complexity), strategic context (pro activeness), and organizational setting (openness) of the innovation
Kujala, S., Artto, K., Aaltonen, P. and Turkulainen, V., 2010. Business models in project-based firms – Towards a typology of solution specific business models. International Journal of Project Management, 28(2), pp.96-106.	6 Key elements of the business model are: Customers, Value proposition for the customer, Competitive Strategy, Position in the value network, Supplier's internal organization and its key capabilities, Logic of revenue generation
Dikert, K., Paasivaara, M. and Lassenius, C., 2016. Challenges and success factors for large-scale agile transformations: A systematic literature review. Journal of Systems and Software, 119, pp.87-108.	Success factors are: Management Support, Commitment to Change Leadership, Training & Coaching, Engaging People, Communication & Transparency, Commitment & Alignment and Team Autonomy
Magistretti, S., Dell'Era, C., Verganti, R. and Bianchi, M., 2021. The contribution of Design Thinking to the R of R&D in technological innovation. R&D Management.	The nature of research challenges requires carefully adapting the consolidated Design Thinking paradigm
De Boer, S., Gan, W. and Shan, G., 1998. Critical issues facing R&D managers in China. R&D Management, 28(3), pp.187-197.	One of prime importance is the further development of R&D managers in China. This refers to skill development in China and to international exposure. Sending R&D managers and staff to the industrialized countries for training will improve their skills and knowledge and will keep them motivated.
Larson, C., 1996. Critical Success Factors for R&D Leaders. Research Technology Management, 39(6), pp.19-27.	The role of R&D Leaders has evolved from simply directing high quality technical efforts to leading the innovation process and making innovation happen. Leaders ability to plan, prioritize, communicate and accomplish goals through the efforts of others. Thinking globally, do more with less, speed to market to sustain competitiveness, profitability and survival

3.1.Review of literature - Observations

Fifty journals, Books and Articles related to the topic were reviewed. Key observations are:

- There are several frameworks and theories available:
- From innovation Perspective
- From project management perspective
- From service delivery business models
- From thinking styles
- From inter-organizational R&D
- There are success factors studies on:
- Project Life cycles
- Leadership
- Organization
- Service innovation

Research rationale: Study, review and identify suitable R&D Typologies that help value chain growth. Identify critical success factors (CSFs)

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guiding value chain growth. The existing literature is relevant to general R&D, however not related to Mechanical Engineering domain specifically.

4. Problem Statement

Several Engineering R&D centers are established in Karnataka, India by global multinational companies particularly in Mechanical Engineering domain, for leveraging cost efficiency, technical resource pool and capability available. However, these R&D centers struggle to move up to the value chain and transform from service-based thinking to product thinking. A well-developed business model would need to be established to enable this transformation improving productivity, competitiveness, enhance value to customers & attaining business growth. Using multi case study approach & interview technique, this study will identify R&D success factors. The study outcome will benefit the companies planning to set up R&D centers in India, Engineering R&D Ecosystem, leadership teams in various R&D centers, employees, business customers and society in general.

5. Objectives of the Study

The main aim and objectives of this research is to determine a suitable business model and its implementation strategy to transform from Service centric operating model to Product thinking model. The research objectives are formulated based on the aim of this study which are as follows:

- To identify the critical success factors (CSFs) that influences the performance of Research & Development centers.
- To analyze the relative importance of each critical success factors (CSFs).
- 3. To investigate the critical success factors (CSFs) and strategic measures necessary for R&D centers.
- To evaluate a strategic business model framework for transitioning R&D centers from a service-centric operating model to a product-thinking operating model for improving R&D center performance in mechanical engineering companies.

6. Research Methodology

6.1. Research Method

There are several R&D business models and approaches catering to various domains or segments and industries such as Design thinking Model, Agile project management approach etc. However, we evidence lack of R&D business model addressing the above-mentioned challenges[8-12]. A combination or a new R&D typology will need to be determined. Hence, we propose our first research question as:

Question 1: What are the various R&D typologies suitable for Mechanical Engineering domain influencing value chain in captive R&D centers? A focused research to be conducted on the role of various stakeholders including the organizational leadership team and the business model implementation strategy need to be arrived at. Hence, we propose our second research question as

Question 2: What are the Critical Success factors influencing Value chain (competitiveness, sustainability, productivity)?

