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The Effective Measure of R&D Success and Future Research Direction

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Abstract

This research looks at a variety of measures used to estimate R&D effectiveness from 2019 through 2023. This article discusses a variety of strategies for measuring R&D performance and emphasizes its diverse qualities. This study expands on previous research by investigating critical determinants for R&D performance such as innovation production, technical advancement, knowledge creation, and economic effect. Furthermore, in order to acquire a thorough grasp of R&D success, this study examines a number of quantitative and qualitative evaluation approaches. In addition, suggestions for further study are made. The evaluation is based on a thorough literature analysis that examined a broad variety of scholarly publications to discover and categories pertinent information. According to the results, evaluating R&D performance is a complicated process that requires the evaluation of various components as well as the use of a mix of quantitative and qualitative assessment methodologies. Key markers of R&D performance include patents and invention output, technical advancement, knowledge creation, and economic impacts. Organizations and governments may acquire a thorough picture of the success and efficacy of their R&D projects by combining several evaluation approaches. Overall, this study expands and summarizes previous literature research, making it a great starting point for academics interested in R&D success. Future R&D success study should concentrate on the dynamic relationship between technical innovation and organizational abilities, diving into the delicate components of producing successful outputs.

Keywords: R&D Success, Innovation Output, Technological Progress, Knowledge Creation, Evaluation Method

Introduction

R&D activities are at the forefront of technical innovation and economic advancement, and they greatly contribute to the creation of a competitive environment across sectors (Gopalakrishnan et al., 2017). R&D outcomes not only propel the corporation ahead, but also help to further society growth. To make informed choices about resource allocation, investment strategies, and technological trajectories, the performance of R&D efforts must

be adequately monitored. However, defining "R&D success" and devising proper assessment criteria is a complex task that has piqued the interest of academics and industry alike.

The success of research and development has a substantial influence on the long-term sustainability and capacity to innovate of a business. Businesses are always under pressure to innovate and bring new goods, processes, and services to market in a quickly expanding technology environment. In this setting, R&D serves as a catalyst for advancement, assisting businesses in remaining competitive and responding to changing client requirements. According to Chiesa and Frattini (2011), measuring the efficacy of R&D activities in stimulating innovation, generating intellectual property, and ultimately attaining long-term prosperity is crucial.

Traditional R&D performance metrics often emphasize quantitative results, such as the number of patents awarded or financial returns. Although significant, these indicators represent just a subset of the many impacts of R&D operations. The conventional emphasis on patents and financial success, according to Narayanan and Nath (2017), may ignore other crucial components such as knowledge production, technology transfer, and human capital development. The capacity of a company, for example, to accept and integrate new information from R&D initiatives is crucial for long-term innovation sustainability (Lee et al., 2019). As a result, a full evaluation of R&D success requires a larger paradigm that includes both tangible and intangible outcomes.

Given these complications, a rising body of research highlights the significance of assessing R&D efficiency in a thorough and fair way. Researchers have proposed combining traditional measurements such as the number of patents and financial indicators with more qualitative evaluations to capture knowledge spillovers, collaborative networks, and the transformational influence of innovation on organizational culture (Lavie et al., 2010; Hall et al., 2014). This integrated paradigm acknowledges the complex interaction between physical and intangible outputs and seeks to provide a comprehensive picture of R&D success.

This article is the first to provide a complete overview of the available research and development success literature. This article investigates and outlines critical R&D success factors. A variety of quantitative and qualitative evaluation methodologies are investigated, and the successful R&D literature is reviewed and assessed to give a good starting point for future R&D researchers.

Literature Review

Investment in research and development (R&D) is crucial to the long-term success of firms (Goel & Nelson, 2022) and governments (Moncada, 2022), and has increased dramatically over time (O'Connell et al., 2018). According to Chen & Huang (2019), R&D success is the successful transition of research findings into novel goods, processes, or technologies, producing enormous economic value. R&D investments are critical to a company's innovation strategy in today's competitive climate (Baik et al., 2022). In today's worldwide competitive market, effective R&D investment is vital to the survival and success of many businesses (Goel & Nelson, 2022). With market rivalry becoming more strong, more and more firms recognize that inter-organizational collaboration is critical to gaining a competitive edge (Lemmens, 2004). Table 1 lists the markers of R&D performance.

