

Green Innovation Culture: Traceability Path, Current Research and Future Prospects

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Abstract: One of the most important topics in international innovation management research in recent years has been the new technological breakthroughs that many organizations are using to solve the technical challenges of "green performance". However, the existing studies have been focusing on green, ecological, product and technology perspectives to explore sustainable green strategies and build up core competencies globally, but they have always neglected the efficient path of innovation from the spiritual level to help green, which in turn has led to the failure of green innovation culture to be implemented and effectively guide the practice. In view of this, this paper analyzes the current research status of green innovation culture based on literature review and reveals the tracing path of green innovation culture. Finally, this paper makes a prospective view to provide important theoretical and practical guidance for promoting the in-depth study of green innovation culture.

Keywords: Green Innovation Culture; Traceability Path; Current Research; Future Prospects.

1. Introduction

Nowadays, due to the increasing pressure from social, environmental and political forces [1], many organizations incorporate environment and sustainable practices into their competitive strategies and maintain their core competitive advantages on a global scale [2], which has become one of the most important topics in international innovation management research in recent years. Existing research is based on product cooperation [3], low-carbon technology [4] and ecological innovation [5], in order to adopt sustainable practices in product and process development [3] and explore ways to improve organizational green performance [6]. Fundamentally speaking, to solve the technical problem of "green performance", it is necessary to construct a new strategic vision of balance linking sustainable development and green ecological relationship. As far as organizations are concerned, what kind of new technological breakthrough way to improve green performance [7] will first face a major change-fundamentally change the path dependence of the inherent organizational culture to continuously improve its environmental adaptability. Although today's organizations are aware that green or ecology has become an important strategy for high-tech enterprises to achieve sustainable development [7], previous studies have always ignored the path of helping green from spiritual innovation. As the core of the spiritual level, culture is the underlying logic and behavioral basis of any organization or group innovation. Therefore, how to explore the successful path of green performance breakthrough from the cultural perspective? It has become the focus of attention from all walks of life.

Green innovation culture is a set of shared green beliefs, concepts and values, with green shared values as the cornerstone [8]. It has changed the traditional thinking mode of green innovation and become a catalyst for green innovation [9]. However, at present, the research on the relationship between green innovation culture and green performance is very rare [10]. The evolution of green innovation culture has not only changed the mode of competition and cooperation of modern organizations, but

also affected the future direction of the evolution path [11]. Organizational green innovation is no longer a single atomic process, but a value-added system based on green innovation cultural ecosystem. An organization without a green innovation culture will find it difficult to realize employees' innovation ability, motivation and opportunities [1], and the most important factor that determines an organization's innovation will change constantly with the passage of time: from resources to tangible and conscious processes and values, and finally rooted in culture. Organization's innovation with culture has attracted scholars' extensive attention, and also promoted the rapid evolution of theoretical research. The origin of the concept of green innovation culture mainly combines organizational culture theory and green innovation theory, which also explains that green is the essence of innovation economy and the theoretical basis of green innovation culture.

Literature research is an important foundation to promote the development of theory, especially the research on green innovation culture emphasizes interdisciplinary, and pays more attention to creative research topics and ideological innovation [12]. The interweaving of green innovation situation and related research topics brings opportunities and challenges to the research of green innovation culture. Systematically sorting out the literature in this field not only helps to inspire new thinking for domestic researchers, but also answers the following questions: Can the traditional organizational culture theory explain the problems in the new situation? Where should the research on green innovation culture go? How to cultivate green innovation culture? What are the challenges and opportunities for the study of green innovation culture?

2. Collection and Distribution of Documents

2.1. Document Collection

(1) Retrieve the boundary. The literature in this paper is mainly obtained through domestic and foreign databases. First of all, in terms of foreign data, based on WOS, Science

Direct, JSTOR, Wiley Online Library and Springer, we define the search edge as two kinds of journals: one is the top journals recognized in the field of management (FT50 and UTD24); Second, professional journals closely related to green innovation culture, including SSCI-1 journals such as Technovation and Technical Forecasting Social Change. Finally, as far as domestic data are concerned, based on CNKI, Wan fang and VIP databases, we define the search edge as self-funded journals.

(2) Keywords and time. In this paper, "green innovation culture" and "green innovation culture" are the key words for retrieval. In the retrieval, the results are read and checked one by one, and the literature with low connection with green innovation culture at individual, national and international levels is removed. In order to obtain a complete research sample, this paper relaxes the retrieval time range to 1970~2021.

In order to avoid the omission of relevant literature, this paper traces the index and citation of the selected literature by literature tracing method. First of all, on the principle of basically ensuring no repetition or leakage, it is determined that 657 documents will constitute the initial sample of this study. Then, according to the contingency method, the documents in the initial sample are further examined, and finally 319 important documents are identified, which constitute the qualitative sample of this paper.