6.2. Structure of study

The structure of the study is described using the methodology. Methodology deployed involves mainly qualitative study with multi case study analysis involving following steps:

- Study of various business models from literature and white papers & existing R&D 2. Conduct interviews of R&D thought leaders from the Mechanical Engineering industry:
- A business Directors & General Managers from 4 to 5 Indian R&D centers within the industry machinery domain. They would be leading a small, medium to big size organizations in terms of capacity.
- Interview protocol, develop a questionnaire that can be used for face to face Interview/discussion, the sample questions will be:
- Which R&D typology is adapted in your organization? What are its merits and demerits?
- How is your R&D project execution process? What challenges do you generally face? How do you overcome them?

6.3. Sample Area / Data collection Overview

The data collection consisted of a study in which

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interviews were conducted with the following: a semi-structured interview for 45–90 min with the thought leaders who are at the senior leadership positions either currently at various Indian R&D centers or had been in similar positions in the past in their career. Some of the thought leaders were consulting top MNCs in the area of engineering services and R&D. The data collected from 20 such interviews was used for qualitative research.

6.3.1. Data Sources / Interview Protocol

Face to face interview

Thought leaders in the industry, questions which are part of the questionnaire presented above were asked and answers were written down while they are speaking, to gather more subject wise matter additional probing questions were asked so that the reasoning behind their answers were considered and interpreted. The entire excerpts of the discussion were written down and tabulated in a Microsoft excel Spreadsheet [13-20].

Online interview

Through Google form with each of the questions in the questionnaire was prepared and sent to the various respondents through email. They were asked to respond their thoughts and views as elaboratively as possible in the online forms. After receiving the returned forms from respondents with answers they were tabulated in a Microsoft Excel Spreadsheet. The process is shown in figure 3.1 below. Pilot interview was conducted, and transcripts were reviewed with the thesis supervisor to make sure the process is valid shown in Figure 1.

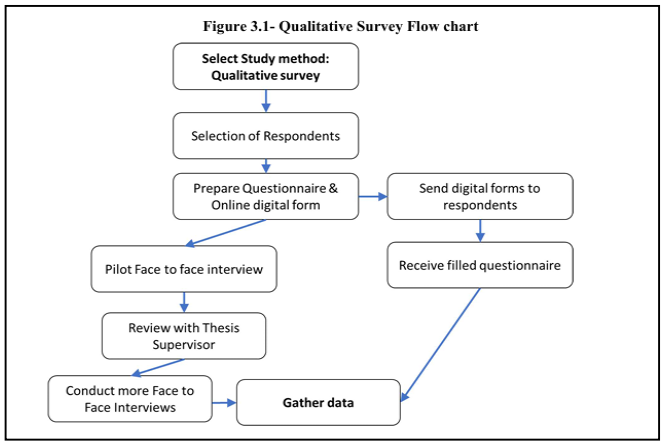

Figure 1 Qualitative Survey Flow Chart

6.4. Respondents Overview

R&D Engineers, R&D Managers, Service Providers and R&D leaders from Karnataka, Indian. R&D centers with Industry experience range of 10-40 years in area of Product Development, R&D Management, and Project management. Most of the respondents were the founders and leaders of several MNC captive R&D centers in India. The list of the variables is shown in the below table 2.

Table 2 Variables Overview

Respondents Overview			
Designation	Location	Years of Experience	Domain
R&D Director/Head	Southern India	25 Years	Mining, construction machinery
R&D Director/Head	Southern India	22 Years	Mining, construction machinery
R&D Director/Head	Southern India	35 Years	Industrial, Transportation & Heavy engg and Marine
R&D Director/Head	Northern India	30 years	Heavy Machinery
R&D Director/Head	Northern India	30 Years	Automotive R&D, Heavy Engg
R&D Director/Head	Western India	25 Years	Mining, Processing, Handling, Pumping Products
R&D Director/Head	Western India	36 Years	Industrial
R&D Consultant	Southern India	35 Years	Construction & Material handling
R&D Consultant	Northern India	36 years	Industrial machinery
R&D Consultant	Western India	32 years	Cranes and material handling
R&D Manager	Southern India	15 years	Heavy Machinery
R&D Manager	Southern India	16 Years	Mining, construction machinery
R&D Manager	Southern India	13 years	Mining, construction machinery
R&D Manager	Northern India	14 years	Mining, construction machinery
R&D Engineer	Southern India	10 Years	Mining, construction machinery
R&D Engineer	Southern India	10 years	Cranes and material handling
R&D Engineer	Southern India	10 Years	Cranes and material handling
R&D Engineer	Northern India	10 years	Automotive R&D, Heavy Engg
R&D Engineer	Western India	8 years	Automotive R&D, Heavy Engg
R&D Engineer	Western India	8 years	Automotive R&D, Heavy Engg

6.5. Reason for selection of respondents

They have several years of leadership experience in setting up, running and sustaining R&D centers in Karnataka, India. Their vast experience over the years at deferent stages of R&D centers evolution, their strategic knowhow, expertise in managing and leading innovation strategies and business models would provide valuable inputs and feedback. The questionnaire was focused on understanding the challenges faced by them and how they overcome those. Respondents were from different domains such

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as Automotive, Heavy Engineering, Construction Machineries and various other industrial machinery companies.

