Research Hotspots and Frontiers of Product R&D Management under the Background of the Digital Intelligence Era—Bibliometrics Based on Citespace and Histcite

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Abstract: The rise of “cloud-computing, mobile-Internet, Internet of things, big-data, and smart-data” digital technology has brought a subversive revolution to enterprises and consumers’ traditional patterns. Product research and development has become the main battlefield of enterprise competition, facing an environment where challenges and opportunities coexist. Regarding the concepts and methods of product R&D projects, the domestic start was later than the international ones, and many domestic companies have also used successful foreign cases as benchmarks to innovate their management methods in practice. “Workers must first sharpen their tools if they want to do their jobs well”. This article will start from the relevant concepts of product R&D projects and summarize current R&D management ideas and methods. We combined the bibliometric analysis software Histcite and Citespace to sort out the content of domestic and foreign literature and explore the changing trends of research hotspots. Finally, combined with the analysis of confirmed cases in domestic masters and doctoral dissertations to test the theory, the literature review of the product R&D project management theme was carried out from the dual perspectives of comprehensive theory and practice. This study uses the core collection library of Web of Science as the object of document extraction. Based on the search conditions of “Product development” or “Integrat* product development”, 8998 sample documents were initially retrieved. The search deadline was June 2019, with a time range from 2000 to June 2019. Then, using the record number of 50 as the critical condition, 5007 analysis samples were deleted, refined, and cleaned. Through the review and measurement of 5007 papers, the analysis showed that: (1) in the last ten years, sustainability, consumer focus, new approaches to product development management, and organizational design have become critical considerations in the product development process stage; (2) at this stage, researchers are paying more attention to the innovation, design, product development, identification, simultaneous engineering, consequence, and stage/gate model aspects of product development; and (3) factors such as long development cycles, high costs, and poor organizational design are now common problems in the product development process.

Keywords: digital intelligence era; product R&D management; document metrology; informetrics; scientometrics; Web of Science

1. Introduction

In the context of globalization, the era of the digital economy, marked by digitization, networking, and intelligence, has come. With the acceleration of the iterative speed of the competitive market, the rapid changes in technology, and the transformation of the role of consumers to “value co-creators”, the logic-oriented business model of production has gradually exposed the disadvantages of its disconnect from the market. In the face of
market and technological uncertainty, continuous innovation and in-depth research and development have become important ways for companies to build their core competitive advantages. In the 2019 report "New Economic Species: Practice and Innovation of Chinese Enterprises", released by the China Development Model Research Center of Cheung Kong Graduate School of Business, it mentioned that in "the new era of competition, research and development capabilities are the foundation. Technological advancements such as artificial intelligence and the Internet of Things will test the ability of enterprises to experience innovative products". It can be seen that from R&D to production, sales to service, users to data, and facing the future, companies with collaborative development networks will become development managers of global companies.

Cooper [1] pointed out that new product development is an essential driving factor for gaining competitive advantage in early research. According to statistics [2], in the mid-1980s, new products only represented about 33% of the company's sales and 22% of the profits. However, in modern enterprises, these two indicators' values have increased significantly, reaching 60% and 50%, respectively. Therefore, today's successful companies are often able to continue to launch high-quality new products. For example, Huawei's number of patent authorizations in 2019 ranked first in China. The new products launched during the same period were also well received in the market, which fully reflects Huawei's strong technical research development capabilities and new product development capabilities. With the acceleration of the company's product diversification and market globalization, an increasing number of companies have realized that new product development and management capabilities are essential for companies to enhance their core competitiveness. In a limited time, continued development of new products with better quality, better prices, and more powerful functions are needed to occupy a leading position and dominant advantage in the market [3]. However, due to the corporate product development system's insufficiency, many companies lost 46% of their resources in the process of new product development, and the success rate was less than 15%. Among them, more than 60% of CEOs were dissatisfied with the performance of new product development. This shows that most companies have weak independent R&D capabilities and low R&D efficiency. Therefore, it is particularly urgent to reform the product R&D management system [4].

Product development has become the main battlefield of industrial competition since the 1990s. Since then, domestic and foreign scholars have carried out research on the concepts, goals, processes, organizational structure, and performance evaluation of product development one by one, constantly proposing new management methods, and optimizing theoretical models in combination with practice. In the book "The Power of Pace", the author discussed how to improve R&D performance and forge the core competitiveness of enterprises in the field of product development via the product and cycle-time excellence method (PACE). The idea of integrated product development (IPD) also originated from this. Subsequently, the practice of IBM, which greatly shortened the time to market, improved the efficiency of product development, and increased the profit of the product, has become a recognized high-efficiency product development model. However, few scholars have systematically analyzed and summarized product development project management and have not explored the changing patterns of the theoretical basis and product development direction. Using Histcite and Citespace software, a scientific and predictive tool based on instrumental analysis, it is possible to summarize and predict the topical trends of existing research on product development and future evolution. This paper, therefore, introduces the concepts of product development and project management, and performs a review of research, using bibliometric methods to explore the evolutionary logic of product development and provide suggestions for an optimized path for product development management in companies. Firstly, based on Histcite software, the article provides a statistical overview of research related to product development and explores the changing situation from the formation of product development management to the diversity of product development directions. Secondly, based on the Citespace software, statistics on research themes and hotspots in product development were conducted to
analyze the evolution pattern of research themes. Finally, a practical case study of product development was explored. Through the above research design and analysis, the concepts, methods, evolutionary patterns, and future product development directions will be clearly described. On the one hand, it provides scholars with future research directions for product development in theory. On the other hand, it builds a bridge between theoretical research and enterprise R&D in practice, applying the rich academic research and case studies to actual enterprise R&D, providing new ideas for product development. The specific research ideas are shown in Figure 1.

Figure 1. Research idea map.