Table 1
The Indicators Involved in R&D Success

Indicators involved in R&D success		
Smith et al.（2018）	Patent Quantity and Quality	The number and quality of patents reflect R&D success, with quality indicating transformative potential.
Hall et al.（2014）	Patent Citation Analysis	Citations received by patents showcase their influence, highlighting their contribution to advancing technology.
Tidd & Bessant（2013）	Technological Innovation	R&D success translates into the introduction of novel technologies, products, and processes.
Chen & Huang（2019）	Financial Metrics	Return on R&D Investment (RORI) and Revenue from New Products (RNP) assess financial effectiveness.
	Market Performance	Market share growth and successful product launches reflect R&D success.
	Time to Market	Rapid translation of R&D outcomes to marketable products signifies agility.
	Innovation Adoption	R&D success extends to the spread and adoption of outcomes across industries.
Lavie et al. (2010)	Knowledge Creation	R&D contributes to new knowledge generation, enriching organizational intellectual capital.
Mazzucchelli et al. (2021)	Collaborative Networks	Improve the success of R&D initiatives by strengthening SMEs' knowledge exchange and innovation skills.
Lavie et al. (2010)	Human Capital Development	Nurturing an innovative workforce and culture underpin R&D success.
Tidd & Bessant, (2013)	Technological Impact	Breakthroughs in scientific knowledge indicate R&D success.
Dodgson et al. (2008)	Risk Management	Successful R&D involves managing technical and market risks.
Tidd & Bessant (2013)	Customer Satisfaction	R&D success lies in aligning innovations with customer preferences.
Yu et al. (2021)	Environmental Impact	Successful R&D encompasses the development of green new goods and green technology.
Owen et al. (2013)	Ethical Considerations	Adherence to ethical standards demonstrates responsible R&D success.
	Regulatory Compliance	R&D success encompasses compliance with legal and regulatory standards.
Tidd & Bessant (2013)	Long-term Viability	R&D success is indicated by the enduring relevance of innovations.

Lavie et al. (2010)	Knowledge Transfer	Effective dissemination of R&D findings to stakeholders signifies success in knowledge-sharing.
Dodgson et al. (2008)	Cultural Transformation	R&D success requires fostering a culture of innovation and adaptability.
Sengoku (2019)	International Collaboration	Global R&D collaborations indicate effectiveness in harnessing varied resources.
Archibugi & Coco (2004)	Economic Growth	R&D contributes to economic growth at various levels.
Molas-Gallart et al. (2002)	Social Impact	R&D success involves addressing societal challenges through innovative solutions.
Dodgson et al. (2008)	Competitive Advantage	Successful R&D leads to differentiation and competitive positioning.
Chesbrough (2003)	Open Innovation	R&D success embraces open innovation, incorporating external knowledge.
Tidd & Bessant (2013)	Adaptabili ty	R&D success is evident in an organization's ability to adapt to market dynamics.
Hobday (2005)	Resource Efficiency	Efficient utilization of resources contributes to R&D success.
Perkmann & Walsh (2009)	Scientific Collaboration	Collaboration with academia enhances R&D success by tapping into specialized expertise.
Youtie & Shapira (2008)	Productivity Gains	R&D success leads to productivity enhancements through improved processes.
Arora et al. (2001)	Intellectual Property Strategy	Effective management of intellectual property reflects R&D success.
Marquis & Lounsbury (2007)	Cultural Diversity	A diverse workforce contributes to R&D success through varied perspectives.

Success in research and development (R&D) is the ultimate outcome of interconnected processes ranging from inspiration through execution. This essay goes into the intricacies of research and development success by emphasizing five essential processes that lead to R&D success, as seen in the illustration in Table 2.