7. Analysis and Findings

Research question 1 was to identify the R&D Typologies for value chain growth. Before determining these, it was important to understand what the respondents view the top of the value pyramid as. This was essential since each respondent might have a different thinking about what they would consider as the top of the value pyramid. Hence this was taken as the first step. In this step, the responses received from the thought leader interviews and discussions were reviewed, grouped together forming different themes. The data was segregated into four categories based on the interview transcripts:

- Understanding the top of the value pyramid
- Challenges currently faced by the Indian R&D centers affecting value chain growth.
- Key success factors affecting value chain growth
- Critical Success factors for enhancing Productivity, Competitiveness and Productivity.

Against the above four categories of information, the key words emerging from the transcripts were tabulated for all respondents in an excel sheet. An example of mapping of thoughts for describing the top of the value pyramid is shown below in Figure2.

7.1. Value Pyramid Analysis Description

Below are the descriptions of the top of the value pyramid analysis from sample 10 Variable:

- Variable 1: challenging product development
- Variable 2: New Product from Scratch
- Variable 3: Developing Innovative products
- Variable 4: Providing solutions with functional value to the customer
- Variable 5: innovative solutions to customer problems
- Variable 6: Life changing and socially impactful solutions
- Variable 7: Innovation to solve world problems
- Variable 8: Sustainable solutions to critical problems faced by customers
- Variable 9: Innovative products changing lifestyle
- Variable 10: New products which outperform competition

By analyzing the variables, it is observed that the respondents believe that the customer centric solutions which bring in innovation and functional value to the society is considered as the top of the pyramid. A generic R&D Pyramid can be drawn as shown in below figure 2.

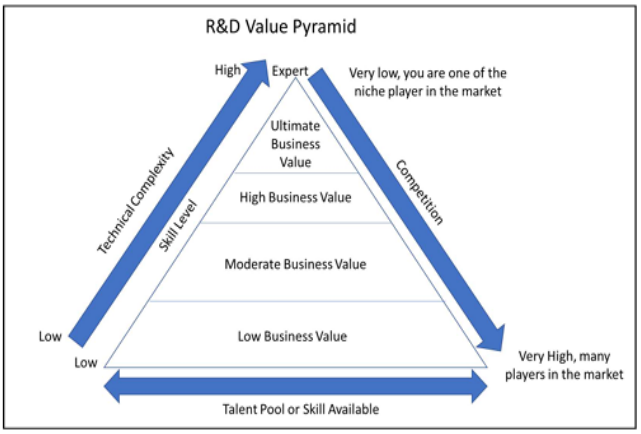

Figure 2 R&D Value Pyramid

It is observed from the value pyramid diagram, as the companies strive to reach the top of the R&D pyramid the skill level needed increases as the technical complexity of the projects increase. Also observed that there is lesser competition at the top of the pyramid with the companies performing as niche player in the market whereas its lowest at the bottom of the pyramid where you have many players in the market [21-25]. Hence to reach and sustain at the top of the pyramid the companies must consider the right business model or R&D typology.

7.2. Data Analysis & Findings for Research Question 1

Five respondents had emphasized about R&D Typology called “Basic & Applied research”, as one of the successful R& D Typology influencing value chain. The responses were as below:

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- Respondent 6: “Our basic research looks at how processes or concepts work. Information obtained from basic research often creates a foundation for applied studies”
- Respondent 3: “We use two main research methods, basic research, which helps expand existing knowledge, and applied research, which provides a solution to an existing problem”
- Respondent 10: “Our Research and development focuses on creating new products or services to meet a target market's needs using action research which is a type of applied research methodology”
- Respondent 11: “Applied research method saves our businesses money by helping them make better decisions. Our Market research analysts use basic research to help predict sales trends and uses applied research to come up with new ways to collect data from customers to use for market strategies”
- Respondent 12: “we favor applied research over basic research since it has the potential to lead to a monetary gain and can help create new products”