2. Research Review

2.1. Research and Development of New Products and New Products

New products can be divided into three categories according to the innovation process: brand-new new products, improved new products, and renewal new products. The development method can be divided into new products of technology introduction, independent development of new products, and mixed development of products [5]. New product development refers to the whole process of a series of activities from conception, development, and production to the sale of new products [6]. Its goal is to seize market opportunities and transform technical assumptions about products into products that consumers need [7]. Among them, the product idea is a marketing-oriented idea based on the market environment and consumer demand. Development refers to transforming product ideas and concepts into physical forms; that is, product prototypes, through technology, and the product prototypes which then evolve into final products after repeated use, evaluation, and testing. In the end, the marketing department combined with the testing of relevant market elements to launch. Therefore, the development of new products is an intricate system of engineering, which puts forward higher requirements for allocating corporate resources, including human, financial, and material [8]. In the process of new product development, open innovation is an essential model for companies looking to develop their technology and extend the innovative power of their products. Open innovation opens up a company’s traditionally closed innovation model to bring in external innovation capabilities [9]. Under open innovation, companies can borrow external research capabilities in the same way as they use internal research capabilities to develop new
products or use their internal and external channels to expand their innovative approach to the market jointly. In the era of digital intelligence, it has become difficult for companies to adapt to the rapidly evolving market demands and the increasingly fierce corporate competition by relying solely on internal resources for costly innovation activities [10]. In this context, “open innovation” is becoming the dominant mode of corporate innovation. The concept states that companies should elevate external ideas and external marketable channels to the same level of importance as internal ideas and internal marketable channels in a closed innovation model. The balanced coordination of internal and external resources for innovation not only focuses on the traditional product business, but also actively seeks external business models such as joint ventures, technology licensing, outsourced research, technology partnerships, strategic alliances, or venture capital to turn innovative ideas into natural products and profits as quickly as possible [11]. Indeed, open innovation is at the center of corporate R&D and is at the heart of all connectivity and development movements. It effectively brings in various resources and internalizes the flow of external factors. As a result of this conceptual model, external design thinking and design-driven technologies are being incorporated into the R&D innovation system, and it can be said that open innovation has given rise to a greater flow of innovation factors. Tranfield [12] points out that traditional narrative reviews lack thoroughness and, in many cases, are not conducted as an actual science of inquiry, hence the need to develop methodologies for evidence-based management knowledge through systematic evaluation. An analysis of 187 articles by Magistretti [13] highlighted process, organization, and knowledge as the three key dimensions that influence the development of new technologies.

2.2. New Product Development Process

Product development is a process. PACE divides the product development process into seven related elements: decision-making, project team composition, the structure of development activities, development tools and technologies, strategic product processes, technology management, and pipeline management [3]. New product decisions are made through a staged review process. In many decisions, opportunities suitable for enterprise development are identified and the review process is used to make decisions, allocate resources, and authorize small groups of projects to develop products in stages [4]. The formation of a core team is an effective way to resolve uncertainties and fluctuations in product development, by integrating cross-departmental project teams to develop specific products and achieve horizontal and vertical communication and coordination. The structured definition of R&D activities constructs activity dimensions through four levels of phases, steps, tasks, and activities. The product development strategy is mainly divided into leading, imitation, cost minimization, and market segmentation. A clear product strategic vision can answer three questions concerning the company’s goals, how to achieve them, and why they succeeded. Pipeline management, also known as funnel management, refers to balancing the required resources during the research and development process [6].

With the upgrading of technology, the entire process of product development has undergone several changes. From the perspective of technical capabilities, product R&D management has gone through the stage of quality control-imitation innovation-independent innovation. Through the technical testing center, it is necessary to establish a complete quality inspection program, develop into shape and function design, and then evolve into a product research and development project dominated by high-quality research and development personnel [8]. Starting with the focus on research and development, Rogers divided it into five stages: the technology center, the project center, the enterprise resource center, the user center, and the knowledge center. The management ability perspective is divided into five levels internationally, namely informal management, excellent functions, excellent projects, excellent product portfolio, and excellent industrial value chain. The initial product R&D management showed the characteristics of non-standard time based on personal experience and gradually developed into a project with clear functions and
cross-functional operations [14]. It was then developed to use the leverage of the platform to carry out portfolio management and, finally, achieve cross-enterprise value chain innovation. It is evident that, with the current ever-changing, complex environment, the process of enterprise product research and development is no longer an “alone fight” under the traditional business model, but instead a cross-departmental, cross-organizational, and full-process product research and development process.

2.3. New Product Research and Development Management Methods and Thoughts Combing

2.3.1. Agile Development Philosophy

The core idea of agile development is short-term gradual delivery and team, cross-departmental, and cross-functional cooperation. Agile development divides the R&D process into multiple iterative small cycles, adjusting to problems and emergencies after each cycle, and adjusting the next cycle’s direction and tasks until the product development is completed. The agile development method’s advantage is that it allows for the obtainment of the latest and most accurate customer needs through timely communication with customers. It also reduces deviations and saves on costs in the rapid development process. It is an effective method to effectively shorten the product development and delivery cycle [14].

2.3.2. Lean Production Concept

Lean production (LP) is a concept where “precise” refers to precision, sophisticated, and exquisite; and “benefit” refers to efficiency and interest. The core of the lean production concept is “0” inventory and “0” defects. In the enterprise’s production process, LP eliminates faults and waste as much as possible and realizes timely manufacturing. At present, most companies have increased the cost of new product development, but the output efficiency cannot be improved. Therefore, scholars use lean management to reduce product development costs. Through early lean management, clearly defining waste issues in the development process and coordinating various departments’ resource support, the whole process management of new product development costs can be realized [15].

2.3.3. SGS Doorway Management System

The stage-gate system (SGS), also known as the quality gate, refers to the setting up of gates in every link of the new product development process. After the task at the upper level is completed, the level will be checked, and it can enter the following link if it passes. Generally, the new product development stage is divided into conception, development, testing and modification, final product release, and launching onto the market. These links have a strict sequence. The SGS portal management system emphasizes the need for multi-departmental collaboration at each stage. Therefore, this method’s advantage is that inspecting each step in the process can ensure that the R&D project is proceeding in the right direction and that problems and changes can be corrected in time. However, due to its strict sequential logic in the actual operation process, it has a specific impact on new product development speed. Automobile manufacturing companies, for example, use the method [16].

2.3.4. Product Value Management Model

Product value management (PVM) evolved based on the idea of the SGS. The core connotation is “find the right thing”, “find the right way”, and “do the right thing correctly”. PVM inherits the process control and decision-making review of the R&D link in SGS and recognizes the role of cross-departmental and cross-functional team collaboration. PVM pays more attention to the analysis of profitability and cost value, and emphasizes that, through the organic combination of demand, concept, and marketing, the value of corporate resources can be fully utilized to shape the company’s business advantages and form core competitiveness [17].
2.3.5. Product and Cycle Optimization Method

The core idea of product and cycle-time excellence (PACE), introduced above, is that it is decision-driven. The practice has proved that this method can effectively shorten the product development cycle by 40–60%, increase product productivity by 25–80%, and reduce time waste by 50–80%.

2.3.6. Integrated Product Development Method

- Concept and characteristics

Integrated product development (IPD) is a set of leading and mature product development management ideas, models, and methods. It is the integration of all processes related to product development. IPD regards product development as an investment activity, conducts a portfolio analysis, and decides whether to continue the next stage according to the review results throughout the process. Different from other methods, IPD is a market-oriented product research and development system. It requires that the entire product research and development innovation process be based on consumer demand and the monitoring of market competition changes during the research and development process. In terms of technology management, IPD emphasizes the platform’s role and implements an asynchronous R&D strategy through public modules, which distinguishes technology R&D from product R&D, and emphasizes cross-departmental collaboration. To solve the shortcomings of other methods, IPD proposes a structured parallel R&D process to improve organizational capabilities and the development of specialized and compound human resources [18].