Table 2
R&D Success Interrelated Process

	R&D success interrelated process	
Tidd & Bessant (2013)	Idea Generation and Conceptualization	The journey towards R&D success commences with the generation of innovative ideas and their transformation into actionable concepts. This process involves brainstorming, exploration of emerging technologies, market analysis, and creative thinking to identify novel opportunities.
Dodgson et al. (2008)	Strategic Planning and Resource Allocation	Successful R&D requires strategic planning that aligns innovation goals with the organization's overall objectives. This process entails assessing market needs, competition, and technological trends to determine where to invest resources.
Chesbrough (2003)	Technological Development and Experimentation	This phase involves turning concepts into tangible prototypes and engaging in iterative experimentation. Here, R&D teams explore different technological paths, optimize designs, and address technical challenges.
Monsef & Mohamed (2022)	Collaboration and Knowledge Exchange	Collaboration with internal and external partners is frequently critical to R&D success. Collaboration networks facilitate the interchange of information, experience, and resources, increasing the likelihood of breakthroughs.
Chen & Huang (2019)	Market Launch and Adaptation	The culmination of R&D success lies in bringing innovations to market. This entails refining the product or technology based on user feedback, ensuring regulatory compliance, and orchestrating successful market launches.

Finally, R&D success is a multifaceted achievement reached via a series of interdependent operations. From concept generation and strategic planning through technology development, collaboration, and market launch, each step contributes to the overall achievement of R&D goals.

R & D Performance

R&D and national economic development benefit each other (Zhang et al., 2021). According to Garrido-Prada (2021), Analyzing R&D success is essential for evaluating the amount of public R&D spending. Mitchell et al (2022) identified a relationship between sensemaking and the efficacy of research and development. Despite high industry demand, there are few studies with appropriate R&D performance criteria (Birchall et al., 2011; Dziallas & Blind, 2019; Larsen & Lindquist, 2016). There are numerous approaches to analyses the effects of innovation on R&D performance, depending on the purpose of the study, such as quantitative or qualitative (in terms of citations) patent counting, cost and resource allocation, or external collaboration (e.g. Beers & Zand, 2014; Detzen et al., 2018; Khanna et al., 2016). Return on investment and time to market are two examples (Englund & Ludvigsen, 2015; Kristiansen & Ritala, 2018; Larsen & Lindquist, 2016).

R & D intensity

According to Eom and Lee (2010), R&D intensity has a positive influence on several types of performance depending on the partner. Given that R&D expenditure or intensity may reflect a firm's R&D or even absorptive ability (Kafouros et al., 2020), organizations with strong R&D skills are often projected to achieve higher innovation performance via R&D collaboration (Eom & Lee, 2010; Fernande et al., 2017; Gkypal et al., 2017).

R&D intensity, which is an investment made by top executives, has a strong effect on innovation (Li et al., 2013). As the intensity of R&D increases, specific incentives, threats, deadlines, and competitive pressures reduce staff intrinsic motivation (Ryan et al., 2000). The traditional view of R&D activities is that corporations desire the same level of R&D intensity as their competitors in the same sector (Grabowski & Baxter, 1973). As a result, R&D intensity within the same industry should be consistent (Cincera & Veugelers, 2013). R&D intensity varies among sectors and even within the same industry, for example (Leiponen & Drejer, 2007; Coad, 2019). R&D spending in private companies are much below the acceptable amount (Jones & Williams, 2000; Brown et al., 2017). The high turnover and momentum trading of institutional investors also promotes myopic R&D investment choices (Garel & Petit-Romec, 2021). Second, corporate governance practices and family ownership may discourage high-risk, long-term R&D investments (Chen & Hsu, 2009; Block, 2012). Lin et al. (2012) investigated several perspectives on absorptive capacity and discovered that R&D intensity favourably promotes absorptive capacity innovation performance. According to Stia et al. (2020), increasing R&D intensity leads to increased sales and income. Falk (2012) and Capasso et al. (2015) study the link between R&D investment and employment growth. Both variables exhibit a positive association, indicating that employment growth is connected to R&D intensity. Falk (2012), like Lome et al. (2016), investigates the influence of R&D intensity on revenue growth. When R&D intensity increases, there is a measurable increase in revenue for both parties.

R&D Collaboration

R&D (Research and Development) or technical cooperation is based on inter-organizational collaboration, which refers to the exchange of resources, information, and ideas between independent firms for mutual gain (Hausman et al., 2002). R&D (joint research) collaboration is essential to repair weaknesses in the innovation system and boost innovation qualities such as absorptive ability and invention capacity (Laakso et al., 2012).