There are five different transcripts which are emphasizing the importance of a research method called “Basic & applied research” which is the aggregate code determined from the quotes. This aggregate code is one of the evidence-based R&D Typology which answers the research question 1. The Basic & Applied research method has been used in several companies which is a structured approach to solving engineering problems, used by different people in the R&D projects such as Market research analysts predicting sales trends, collect data from customers (voice of customers). Based on the study as described above, it is observed that the four R&D Typologies that are critical to value chain growth are:

- Basic & Applied Research
- Experimental Development
- Design Thinking 4. Agile Methodology

7.3. Data Analysis & Findings for Research Question 2

Similar process by studying and reviewing respondent transcripts, the critical success factors for value chain growth were analyzed which answers our Research question 2. (What are the Critical Success factors influencing Value chain in terms of competitiveness, sustainability, productivity?) Here we observed that there are secondary codes emerging from the transcripts which finally can be summarized as one aggregate code. The aggregate code can be considered as one of the success factors. Based on the above analysis it is observed that the transcripts led us to 3 secondary codes- Organizational Vision, Management Agility and Strategy & Roadmap. The first evidence-based success factor emerging from the study for value chain growth is “Value Focused Leadership”. Based on the study as described above, it is observed that the four critical success factors that affect value chain growth (competitiveness, Productivity & Sustainability) are:

- Value Focused Leadership
- Agile Team Ecosystem
- Customer Centricity
- Purposeful Innovation

8. Results and Discussions

8.1. Findings from study for Research Question 1

Our study suggests through evidences that there are four important R&D Typologies that contribute to value chain growth in Karnataka, Indian R&D centers. They are described as below:

8.1.1. R&D Typology 1: Basic and Applied Research Method

It is observed from the study that basic research looks at how processes or concepts work, information obtained from basic research often creates a foundation for applied studies. Basic research, which helps expand existing knowledge, and applied research, which provides a solution to an existing problem. R&D focuses on creating new products or services to meet a target market's needs using action research which is a type of applied research methodology. Applied research method saves businesses money by helping companies make better decisions. In many companies’ market research

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analysts use basic research to help predict sales trends and uses applied research to come up with new ways to collect data from customers to use for market strategies. This approach helps in monetary gain and productivity improvements. The respondents stressed on the need to use the right approach either basic or applied based on the nature of the project and the problem being solved. According to this study it is observed that this R&D Typology is commonly used for the problems where a human centric or environmental based behavior studies are conducted to arrive at the parameters and specifications. The value chain growth is achieved by developing products which are at the top of the value pyramid using the basic and applied research method.

8.1.2. R&D Typology 2: Experimental Development method

It is observed from the study that basic experimental research methods such as conceptual definition, planning and documentation of new products, processes and services are critical to establishing a streamlined product development process. It is the most scientifically sophisticated research method which is performed at our R&D test laboratories of Indian R&D 38 centers to proof test concepts and validate design ideas. Experimental Research is a method used often by us where existing knowledge gained from research and/or practical experience is used on developing new solutions and products. This method helps in capturing detailed information and data of the existing products in the market at the beginning of the NPD to develop a baseline & conceptual designs, which is often considered as a pivotal step in capturing voice of customer and user experiences and challenges. The experimental research process can be followed in a five-step approach namely Imagine, Plan, Create, Test & Improve. This process reduces the cost of the new product development process by envisioning the potential problems or failures that could occur on the product since the experimental development of proving of concept is done at the early stages of product development. This has multiple benefits to the organization as well as customer. This R&D Typology ensures that the product is thoroughly validated before presenting to customer which is an important aspect of gaining customer delight. The value chain growth is determinant of the products and solutions that are fool proof which this R&D typology helps in achieving. Most of the respondents suggested that this R&D typology is used for products which are either niche or mass produced so that enough experimentation is done at the conceptual stage. The design of systems is rarely accomplished exclusively by applying fundamental scientific principles. In most cases, the engineering and design of systems also requires some use of empirical data and experimentation. This fact is driving a trend to teach engineers the design of experiments so they can more efficiently plan experiments and analyze and understand the results. These techniques are now widely taught in industry through “six sigma” programs, as well as through more traditional college and professional engineering programs. The methods of experiment design are now widely disseminated and are having a significant impact throughout industry. However, the statistical methods of experiment design alone will not be enough for engineers to learn effectively through experimentation. Engineers must also learn to alternate between inductive processes and deductive processes, using physical understanding or engineering models to inform the experimental approach and then updating their understanding and models based on data. There is potentially great promise in research on how to teach engineers to make coordinated use of engineering models and experiments.