- Key factors affecting the implementation of IPD

Foreign scholars have proposed that the successful implementation of IPD will be affected by corporate brand positioning and goal setting, the understanding of customer needs, contact with suppliers, and the level of procurement and project management [19]. Domestic scholars have also identified seven types of key factors through factor analysis methods, namely: corporate executives’ support for IPD, knowledge sharing, corporate strategic planning, project management, IPD project team integration, communication, and collaboration, and other factors [20]. It is clear that the above conclusions are closely related to the definition of IPD. Based on these critical factors, an optimization plan for the IPD process can be proposed. However, there is still a lack of empirical research on the relationship between the various factors and the action mechanism in current academic circles.

- Similarities with the agile concept

The concept of IPD and the concept of agile development are the same. For example, with market demand as the core, product development is regarded as an investment (user value), and products can be launched accurately (commercial value), quickly, at low cost, and with high quality through basic public modules and cross-departmental teams. There is multi-team participation and decision-making at each review point, through various technical improvements to improve product development efficiency and reduce waste, and continuous delivery. It can be used to customize the process to adapt to the corresponding team size and further product development. The specific research classification is shown in Table 1.
### Table 1. Horizontal comparison of research theories and methods.

| Theoretical Foundations of Research | Research Methodology |
|------------------------------------|----------------------|
| Research and development of new products and new products | SLR [12] |
| New product development process | [3,4,6,8,14] |
| New product research and development management methods and thoughts combing | [14–20] |

This paper builds on the theory to structure the entire article. By combing through the literature on new products, new product development, the process of new product development management, and the ideas of new product development management, the paper uses the Histcite and Citespace tools to summarise and organise research hotspots and methods, and to discover the patterns of change in the historical process of product development.

The SLR literature analysis method is suitable for research areas where the structure of the field is well defined and where there are no conflicting parts. The research on product development hotspots in the digital intelligence era is relatively new, and Histcite is more effective for rapid access to unfamiliar areas and achieving universal literature analysis. Supported by scientometrics and data visualization, Citespace can complement Histcite’s historical presentation capabilities.

### 3. Research Methodology

Bibliometrics is a cross-cutting science that uses mathematical and statistical methods to analyze all carriers of knowledge quantitatively. It is a vast body of knowledge that integrates mathematics, statistics, and documentation focusing on quantification. The measurement objects are mainly: the number of documents (various publications, significant journal articles, and citations), the number of authors (individual collectives or groups), the number of vocabulary terms (various document identifiers, most of which are synonyms), and bibliometrics, the essential feature is that its output is quantity. Many documentation issues are still challenging to quantify because of the human factors that affect the flow of literature and intelligence. In particular, due to the high degree of complexity and instability of the documentation system, it is impossible to obtain sufficient and valid information to reveal the macroscopic patterns of the literature. The development of bibliometrics is dependent on the support of mathematical tools and statistical techniques, and the transplantation or use of more effective mathematical tools and statistical methods will be an essential part of its development.

The hotspots and frontiers of research on product development and management in the context of the digital intelligence era contain a large number of research directions, concepts, and connotations (as seen in the previous section), so the grasp of the knowledge structure and literature level of this hotspot is more dependent on the “quantity” and “quality” of the literature. In terms of mainstream methods, Tranfield (2003) [12] proposed the SLR (systematic literature review) approach to literary analysis, which is a systematic literature regression. SLR better explains research structure in a given field and allows for the analysis of the critical literature in reconfiguration, transformation, integration, (short-term) collaboration, maintenance, perception, capture, and knowledge acquisition in the research system. The strength of the SLR approach is that it identifies key scientific contributions, and provides scholars and practitioners with a basis for understanding the current state of the subject matter in question and taking the proper steps for future action. It is a replicable, transparent, and auditable approach. In research, SLR follows a formal process: (1) formulation of the research question; (2) positioning of the study; (3) identification of selection and evaluation criteria; (4) data analysis and synthesis; and (5) reporting and discussion of the results (Denyer and Tranfield) [12]. The SLR analysis method is implemented based on LR grammar, requiring that every LR (0) grammar item contain a conflicting item, which is a demanding condition. For most programming languages, the conditions of LR(0) grammar are generally not met. In order to perform a deterministic analysis of language sentences, conflict resolution is required. Conflicts can be resolved by looking forward one input symbol for the set of items containing conflicts, an analysis known as simple LR analysis, or SLR(1) analysis. The operating mechanism of the specific algorithm is shown in Figure 2.
clarify the strong and weak connections between the stratified studies.

ships between the dependent and independent variables in the research literature and corroborate the stratified views and construct integrated models to reveal the relationships between the dependent and independent variables in the research literature and clarify the strong and weak connections between the stratified studies.

The literature related to product development management research hotspots in the digital intelligence age is significant, without prior synthesis and comparative evidence, and lacks a specific focus and essential research questions. In the absence of valid inclusion thresholds and exclusion criteria, this research topic also does not fail to explain internal levels of relevance using textual evidence, making the applicability of SLR relatively low. The study of product development hotspots in the digital intelligence age is relatively new and Histcite is more effective for literature analysis that quickly enters unfamiliar territory and achieves generalizability. As mapping analysis allows a direct graphical representation of the relationships between different literature in a field, it can quickly help with mapping the history of a field, and locate the critical literature in the field and the most recent literature of importance. Supported by scientometrics and data visualization, Citespace can complement Histcite’s historical presentation capabilities to further present the structure, patterns, and distribution of scientific knowledge in this field. In summary, the SLR approach is suitable for the re-exploration of mature fields and validating specific hypotheses, evidence, and integrated models. However, it cannot capture historical literature and knowledge structures, which requires self-familiarity and learning by scholars. The combination of Citespace and Histcite, on the other hand, allows for the precise reproduction of the knowledge map without these limitations.

4. Quantitative Analysis of Related Literature on Product R&D Management

The Web of Science (WoS) is recognized as a highly authoritative and influential journal library in the academic world, with a core database including more than 10,000 well-known academic journals in more than 10,000 fields. Thus, for this paper, we selected the Scientific Citation Index and Social Sciences Citation Index databases in the WOS core database as our data source. The literature period selected covered 1 January 2000 to 30 June 2019. This period was chosen as the initial search found that the earliest literature was published in 2000, and no research papers in this area existed before 2000. In addition, 20 years was considered to constitute a complete research cycle, and so the search was conducted up to 2019.