Measuring the Results of R&D Cooperation among SMEs

1. The results of R&D cooperation can be measured differently depending on the goals of the collaboration: in the case of technical goal-driven cooperation, the acquisition of proprietary technologies and patents through technological development and the identification of technological opportunities can be counted as realized results (Caloghirou et al., 2021; Jun et al., 2020; Zacharias et al., 2020).
2. Where there are economic goals, results can be measured in terms of various performances, including increased sales from new product development and reduced R&D costs, reduced time to market, increased R&D success, and entry into new markets (Fernandez- Olmos & Ram írez-Aleson, 2017; Greco et al., 2020; Hottenrott & Lopes-Bento 2016; Jun et al., 2020; Salpon & Terlink, 2018; Zacharias et al., 2020).
3. In order to overcome the limitations of patent-based measurement, the results of R&D cooperation among SMEs are frequently measured more broadly based on production or

service innovation, focusing on the market share of new products (Fern'andez-Olmos & Ramrez-Aleson, 2017; Hagedoorn et al., 2018; Jun et al., 2020).

4. Furthermore, SME partners (including R&D partners) should be chosen based on portfolio composition and diversity, as well as collaborative results (Hagedoorn et al., 2018; Sarpong & Teirlinck, 2018).

Determinants of Successful R&D Collaborations

R&D characteristics, technical characteristics, and enterprise characteristics are approximately distributed among these variables. Initially, R&D characteristics are those that emerge throughout the R&D process, and investment, procurement, and cooperative experience are often seen as decisive criteria. The volume (or intensity) of R&D investment, as well as the structure of the partnering organization, are important considerations (Caloffi et al., 2018; Gkypali et al., 2017; Hottenrott & Lopes-Bento, 2016; Kafouros et al., 2020; Markovic et al., 2020; Sarpong & Teirlinck, 2018). Because we must investigate the complexities of R&D collaboration, the proportion of internal or external R&D collaboration is also an important factor determining collaboration performance results (Caloghirou et al., 2021; Hottenrott & Lopes-Bento, 2016; Sarpong & Teirlinck, 2018). Furthermore, the necessity for and effectiveness of public assistance for SMEs' R&D collaboration has been the subject of ongoing research (Caloffi et al., 2018; Jun et al., 2020; Yoo et al., 2018): When it comes to R&D qualities, Furthermore, R&D financial sources and the financing mix are critical factors (Arranz & de Arroyabe, 2008; Greco et al., 2020; Sarpong & Teerlinck, 2018).

R & D Expenditure

R&D investments are critical to increasing firm productivity and, as a consequence, a country's long-term economic development (ÇIFTCI & AKPEROV, 2023). Inadequate startup R&D spending may have a double-edged effect: it may result in the loss of a prospective competitive advantage. If excessive sums are devoted to R&D activities, they may become a financial burden, draining resources and hastening failure (Chen, 2008; Artz et al., 2010; Delmar et al., 2013; Ugur et al., 2016; Grimp et al., 2017). R&D investment is the most common indicator of innovation activity. The accessible percentage of a company's funds for R&D reveals its strategic choices and dedication to innovation (Vithessonthi & Racela, 2016). R&D capital shares are traded on the stock markets of Germany, Italy, and France (Hall & Oriani, 2006). Rahko's study on Finnish firms indicated a significant positive association between R&D and R&D (Rahko, 2014).

According to Lee (2020), R&D investment has a positive time-lag influence on a company's market value. According to Falk (2012) study, sales growth is the outcome of competitive advantages gained via R&D spending. R&D expenditures will be lucrative and cost-effective (Jaisinghani, 2016). Chen et al (2019) identified a negative relationship between R&D spending and current firm performance, but a favorable relationship between R&D spending and future business success. In comparison to other investments, knowledge of new services, goods, or processes is the most important innovation output from R&D efforts.

Most R&D success or productivity evaluations concentrate on inputs such as yearly R&D expenditures and staff, rather than outputs such as awarded patents, new product designs, or completed projects (Cannon & JOHN, 2021). According to studies on the link between R&D investment and patenting activity, patents help organizations improve their knowledge stock (Pegkas et al., 2019). There is an association between expenditure and patenting activity (Glaeser et al., 2020). R&D costs are also associated with the creation of new products (Xin et

al., 2021). Many of these studies have been reprimanded for failing to capture the commercialization process and for failing to predict firm-level outcomes such as increased revenue or profitability (Webb et al., 2021).