8.1.3. R&D Typology 3: Design Thinking Method

It is observed from the study that the design thinking framework helps inspire creative thinking and strategies that lead designers to create user-friendly products that help solve a problem. The literatures suggest that Design thinking is an innovative approach traditionally used to frame 39 complex problems and develop more desirable solutions by adopting a collaborative approach. Hence, a growing number of companies have implemented design thinking to develop better products and services but the effectiveness of design thinking in project environments needs to be studied. (Lahiri, Cormican

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and Sampaio, 2021), (Lu and Liu, 2016), (Luchs, Swan and Griffin, n.d.). Respondents suggested that Design thinking approach is suitable for any domain or type of products. Respondents have argued that the knowledge of technical systems or analysis is not sufficient to understand the thought processes that lead to successful design and successful engineering solutions, and that studying those thought processes is critical to improving design methodologies. Engineering design is a systematic, intelligent process in which designers generate, evaluate, and specify concepts for devices, systems, or processes whose form and function achieve clients' objectives or users' needs while satisfying a specified set of constraints. Respondents suggested that there are many informative approaches to characterizing design thinking, these characterizations highlight the skills often associated with good designers, namely, the ability to: tolerate ambiguity that shows up in viewing design as inquiry or as an iterative loop of• divergent-convergent thinking maintain sight of the big picture by including systems thinking and systems design• handle uncertainty• make decisions• think as part of a team in a social process• think and communicate in the several languages of design• The study suggested that creative people tend to work in two different ways: either as finders or as makers of engineering solutions. Finders demonstrate their creativity through discovery. So, evidences suggest that the Design thinking approach helps companies improve the productivity and enhance creativity there by helping in value chain growth.

8.1.4. R&D Typology 4: Agile Methodology

It is observed from the study that the Agile methodology is a natural choice for product design. Most respondents mentioned that they use it for complex projects that have ever-changing needs and requirements. Agile methodology is of the perfect use for Computer Aided Design and Drafting. During this process, iterations are short, and the design is broken into multiple logical parts. Agile engineering unites teams across the organization and creates a better product. By responding to user feedback with prototypes, teams develop products that users want. An agile transition is about getting the team to focus on delivering the most important features first and assuming that the rest will change due to customer feedback or market demands. Facing a shortage of engineers in Indian R&D centers, it's not easy afford to have one engineer dedicated to one design for a long period of time, hence need to be more flexible & more agile- which is an approach that is custom made for mechanical engineering discipline. Prototyping and industrializing equipment is expensive, as is modifying the definition of a system if it affects the test and production phases. A key characteristic of agile project execution is breaking up the traditional phased approach into several increments called "sprints" in the Scrum method. Each "sprint" or increment is operated as a mini V-cycle, with defined objectives and a set of tasks to be performed. Not only does the team get a regular sense of accomplishment, but also the stakeholders receive tangible value more often. By prioritizing features, risk is reduced earlier and core features are emphasized, leading to a clearer understanding of project goals. Finally, feedback is encouraged and can be incorporated before it becomes too expensive to implement. The entire Agile methodology as a R&D Typology brings in huge benefits towards value chain growth and increased agility in the organization thereby helping enhance productivity. In summary, we see enough evidences from the study suggest that the four R&D Typologies identified for value chain growth namely Basic & Applied Research, Experimental Development, Design thinking & Agile Methodology practiced together will provide companies a business model to pursue for profitability growth, increased competitiveness and overall productivity of the organization. These methods must be chosen depending on the project type, the product needs and organizational ecosystem.

8.2. Findings from study for Research Question 2

Our study suggests through evidences that there are four critical success factors that contribute to value chain growth in Indian R&D centers. They are described as below:

8.2.1. Critical Success Factor 1: Value Focused leadership

It is observed from the study that a visionary leader, enthusiastic, skilled and motivated leadership team,

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global collaboration facilitators, engagement is university and industry wide forums are critical to success of a R&D center. Value chain growth is a resultant of technical ability growth, having physical infrastructure for practical validations and experimentations, strong organization vision to grow in ability rather in strength alone, global collaboration and roadmap for product development, all these aspects are facilitated by the leadership team. Servant Leadership & Visionary management process is recommended for value chain enhancement. This bridges the gap b/w management and employees, having a clear vision set the right direction.