To explore the research of product R&D management and review the research literature of the IPD management method, this paper chose to use Title = “Product development”
or “Integrated* product development” as search criteria. This meant that documents with “product development” or “integrated product development” in the document’s title would appear in the search results. Considering the various expressions of “integration” in English, we used “Integrate*” in the search conditions, wherein the symbol * meant that “Integrated”, “Integration”, and other related forms would appear in the search results. The first search resulted in 8998 articles. After that, the “article” type of literature was screened out, and the Web of Science categories with records more significant than 50 was further refined, including, for example, management, business, and engineering, and, combined with Citespace’s literature cleaning function, the literature on unrelated topics under this search catalog were eliminated resulting in 5007 papers. For example, scientific and technical papers with titles containing R&D that dealt with a specific kind of molecule or process technology, which was not in line with the purpose of this social sciences study, and papers with low or no relevance to the digital intelligence era were eliminated. As shown in Figure 3, in the past 20 years the academic community has continued to pay attention to the field of product research and development, and the popularity has increased, which is consistent with the development trend of enterprises paying increased attention to new product development in practice. In the nearly ten years since 2011, the number of annual publications has remained above 200.

![Figure 3](image)

**Figure 3.** Trends in the number of literature publications in the past 20 years from 2000 to 2019.

4.1. Research Citation Analysis Based on Histcite

Histcite (history of cite) is a citation map analysis software developed by SCI founder Garfield. It can visualize the citation relationship between many documents in a particular field, locate important documents in this field, and find the history of document development. In this study, we imported 5007 documents into this software and came to the following conclusions:

4.1.1. Before 2010

In the first analysis, all 5007 documents before 2020 were imported, and Histcite used the LCS (local citation score) to draw a citation analysis map for the top 30 documents, as shown in Figure 4. Considering the limitations of the software on the year and the number of documents, and the longer the documents are cited, the more complete the literature citation relationship between 1986 and 2005 is finally presented.
4.1.1. Before 2010

In the first analysis, all 5007 documents before 2020 were imported, and Histcite used the LCS (local citation score) to draw a citation analysis map for the top 30 documents, as shown in Figure 4. Considering the limitations of the software on the year and the number of search results during this period, Brown and Eisenhardt reviewed it from three aspects: the product development plan, communication network, and solving critical problems [24]. Later, scholars found that integrating different departments improved product development performance in practice and defined product development performance based on this [25]. In further research, Madhavan and Grover found that trust in technical capabilities, information richness, and effective interpersonal communication in the product development process could ensure sufficient knowledge creation capabilities. Moreover, this was also the key driving force of product development, and the authors regarded the process of product development as knowledge management in terms of knowledge embedding and knowledge performance [26].

By analyzing the literature during this period, we found that, in the enlightenment and early stages of product R&D management research, academic research aimed to analyze the success and failure cases of product R&D management. Then, it focused on defining related concepts, looking for influencing factors, and refining theoretical models and frameworks:

- **Case analysis.** During this period, because the related theories of product development were still in the exploratory stage, scholars mainly summarized the success and failure cases. Leonardbarton found a paradox between core competence and strict standards in new product development management [21]. Griffin and Page directly evaluated the success and failure of the product development process and recognized that there was no single measurement standard that could measure every product development project [22]. Therefore, after three years, Griffin assumed that the most appropriate set of measurement standards depended on the project and business strategy and design experiments to verify it [23].

- **Concept and model.** Takeuchi and Nonaka pointed out in the “Harvard Business Review” that new product development is the “new game” that companies will face. Since then, related research in academia has gradually increased. Regarding the research results during this period, Brown and Eisenhardt reviewed it from three aspects: the product development plan, communication network, and solving critical problems [24]. Later, scholars found that integrating different departments improved product development performance in practice and defined product development performance based on this [25]. In further research, Madhavan and Grover found that trust in technical capabilities, information richness, and effective interpersonal communication in the product development process could ensure sufficient knowledge creation capabilities. Moreover, this was also the key driving force of product development, and the authors regarded the process of product development as knowledge management in terms of knowledge embedding and knowledge performance [26]. After more than ten years of research, with the success of the IPD method in IBM, Gerwin and Barrowman conducted an integrated evaluation of the related literature, which provided a theoretical basis for later scholars to study IPD optimization and application [27]. Based on theory and practice, some scholars established models and summarized frameworks to provide theoretical support for subsequent empirical research. Eppinger et al. built a model for the organization of tasks in the product development project [22]. Therefore, after three years, Griffin assumed that the most appropriate set of measurement standards depended on the project and business strategy and design experiments to verify it [23].

**Figure 4.** Citation map of the top 30 documents ranked by LCS from 1986 to 2020.
development process [28]. Since there are repeated activities in parallel development, Krishnan et al. built a framework for the management of these repeated activities to reduce time waste and cost loss [29].

- **Influencing factors.** The marketing department gradually joined the product development process and even led to the development of new products, which was usually facilitated through organization and coordination. Nevertheless, Olson et al. questioned whether cross-departmental teams applied to all types of projects. The author proposed a contingency model based on resource dependence theory and believed that a cross-functional team was more likely to improve development effectiveness when the developed product was entirely innovative. For R&D projects with a low degree of innovation, a relatively bureaucratic structure would achieve better results [30]. Crawford first pointed out the hidden costs in the process [31]. Griffin proposed a measurement method for the product development cycle [32]. Subsequently, Cooper and Kleinschmidt launched a study on the decisive factors of time loss [33]. Four years later, Griffin found, based on previous research, that cross-functional teams played a huge role in shortening the product development cycle, and that the implementation of meticulous and rigorous processes in companies that develop complex products had a more significant impact on shortening time [34].

- **Focus on supplier integration.** Compared with other stakeholders in the early stages of product development, scholars paid more attention to issues related to suppliers. Handfield et al. proposed that when supplier integration was driven by a process that comprehensively considered supplier capabilities, technical complexity, and risk level, then supplier participation in the strategy could be successful [35]. Ragatz et al. found that in the case of technical uncertainty, incorporating supplier integration into the R&D process as soon as possible could reduce costs and improve efficiency [36]. Subsequently, Petersen et al. empirically found that the increase in supplier knowledge was more likely to lead to a greater degree of information sharing and participation behavior. Technology sharing behavior makes it more able to improve results, thereby alleviating the problems caused by technological uncertainty [37]. Two years later, Petersen et al. once again improved the previous conclusions and examined the relationship between supplier participation in financial performance and product development performance improvement, and comprehensively confirmed the significance of supplier integration for new product development [38].