R & D Subsidies

Government R&D subsidies will encourage companies to increase their R&D investment. On the one hand, government subsidies may directly increase firm R&D investment, minimize the unpredictability of technological innovation, and compensate for a lack of innovation (Hall, 2002; Kleer, 2010). Government subsidies, on the other hand, may complement corporate R&D investment indirectly, relieve financial strain on R&D enterprises, and reduce the unpredictability of technological innovation.

Another school of thought is that government research and development subsidies will reduce industry R&D investment (Meuleman et al., 2012; Wallsten, 2000). According to Koga (2003), for every one percent decline in tax revenue, government and business R&D and innovation spending increases by 0.68 percent. Government subsidies are linked to R&D investment in the sector. Financial incentives increase the amount of money spent in innovation by firms.

Huang and Sattar (2021) revealed positive and inverted U-shaped relationships between government subsidies and R&D investment, as well as that the marginal benefits of corporate subsidies fade faster for firms with internal structural problems. Cerulli and Pot (2012) used a unique econometric approach to investigate the impact of government subsidies on industry R&D activities. According to the data, government subsidies had a consistent positive impact on the R&D activity index. Increasing government subsidies to state-owned businesses, according to Sun et al (2020), may raise the probability of enterprises participating in R&D activities but will not increase R&D investment; nevertheless, increasing government subsidies to private enterprises may increase R&D investment. Firms have the opportunity to engage in and invest in R&D. Government subsidies, according to Xu et al (2020), do not directly improve innovation performance. Makeeva et al (2019) studied the impact of various fiscal tax exemptions on R&D investment. According to Eng (2021), such activities are funded via two methods: direct assistance (government subsidies) and indirect assistance (tax incentives).

R & D Activities

Research and development activities are even more important for entrepreneurial firms since they play a big role in the introduction of new items and processes (Stam & Wennberg, 2009). Unlike small business owners, entrepreneurs wishing to develop their enterprises must invest in innovation, especially R&D activities (Samuelsson & Davidsson, 2009). Investing in R&D may assist firms in improving core strengths and capitalizing on growth prospects (Liu & Polkinghorne, 2023). Successful R&D activities enable firms to accumulate patents, which may dramatically increase the amount of funds available for early-stage investment (Hoenen et al., 2014). R&D operations help firms create new products, technologies, and processes in order to gain a competitive edge and maintain future growth (Hanaysha et al., 2022). The majority of studies on firms' R&D activities are based on fundamental firm characteristics such as production scale (Kim et al., 2009), profitability (Ciftci & Cready, 2011), cash holdings (Brown & Petersen, 2011; He & Wintoki, 2016), tax breaks (Czarnitzki et al., 2011), government subsidies (Hu & Deng, 2019), and stock price spillover effects (Fung, 2006). Some studies also look at managers' education, personal interests, and gender (Ahn et al., 2017;

Sunder et al., 2017). Similarly, Xie et al (2020) discovered that demographic features such as gender diversity significantly improve Chinese firms' innovation performance. R&D productivity is a valuable indicator for assessing a company's innovation productivity (Song et al., 2015). Those with an R&D background understand the company's R&D efforts and the importance of technological innovation more deeply than those without an R&D experience (Finkelstein, 1992).

R&D Information Disclosure

The motivations for companies to disclose R&D information, according to Zhang Yue & Wu Qifu (2018), are as follows: it becomes more important to the company, and companies become more willing to disclose R&D information; to satisfy regulatory requirements; and to highlight your competitive advantage. Shi Xiaohui & Wu Lei (2013) examined the listed businesses of high-tech firms from 2008 to 2011 and determined that there are still concerns with information disclosure by listed companies: The proportion of R&D information disclosure is low; overall R&D investment is insufficient; and R&D information disclosure is insufficient. The location and name are inconsistent (Huayuan Huang, 2010). According to Wu Xueqing (2014), the following elements may influence the quality of R&D information disclosure:

(1) The quality of information released outside. R&D environment, including industry hazards, trends in industry development, and competitor descriptions;

(2) R&D overview, including project names, R&D goals, government subsidies, R&D funding sources, R&D project competition, and R&D risk descriptions, R&D success possibility statement, R&D failure statement, R&D model, R&D infrastructure, R&D accounting policy;

(3) Ratio, whether R&D expenditures are disclosed, and whether R&D expenses are disclosed in management evaluative information; and

(4) Prospects for future R&D, including R&D investment orientations, R&D strategies and plans.