8.2.2. Critical Success Factor 2: Agile Team Ecosystem

It is observed from the study that to move up the engineering value chain and become an innovation powerhouse, requires change in the mindset of our engineers, a better understanding of the outside world. Nurturing talent, provide global exposure to engineers, is key to shift from engineering services and support to become a global engineering and innovation hub. Right mix of skills and team formation, balanced coordination among the team members who are self-motivated and committed to work in group are essential requirements for value driven work culture. Respondents suggest that on certain technology side there is still lack of expertise 42 which needs to be enhanced by company-university academic relationships. There is a general tendency to be intrinsic in product research, which can be dangerous for fostering innovation. Instead, an ecosystem where the companies work together across industry along with academic institutions and universities for latest technology development supports value chain improvement especially in the area of sustainable products of the next generation. The unprecedented change in the mobility industry moving from fuel-based machineries to electric power-driven systems is a perfect example where the universities, startups in India have been collaborating with MNC R&D centers to come out with innovative products faster to market.

8.2.3. Critical Success Factor 3: Customer Centricity

It is observed from the study that the R&D process needs to adapt connection to both internal & external customers on a frequent basis from inception to completion. The critical success factors related to customers include, product meeting customer specifications and requirements, faster time to market leveraging global talent pool, incremental improvement in profitability for the organization and customer, reduced cost of ownership for customers. Respondents suggested that lack of opportunities to engage with the actual customer limits understanding of customer needs and understanding of the market resulting in customer distrust. Many or some of the products that are developed in these R&D centers often doesn't get sold in Indian market, hence the actual application, the customer requirements are not fully known and difficult address which limits organization and business growth, hence a global customer centricity and relationship building is necessary. Providing engineers first-hand experience of the customers/consumers they are designing for, is equally essential to offer product managers opportunities to collaborate with global clients and colleagues to impart a better understanding. Hence, the evidences suggest that the customer centricity is one of the major success factors in determining value chain growth of Indian R& D centers. Evidence suggests that, companies can develop an industry-specific platform, consolidate, or open existing platforms to create an industry solution for their customers at scale, which brings Customer centricity to the fore.

8.2.4. Critical Success Factor 4: Purposeful Innovation

It is observed from the study that the as organizations mature, innovation-driven growth becomes increasingly important, as their traditional means of organic growth, such as geographic expansion and entry into untapped market segments diminish. Scalability is another important consideration, that is innovation at a scale which can be dialed up or down depending on the business and innovation needs. Respondents suggested that the only way to success in value chain is innovation in products, manufacturing and cost reduction both on the process and product side. This means Indian companies can re-purpose their R&D efforts to meet three key

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0291
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
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endpoints: India for global, India for the region and India for local. In the international R&D business, skills in patenting, filing, reading and exploiting patents will be most crucial. The mantra for success from an innovation perspective is to value 'knowledge' and respect intellectual property. It is necessary to inculcate patenting culture and build patent literacy within the organization. Purposeful innovation is about solving the problem as best as you can, and this has the bonus of making you less vulnerable to the impact of your competitors who may take on the same problem. Respondents suggested that rather than compartmentalizing the innovation to a team or group of people, think about ways to encourage an innovation mindset that spans across entire organization. All the respondents interviewed in this study believed that it's important to have a clear and compelling vision. The vision must be constantly reinforced by the leadership team and employees must recall it almost like a mantra. It is important to support purposeful innovation vision with a carefully crafted set of values designed to create a growth-focused culture. In summary, evidences from the study suggest that the four Critical Success factors are identified for value chain growth namely, Value Focused Leadership, Agile Team Ecosystem, Customer Centricity & Purposeful Innovation.

Conclusion

This study started with two main research questions:

- To determine the R&D typologies affecting value chain growth of Karnataka, Indian R&D centers.
- To determine the critical success factors for value chain growth.

During the study with thought leader interview transcripts and discussion points, using the evidence-based coding process four R&D typologies were identified as critical to Value chain growth. They are:

- Basic & Applied Research
- Experimental Development
- Design Thinking approach
- Agile methodology.

Using the similar approach of evidence-based coding, four critical factors for value chain growth were identified. They are:

- Value focused Leadership
- Agile Team Ecosystem
- Customer Centricity
- Purposeful innovation.

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https://doi.org/10.47392/IRJAEM.2026.0291
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https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0291
e ISSN: 2584-2854
Volume: 04 Issue: 05
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