### 4.1.2. Nearly 10 Years from 2011 to 2020

Compared to the citation analysis mapping in Figure 4 for the years before 2011, it is evident that the research of the past ten years has not formed a systematic mutual citation relationship, which is closely related to the new characteristics of product R&D management in recent years and the increasing diversification of product R&D management methods. Due to the increasing number of problems to be solved and the increasing diversity of research scenarios, scholars’ research has also shown different clustering distributions. Moreover, considering the reasons of time, many theories were still under development, and, when proposing new concepts and viewpoints, the referenced documents were often traced back to the early stages of the research, starting from the original phenomenon to explore the essence of the new problem. Therefore, most of the citations are still relatively early and authoritative documents, and thus the citation network is not systematic enough.

According to the citation analysis in the past ten years, shown in Figure 5, we can identify the current topics of interest in the academic world and research progress based on the selected LCS top 30 documents.
4.2. Analysis of the Evolution of Research Hotspots Based on Citespace

As a bibliometric analysis software, the most significant difference between Citespace and Histcite is that Citespace uses algorithms to perform clustering by extracting the title, abstract, and keywords of the literature to realize the "review" of a particular field through the system. In addition to using clustering to find hotspots, we can also use the "emerging words" function to capture academic frontiers. Citespace can display the cooperative relationship between the literature through the visual operation of the authors' contribution network and literature institutions to help us find the authoritative experts and institutions in the field. To analyze the 5007 literature data sets searched above, we imported them into Citespace software, and the results were as follows:

4.2.1. Cluster Analysis of Research Topics

It can be seen from Figure 6 that Citespace extracted the clustering of subject terms in all documents. The top seven terms were innovation, design, product development, identification, concurrent engineering, results, and stage-gate models. The sizes of the clusters are explicitly shown in Table 2. That is, the number of related keywords involved in each clustering topic, the average cluster contour value (Silhouette, $S > 0.5$ clustering is reasonable, $S > 0.7$ clustering is convincing), and the average year of the literature.

- Sustainable development. As the industry’s green transformation has become a general trend, integrating green concepts into the product development process to continuously provide society with green products and solutions is one topic that scholars have been paying attention to over the last decade. Lee and Kim pointed out that green innovation is a critical factor in achieving a win-win situation between the environment and the economy, and achieving green product innovation and development through supplier participation is a strategy that enterprises should give priority to [39]. Through the analysis of eight cases, Driessen et al. pointed out that the greenness of products played a pivotal role in realizing the green transformation of the industry [40]. Through empirical research on the determinants of green product R&D performance, Chen and Chang found that green dynamic capabilities, green transformation leadership, and green creativity could significantly improve product R&D performance [41]. Subsequently, Gmelin and Seuring built a new product development framework for sustainable development based on the life cycle theory and proposed to support the cooperation among them by reducing complexity, coordinating processes and technologies [42]. For integrated product development that considers environmental factors, Poulikidou et al. conducted interviews with a sample of Swedish manufacturing companies and found that they still needed to consider the system integration of environmental requirements in product development decisions [43]. In the second year, Jabour et al. inspected the green product R&D and performance of Brazilian companies and studied the acceptance of green product R&D (GPD) by technology and organizations. The authors proved that the degree of technology adoption can effectively promote GPD, but that the degree of organizational adoption was affected by uncertainty, and management needed to control the uncertainty to enhance the effect of organizational adoption of GPD [44].

- Pay attention to consumers. Compared with previous studies, scholars are primarily concerned with the impact of supplier participation on product development. In the Web2.0 era, with consumer identity transformation, consumer participation began...
to play an essential role in the value chain. Scholars also paid attention to this point and carried out research on the subject. Chan and Ip looked at the gradual evolution of product research and the development of market-oriented logic, and found that the relationship between these changes and consumer purchase decisions did not receive attention. Therefore, the authors built a dynamic decision support system (DSS) to predict consumer behavior and define consumer value from the perspective of the life cycle of given products, consumers, and market influencing factors [45]. Djerassi and Decoopman studied how consumer participation played a role in product development in a crowdsourcing scenario [46]. Chang and Taylor proposed a conceptual framework that integrated various accidental factors based on the original analysis method and knowledge management theory. In the conception stage of new product development, customer participation can speed up the time to market and improve financial performance. On the contrary, that is not the case in the development phase. In technologically turbulent new product development projects, emerging countries, low-tech industries, corporate customers, and small companies, the incorporation of customer participation has more significant benefits for new product development performance. On this basis, Cui and Wu further subdivided the types of consumer participation into information resource function (CIS) and co-developer function (CIC). The results showed that, when companies adopted more experimental R&D methods, CIS was more advantageous, and when the R&D process was less experimental, the CIC effect was more substantial, which has important guiding significance for integrating consumer participation in corporate practices.

• New methods of product research and development management. (1) Collaborative product development (CPD). Buyukozkan and Arsenyan conducted a systematic review of CPD and summarized its dynamic development, partnership formation, and infrastructure [47]. They pointed out that trust was the basis of collaborative innovation, discussed the role of trust in selecting new product development suppliers and organizational innovation, and found that business trust was the key to cooperative dependency. However, excessive reliance on trust can lead to incremental innovation, which hinders the organization’s ability to innovate radically [48]. Based on the theory of organizational information, the author examined whether the relationship between the use of IT tools in collaborative product development and the performance of new product development would be affected by the project’s complexity. Three dimensions, namely, product scale, project novelty, and task dependence, verified this hypothesis. (2) Lean product development (LPD). Khan et al. started from a case study of Toyota, Japan, and, through a survey of five companies, found that, although some technologies were used, they were not formally implemented in the organization, and so the authors attempted to define LPD for the first time [49]. Subsequently, Johansson and Sundin further differentiated the concept of LPD by comparing the concepts of LPD and GPD [50]. (3) Agile product development (APD). With the increasing complexity of product development in manufacturing companies, the traditional portal model has exposed its limitations. Thus, Sommer et al. proposed the agile/stage-gate hybrids model and verified it by comparing the cases of seven technology-intensive companies [51]. Subsequently, Cooper, who regarded this as the next development stage of product research and development, demonstrated how to use the model through two large companies [52]. (4) Integrated product development (IPD). Rauner and Rawski explored the impact of the IPD parallel environment on the front-end organizational structure and team structure, and verified the IPD method’s significance through data from the U.S. automotive industry [53].

• Organizational design. Regarding the driving factors of new product R&D performance, most of the literature is considered from the enterprise/team level, and few scholars pay attention to the role of individual ability in the team. The results showed that personal social ability is a crucial factor, among which learning ability is an inter-
mediary and moderating variable, and technical ability and market knowledge are moderating variables of personal social ability and new product performance [54].

• Others. Moreover, we found that there were some other topics of research, such as Acura et al.’s analysis of the role of strategic alignment, which concluded that strategic planning and innovation can have a positive effect on the consistency of technology, market, and product development [55]. Chen et al. conducted an in-depth discussion on the relationship between product development speed and success from the uneconomic time compression, focusing on defining the meaning of product development speed under different uncertain conditions. Finally, an analysis of the source and degree of project uncertainty and the consideration of the team absorptive capacity and customer absorptive capacity to plan the product development time was proposed [56].