R&D Investment

Funding for research and development (R&D) lays the groundwork for enhanced local productivity and economic growth. Arik and Ndrianasy (2018) show a relationship between high levels of R&D investment and high GDP, taking into consideration that R&D spending leads to business production. Entrepreneurial firms should, in principle, have an optimum level of R&D spending, but research demonstrates that a range of circumstances cause variances between real R&D investment levels and theoretical ideals. These problems include institutional disputes, ownership, the social and legal atmosphere for R&D underinvestment, R&D investment characteristics and the competitive environment (Ahuja & Novelli, 2017), and R&D overinvestment (Kreß et al., 2017). Furthermore, conflict and poor communication between the management team and the board of directors may jeopardize R&D spending (Kor, 2006). The legal and social environments might have an impact on a company's R&D investment. Private R&D investment and private profits are inadequate in nations with poor intellectual property legislation (Brown et al., 2017). Corruption also reduces business R&D spending owing to rent-seeking behavior in the bureaucracy (Xu & Yano, 2017). Uncertainty, boundary ambiguity, delayed feedback, R&D volatility, and legitimacy are all R&D investment qualities that raise the chance of overinvestment (Ahuja & Novell, 2017). Based on the conversation, Table 3 illustrates the parameters along which R&D performance is assessed.

Table 3
Dimensions of R&D Success Measurement

Dimensions of R&D success measurement			
Quantitative		Qualitative	
Hall et al. (2014), Smith et al. (2018)	Quantitative metrics include patent-based metrics such as number of patents granted, patent citations, and patent quality, which provide insight into the innovation output and impact of R&D efforts	Lavie et al. (2010)	Qualitative aspects such as knowledge creation, collaborative networks, and the development of an innovative organizational culture play a crucial role in R&D success by fostering long-term innovation capabilities and sustainability
Chen & Huang (2019)	Financial performance metrics such as R&D ROI and new product revenue provide valuable insight into the economic impact and market viability of R&D projects	Lavie et al. (2010)	Knowledge Creation: R&D contributes to the generation of new knowledge, enhancing an organization's intellectual capital.
European Commission (2001)	Technology Readiness Level (TRL): Assigning a TRL to R&D projects quantitatively gauges their advancement toward practical application.	Dodgson et al. (2008)	Innovative Culture: An organizational culture that encourages experimentation, risk-taking, and learning fosters R&D success.
Lavie et al. (2010)	Knowledge Creation Metrics: Quantitative measures of new knowledge generated through R&D activities, such as research publications, patents, and prototypes.	Christofi et al. (2019)	Interdisciplinary Collaboration: Collaboration across many disciplines is typically required for successful R&D activities, allowing for the cross-fertilization of ideas and breakthrough inventions.
Broekel (2019)	Collaboration Metrics: Counting the number and quality of collaborative ties formed as a result of R&D initiatives.	Tidd & Bessant (2013)	Adaptability: R&D success lies in an organization's ability to adapt to changing market dynamics, technological shifts, and evolving customer needs.
Lavie et al. (2010)	Training Investments: Measuring the resources invested in training and development of R&D personnel, indicating the organization's commitment to knowledge enhancement.	Owen et al. (2013)	Ethical Considerations: Responsible R&D integrates ethical considerations, ensuring that innovation aligns with societal values and norms.
Tidd & Bessant (2013)	Technological Impact: Quantifying the impact of R&D outcomes on the advancement of technological capabilities and industry standards.	Dodgson et al. (2008)	Cultural Transformation: R&D success involves cultivating a culture of innovation and open-mindedness, promoting a willingness to challenge the status quo.
Dodgson et al. (2008)	Risk Assessment Metrics: Measuring the accuracy of risk assessments and	Chesbrough (2003)	Open Innovation: Successful R&D embraces open innovation practices, engaging external