4.2. Analysis of the Evolution of Research Hotspots Based on Citespace

As a bibliometric analysis software, the most significant difference between Citespace and Histcite is that Citespace uses algorithms to perform clustering by extracting the title, abstract, and keywords of the literature to realize the “review” of a particular field through the system. In addition to using clustering to find hotspots, we can also use the “emerging words” function to capture academic frontiers. Citespace can display the cooperative relationship between the literature through the visual operation of the authors’ contribution network and literature institutions to help us find the authoritative experts and institutions in the field. To analyze the 5007 literature data sets searched above, we imported them into Citespace software, and the results were as follows.

4.2.1. Cluster Analysis of Research Topics

It can be seen from Figure 6 that Citespace extracted the clustering of subject terms in all documents. The top seven terms were innovation, design, product development, identification, concurrent engineering, results, and stage-gate models. The sizes of the clusters are explicitly shown in Table 2. That is, the number of related keywords involved in each clustering topic, the average cluster contour value (Silhouette, S > 0.5 clustering is reasonable, S > 0.7 clustering is convincing), and the average year of the literature.

| Cluster ID | Size | Silhouette | Mean (Year) | Label (LLR) |
|------------|------|------------|-------------|-------------|
| 0          | 65   | 0.594      | 2002        | Innovation  |
| 1          | 54   | 0.529      | 2003        | Design      |
| 2          | 46   | 0.568      | 2004        | Product development |
| 3          | 42   | 0.891      | 2005        | Identification |
| 4          | 20   | 0.724      | 1999        | Simultaneous engineering |
| 5          | 12   | 0.808      | 1998        | Consequence |
| 6          | 9    | 0.869      | 1997        | Stage/gate model |

Product development management is a process that covers the entire life cycle of a new product from the perspective of different links, such as the generation of new product ideas, conceptual ideas, product design, and product development. “Innovation” is an essential driving force for new product ideas, and “design” is the development of new product concepts from different departments, such as the marketing, technology development, and supply departments. In the development process, models such as “stage gates” are used to optimize the process, and, through the evaluation of the “result” performance, the risks in product development management and the inducements that lead to failure are constantly “identified”. According to different era characteristics, scholars conducted research on all aspects of product development management, exploring successful experiences, summa-
rizing theoretical frameworks, and forming more universal rules to guide more companies to improve new product development performance in practice.

![Literature keyword cluster map.](image)

Figure 6. Literature keyword cluster map.

4.2.2. Research Hotspot Analysis

Burst detection is used to find keywords whose data volume in a specific period is significantly abnormal compared to other periods. The frequency of keyword occurrences suddenly increases rapidly, which shows that the relevant topic has hit the academic field’s key points and is a current research hotspot. Figure 7 shows the emergent words in all research areas of product development.

![Results of sudden detection of documents.](image)

Figure 7. Results of sudden detection of documents.
As can be seen from Figure 7, the focus of scholars has gradually evolved from the initial focus on R&D, concurrent engineering, and R&D teams to the focus on communication, cross-departmental collaboration, collaborative product development (CPD), and, more recently, to the current research on the dynamic capability and sustainability of enterprises and project teams. The research focus at different stages is closely related to the economic environment and industrial capabilities.

4.2.3. Analysis of the Evolution of Research Topics

A time zone diagram, also known as keyword topic path diagram, has circles which each represent a keyword and the corresponding time when the keyword first appeared in the data set. This means that even if the keyword reappears in the future, it will not be recorded repeatedly in the time zone chart, but every time it is increased, the frequency of the keyword will increase, which is shown through the expansion of the circle. The details are shown in Figure 8:

![Figure 8. The path map of the literature keywords.](image)

The research and development results of the time zone diagram and the cluster diagram complement each other and more concretely and intuitively show the evolution trend of research hotspots. It is not difficult to find that, in the enlightenment and exploration stage, scholars paid attention to the analysis of product innovation, quality, R&D capabilities, R&D cycle, reasons for failure, organizational structure, and supply chain management. Furthermore, with the diversification of product R&D management methods and contexts, scholars have followed these trends in their research. In an increasingly complex environment, with the emergence of the Internet and the rise of information technology, the uncertainty faced by product research and development has increased. Under the fuzzy logic, the scholars introduced the product life cycle theory, introduced suppliers’ participation in the research and development process, explored the development of the dynamic enterprise, and identified the importance of cross-departmental and cross-functional integration for product research and development. When consumers’ identities changed and played a more critical role in the value chain, companies began to adopt open innovation in R&D, using mass customization and consumer participation to achieve value co-creation. Due to the gradual intensification of environmental pollution, more requirements were put forward for the sustainable development of industrial product research and development, and consumers have shown a demand for green products.
5. CNKI Literature Analysis of Product R&D Management
5.1. Theoretical Research Analysis of Journal Articles
5.1.1. The Basic Connotation of Product Development Management

The goal of product R&D is to effectively grasp market opportunities and transform market-related product technologies or theoretical ideas into products that can be sold. Product R&D management is the management activity around this process [57]. As the management activity of an enterprise, product R&D management essentially possesses multiple management attributes:

- **Performance management.** The fundamental goal of management is to achieve controllable and increasable performance. Due to the greater risk and uncertainty of product development, product development management must pay more attention to performance management [58]. The performance management of product research and development is based on the research and development process, including the control of product development strategies, the management of new product development costs, the performance evaluation of development team members, and the market performance after new product development.

- **Coordinate management.** The difficulty of management lies in the effective matching and efficient turnover of resources. Product R&D is an operation process from unfamiliar to familiar, from scattered to a collective, and requires the coordination and cooperation of various workforces, capital, and other production factors, meaning that product R&D requires coordinated management. The coordinated management of product development includes inter-departmental coordinated management, communication management, and management of the entire process.

- **Future management.** The critical concept of management is sustainable development, which is an extension of operation and management. In an increasingly complex market environment, companies implement product development strategies, mainly in the hope of using product development to maintain their long-term competitiveness and market dynamics, and to drive their development with innovation. In other words, the critical responsibility of product development management for future management is to ensure the long-term competitiveness of the product so that the product does not fall behind competitors and get eliminated from the market in the process of development. The key to ensuring that the product is in line with the market lies in managing knowledge and creativity. Therefore, the future management of product development is mainly based on the management of knowledge and creativity and part of the content of operation management.

According to the scholarly classification of what product development management entails, this article analyzed domestic scholars’ research content from three perspectives, namely, performance management, coordination management, and future management, and summarized the corresponding research paradigms.

5.1.2. Performance Management in Product Development

Performance management runs through the entire life cycle of product development, and the effective control of performance management helps to clarify product development ideas. Product development performance management includes the product development strategy evaluation, development cost analysis, team member assessment, and product-market performance analysis, etc. At a certain level, the product development strategy determines the height of product development, and a reasonable product development strategy includes the correct concept of technological innovation and the development of serialized and multi-standard new products [59]. Therefore, the key to evaluating whether a product R&D strategy is reasonable or not lies in whether the company considers the cost of innovation, market demand, and its existing technological foundation, and conducts R&D selectively. In the decision-making of new products, companies need to have relevance to existing products and cannot overemphasize the ambiguity of new products, leading to the disconnection of the product chain and the dispersion of sales channels.
Based on the confirmation of the R&D direction, the company also needs to do an excellent job of cost planning and control in the R&D stage [60]. Through theoretical discussion, implementation of the IPD product R&D management model, determining the appropriate scale of R&D expenditure, optimizing product design processes, and standardizing cost accounting, companies can further control R&D costs and improve their cost management capabilities. Lu [61] emphasized that R&D management performance should pay special attention to the cost of technical input to avoid the occurrence of undesirable problems, such as an insufficient product R&D driving force and an excessive enterprise R&D burden. Alongside controlling the scale of R&D costs, companies also need to form a strong R&D team [62]. On the one hand, the R&D team cannot break through the cost constraints, resulting in a decrease in the enterprise’s R&D efficiency. On the other hand, the R&D team must have sufficient knowledge learning ability [63] to realize the dynamic growth of the knowledge level of experiential learning and collaborative learning and enhance enterprise research and innovation. In short, the key to team performance appraisal is whether team members can achieve high output goals with low input based on collaboration and cooperation [64]. The goal of enterprise product research and development is to create and serve the market, and the final product’s foothold is also the market. Therefore, product market performance has become the key to product research and development performance management [65]. Sha [66] found that a reactive market orientation has a weak impact on product performance, while a proactive market orientation has a positive and direct impact on new product development performance. Market learning ability is also an important influencing factor of new product development performance. Based on the guidance of the dynamic ability theory, the market learning ability will ultimately improve new product development performance through its effect on product development process capabilities [67]. As can be seen, the performance management of product R&D is a complex process, and the performance results of each link will affect the overall R&D effect.

5.1.3. Coordinated Management in Product Development

Coordination management is the key to achieving centralized and efficient product R&D resources, including inter-departmental coordination management, communication management, and management of the entire process. From the perspective of departmental coordination, the establishment of a rapid trust and knowledge transfer channel of a new product R&D team contributes to improving overall innovation performance and avoids the damage caused by a team’s fracture zone [68]. However, it cannot be ignored that the innovation process’s failure experience is also an essential factor in enhancing team cohesion and improving innovation development performance. Through the contribution of failure experience, the team’s entrepreneurial orientation is optimized, the risk aversion cooperation between entrepreneurs and venture capitalists is aggregated, and the orderly progress of product development is guaranteed [69]. Li et al. [70] emphasized that leadership sharing is an essential means of maintaining team trust and improving development performance. As a cross-functional department activity, new product development will be affected by the leadership of different departments. Relatively closed leadership and execution space hinder the transmission of team trust, which is not conducive to various departments’ coordinated operation and interdependence. Zheng [71] also believed that product R&D is a kind of knowledge work, which requires eliminating cognitive differences between R&D team members and the realization of knowledge coordination. Furthermore, knowledge learning is the root of reducing or eliminating cognitive differences. From the perspective of communication management, the focus of communication issues in new product development has shifted to communication effectiveness under virtualized, globalized, and open conditions. The content of communication changes from information to knowledge and the acquisition, dissemination, sharing, and creation of knowledge has become the critical content of communication management [72]. This also corroborates inter-departmental coordination and management content: the sharing of information and knowledge. In response to communication problems, Lin built a new product development...
communication mechanism under the parallel strategy to guide companies to achieve parallel development and optimize the development process [73]. From the perspective of process management, on the one hand, in order to achieve coordinated development and efficient innovation, companies should implement cross-domain integration and optimization based on process architecture and keep the dependencies between components in complex development projects from being destroyed [74]. On the other hand, R&D process management also needs to pay attention to the impact of quality gaps and knowledge gaps to avoid knowledge imbalance and low quality from destroying the process operation mechanism [75].

5.1.4. Future Management in Product Development

The essence of future management is to ensure the progressive nature of enterprise product research and development to ensure the enterprise does not fall behind in the innovation process and avoid the research and development of products that are not compatible with the market. Based on the previous analysis, it can be seen that the key to future management is the management of knowledge and creativity. However, unlike the discussion of knowledge sharing and knowledge application in process management, future management’s focus is to transform knowledge and creativity into sustainable corporate competitive advantages. Shen [76] analyzed how to make strategic decisions and obtain a sustainable competitive advantage in new product development under an uncertain environment. The study results found that demand uncertainty had a positive effect on novelty and rapid new product development strategy choices, while technological uncertainty was also conducive to companies choosing novel and rapid new product development strategies. Companies need to maintain their technological creativity to cope with the complex external environment. Xue [77] believed that the integration of external knowledge would enhance enterprises’ competitiveness and create more research and development benefits. Due to the increasing pressure of competition and the external environment’s complexity, competitive intelligence was also a concern of scholars [78,79]. Competitive intelligence itself is also a kind of R&D knowledge. Based on the processing of intelligence, companies can maintain the adaptability of R&D products to the environment, form information integration about the competitive environment, competitors, and competitive strategies, and ensure the compatibility of products with the market and the future.

5.2. Thesis Case Application Analysis

Unlike journal papers that mostly use empirical analysis, CNKI’s master and doctoral theses are mainly professional degree theses, emphasizing the analysis of problems in the product development/R&D process of a certain company in reality and proposing an optimized path. Most of the reasons why journal papers are limited by space are more refined, while, in contrast, masters and doctoral papers are more detailed. The application of theory to practice can make up for the lack of practice in the previous literature. Therefore, we input in the search criteria of HowNet the Title = “Product R&D Management” or “Product Development Management”, chose 2011–2020 for the degree year, and, finally, obtained 83 results. Using CNKI’s built-in measurement visualization analysis function, we gathered the main keywords for the research of masters and doctoral theses completed in the past ten years. As shown in Figure 9, more masters and doctors paid attention to the management of “people” and “processes” in the product development process and preferred to use the idea of integrated development of IPD products for optimization path exploration. In addition, the topics of “demand”, “design”, “performance”, and “efficiency” were also covered.
Sorting out related papers, scholars will find that the types of companies involved include: manufacturing (automotive and electronic components), the financial industry (banking), and retail industry (e-commerce and shoes), etc. Research showed that, despite the differences in technical difficulty, product development exists in all walks of life. After summation, the problems that major companies encountered in product R&D management mainly included the following aspects:

- The product development cycle is too long. Defects in the design of the product R&D system, disconnected management systems, and imperfect approval systems, for example, have caused the product development cycle to be too long and delayed, and the R&D personnel, thus, face tremendous pressure;
- The cost of product development is overrun. The company does not attach importance to cost management, does not set a unified or standard basic process, and the cost budget’s accuracy is low. Preliminary cost budget approval for checkpoints often results in project input-output ratios lower than expected, affecting financial performance;
- Insufficient demand analysis. Frequently, user needs are fragmented in the development process, customer needs change quickly, but the front-end communication is not timely. After the samples are produced, customers feel that they are not in line with expectations, which eventually leads to the spread of function development and high rework rate;
- The development process is not in place. Due to the cumbersome process and the inadequate application of synchronization engineering, there are often problems such as process confusion and repeated verification of new products, leading to delays in the previous stage and delays in the entire project. The lack of redundancy of the approval system exacerbates this adverse effect. In some traditional enterprises, outdated R&D systems and management concepts are more obvious;
- The organizational structure is unreasonable. The lack of flexibility in team building, many organizational structure barriers, complicated project progress reporting, and the involvement of many leaders means the project team fails to achieve cross-departmental and cross-functional communication. Likewise, the efficiency of internal and external communication within the team is low;
- There are risks in production quality. The lack of standardized production and operation procedures, and the fact that the factory did not participate in the research and development process in the early stage, quickly caused problems such as unstable product quality and low efficiency in mass production verification.

In response to the above problems, the author puts forward optimization plans based on management concepts such as IPD, lean management, and agile management based on the enterprise’s actual situation and compares the optimized project performance to
verify the rationality of the improvement plan. This mainly includes plans: (1) based on the IPD concept, proposing suggestions to improve the decision-making process and organizational structure, establish a systematic product development management mechanism, develop a fuller understanding of customer needs for product development, and form a matrix integrated project development team to break down inter-departmental barriers and improve communication efficiency. Under the guidance of the APQP, this entails carrying out synchronous project management to improve efficiency; (2) based on the concept of agile development, which is proposed to shorten the development cycle through rapid iterative development and management methods; and (3) based on the lean management concept, which proposes integrating lean management, lean approval, and lean production principles into the process of project initiation, the R&D and testing phase, and the verification phase to reduce errors and improve quality.

6. Conclusions, Shortcomings and Outlook

6.1. Conclusions

With the increasingly diversified and complex internal and external environments of enterprises, R&D projects and their management are facing increasing uncertainty. In the same context, a series of R&D ideas and methods that keep pace with the times have emerged. Among them, the effectiveness of agile development, lean management, and IPD, etc., were proven in corporate practice. Theories and practical research were first started abroad. From the earliest case analysis of success and failure to the refinement of concepts and frameworks, and the further investigation of influencing factors to the current focus on consumers and sustainable development, it has played a leading role in relevant domestic research. With the rapid development of Chinese enterprises, the improvement of industrial capabilities, and the advancement of enterprise innovation levels, domestic scholars combine foreign scholars’ ideas to conduct analysis and research based on the characteristics of Chinese enterprises. These management ideas were also confirmed in the analysis of domestic CNKI’s journal literature and masters and doctoral dissertations. This article, which uses bibliometric methods, on the one hand, summarized the past research. On the other hand, it also provides a theoretical basis for future academic research in related fields.

According to the findings of this paper, the methods, ideas, and concepts of product development management have progressed with the times and changes in consumer thinking. Before 2010, product development management research was in its enlightenment phase. Academic research focused on analyzing the experiences of successful and unsuccessful product development management cases, defining relevant concepts, and refining theoretical models and research frameworks. Firstly, researchers used product development case studies to analyze successes and failures and establish a basis for evaluating product development. Secondly, researchers began to develop concepts and models of product development, and through the study of standard paradigms, analyzed ways to reduce costs and improve efficiency in product development activities. Finally, scholars found that product developers had begun to focus on factors within the team organization that affect product development and on the impact of suppliers external to the team on the product development journey.

Since 2010, product development has been characterized by diversity as the years have progressed. Scholars’ research also showed different clusters of distribution, and the focal topic of research showed the characteristics of high-quality development. This paper found, through analysis, that product R&D has not yet formed a complete system in the last decade, which is closely related to the new characteristics, methods, and problems of R&D management. In the current stage of product R&D management, sustainable development is the most important issue for R&D personnel to consider. Focusing on consumer choice, capturing consumer issues, and solving them is the key to product development. New research methods and the organizational design of research teams are also a focus in product development.
An analysis of R&D hotspots revealed that the focus of scholars has evolved with the times, and that the focus of research at different stages is closely related to the economic environment, industrial capacity, and consumer level. At this stage, environmental issues, as a common problem facing global development, are also reflected in product R&D research. The main manifestations are through the general context in which society has put forward more requirements for the sustainability of R&D products, while consumers have increased the demand for green products.

An empirical analysis of enterprise cases revealed that, at this stage, product development cycles are long, R&D costs are overrun, requirements analysis is inadequate, development processes are cumbersome, organizational structures are unreasonable, and production quality cannot be guaranteed. These six factors are the main obstacles affecting product development in enterprises.

This article compares and analyzes the changes in the focus of product R&D in different eras by studying the directions and hotspots in the process of product R&D management under different era backgrounds, and summarizes the outlook for product R&D under the background of the new era, which is of great significance.

From an academic point of view, this article provides suggestions for the future development direction of product R&D and highlights the aspects that need attention in efficient product R&D. Through this new literature research method used to provide researchers with research ideas, researchers can apply this method to other research fields to determine the law of its development. From a practical point of view, this article provided suggestions for the direction of enterprise product R&D concerning the improvement of management mode, and personnel organization and management to promote the efficient conduct of product research and development.

6.2. Shortcomings and Outlook

This paper takes product development as an entry point and comprehensively analyses the concepts and evolutionary logic of product development. It is vital to grasp the market’s needs strategically in the face of a complex and changing social and market environment. The use of big data, text mining, and other tools clarified the development process of product research and development, and achieved breakthroughs in method, thinking, and theoretical innovation. In the face of unexpected events such as the “black swan” and “grey rhinoceros”, especially in the post-epidemic era, market needs are even more critical for the future planning of product development strategies. In analyzing the literature, this paper did not consider the impact of environmental changes on product development in the post-epidemic era, which will be the focus of subsequent work. Follow-up research can summarize the focus of product research and development during the epidemic, and analyze the future development direction of product research and development from a world perspective in the post-epidemic era.

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