	successful mitigation of risks during the R&D process.		partners and stakeholders to tap into diverse knowledge sources.
Tidd & Bessant（2013）	Customer Satisfaction Metrics: Quantitative assessments of customer feedback and satisfaction levels with new products resulting from R&D.	Molas-Gallart et al.（2002）	Social Impact: R&D success leads to technologies that address societal challenges, contributing to social welfare and sustainable development.
Fussler & James（1996）	Environmental Metrics: Quantifying the environmental benefits or sustainability improvements resulting from R&D-driven innovations.	Tidd & Bessant（2013）	Technological Impact: R&D efforts that result in technological advancements and breakthroughs reflect successful innovation.
Archibugi & Coco（2004）	Economic Impact: Quantifying the contribution of R&D to economic growth through indicators such as GDP growth, job creation, and increased productivity.	Tidd & Bessant（2013）	Customer-Centric Approach: R&D success is evident when innovations align with customer preferences, needs, and pain points.

Methodology

This paper's primary research approach is a review of the literature. A vast quantity of relevant literature on the issue of R&D success was gathered, and then a full introduction and explanation of it was created by reading, analyzing, summarizing, and sorting out other researchers' material on R&D success. We chose papers to base our research on in a multi-step process. First, Measure Of R&D Success key terms were extensively reviewed and downloaded from databases (i) Scopus (ii) Googe Scholar (iii) Sci-hub. For the first time, Google Scholar retrieved 2,400,000 articles. 18,100 papers from 2019 to 2023. Excluding citations and excluding patents, there are a total of 16,300 papers. Scopus found 2260 documents for the first time in terms of article titles, abstracts, and keywords. Articles, English, final journal draft, 496 remaining papers from 2019 to 2023. Downloaded 193 papers via Google Scholar and Sci-hub, removing duplicate articles, PhD theses, books, and other languages throughout the download process. Throughout the reading process, 135 articles were deleted because they were found to be unhelpful to the paper through reading the abstracts and findings. As a result, only 58 articles provided enough material to write a dissertation.

Findings

The performance of research and development is intrinsically tied to innovation and technological advancement, making it a top commercial and economic concern. The output of innovation is a critical component of R&D success and is often monitored using patent-related metrics. The number of patents has traditionally been used to gauge innovation (Coluccia et al., 2020). The creation and transmission of knowledge is another critical component of good R&D. R&D activities encourage learning, skill development, and the generation of new knowledge. Collaborative research efforts, academic links, and open innovation approaches all contribute to knowledge accumulation both inside and outside of the company. Sedita and Grandinetti (2023) underline the importance of corporations using

external information via R&D initiatives. To measure knowledge creation, quantitative metrics (such as the number of co-authored articles) and qualitative indicators (such as case studies and expert views) are utilized.

To summaries, measuring R&D success is a tough undertaking that requires the evaluation of multiple elements as well as the use of a mix of quantitative and qualitative assessment methodologies. Patent and innovation production, technological development, knowledge creation, and economic effect are key markers of R&D success. By integrating several evaluation methodologies, organizations and governments may acquire a complete picture of the effect and efficacy of their R&D activities.

Conclusions

To summaries, correctly analyzing R&D success requires a well-balanced method that incorporates both quantitative and qualitative indications. This necessitates acknowledging that R&D results are more than simply patents and monetary incentives. Other significant factors for R&D success include the formation of collaborative networks, absorptive ability, and a creative business culture. As a result, businesses and governments should assess a broad collection of metrics that reflect the overall R&D output. In conclusion, successful R&D necessitates an understanding of the multidimensional nature of innovation outcomes as well as the use of various indicators such as technological progress, financial returns, knowledge production, and overall impact on organizational competitiveness and social progress. Future research avenues One intriguing area will be how emerging technologies like as artificial intelligence and blockchain impact R&D processes and results, as well as how businesses may adapt and capitalize on their potential. A more in-depth examination of the influence of cultural and leadership components on fostering a culture of innovation and risk-taking inside organizations may also give vital insights into developing an environment favorable to R&D success.

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