2.2. Literature Distribution

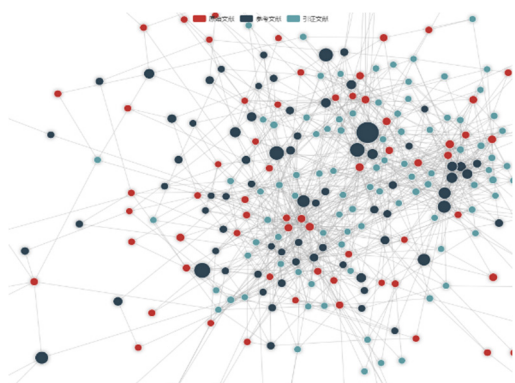


Fig 1. Foreign research focus

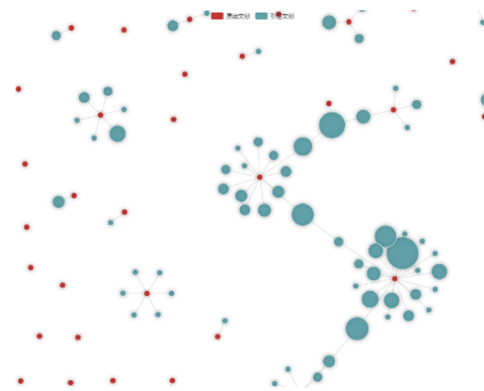


Fig 2. Domestic research dispersion

Based on the literature screening, this study makes a simple quantitative analysis of the literature. As far as the foreign situation is concerned, it shows a "long and slow" trend. In foreign research, there is a steady growth trend after 2002, and the research focus is network-like. On the whole, foreign research started earlier and grew faster, while domestic research appeared after 2005, showing a "short and fast" status quo, but the research was scattered. In the past 40 years from the end of 1980s to the present, the research on green innovation culture has shown a trend of increasing quantity and expanding research fields (Fig. 1 and Fig. 2).

3. Traceability Path

Based on the in-depth understanding of the literature in this field, this paper further puts forward the path framework of green innovation culture. The left part of fig. 3 focuses on revealing its traceability path through the discussion of the causes.

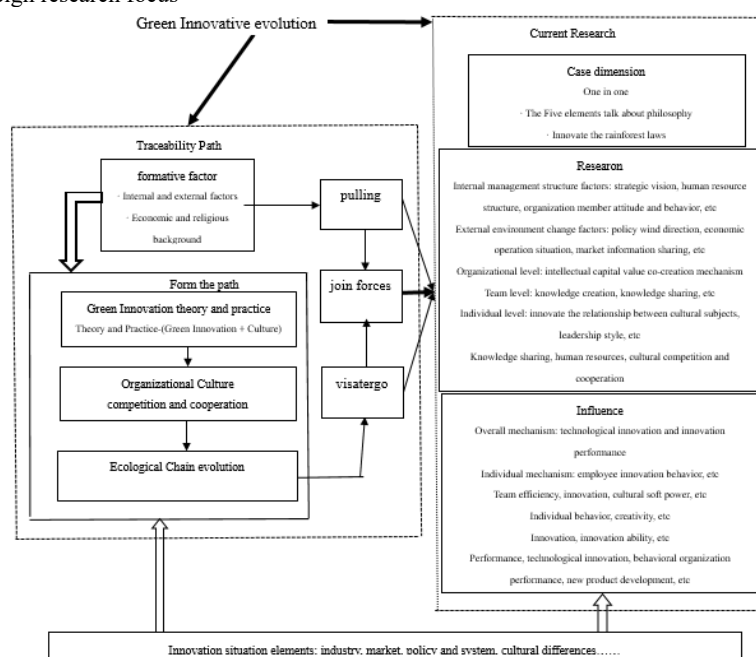


Fig 3. Traceability and Status Framework

3.1. Causes

Most scholars believe that the process of green innovation is influenced by many factors inside and outside the organization, among which external factors include: openness of knowledge, market competition and exploring new opportunities [13]. Internal factors include creativity, product innovation and entrepreneurship [14]. But generally speaking, exploring new opportunities and market changes is the direct motivation to promote its evolution, while product innovation within the organization and pursuing environmental sustainability are the deep reasons. In addition, among the various driving forces for the formation of green innovation culture, different cultural formation paths have their own merits, and even the industry, technology, system, economy and religious background of the organization will have an effect on the traceability path.

3.2. Paths

3.2.1. Green Innovation Theory and Practice

Innovation theory has a long history of development, which has spawned many business empires. Since the advent of Schumpeter's Theory of Economic development, as the baton of operation, it has always revolved around the progress of innovative management. After the 1960s, the United States became a giant in the world, and most organizations quickly entered a period of rapid development. In order to maintain their competitive position, organizations have focused on green innovation [15]. In order to solve the gap between performance and environment, many organizations have made strategic initiatives from innovation to green innovation. Since the 21st century, the globalization of green innovation has pushed organizations to reduce their carbon footprint and become greener in nature, which has pushed green development to a new stage. Then, green regional innovation green practices such as green innovation indicators and green innovation ecosystem are constantly emerging, which further expands the research boundary of green innovation[16].

On the other hand, in China, after a long period of industrialization, the environment in which the organization is located is no longer suitable for the sustainability of the organization, which has led to the emergence of "green". In recent years, green innovation has been added to the articles of association of enterprises, and it has been put in the first place to guide strategies and actions. This humble move has laid the evolutionary logic for Chinese enterprises to pay more attention to green environmental protection from performance, and it is also the earliest embodiment of green innovation culture in Chinese innovation. Although green innovation culture is not the same as organizational innovation culture, it belongs to an attribute of organizational innovation culture. Organizational innovation culture is a process, an innovation process of organizational culture self-evolution, while green innovation culture is a result, a clear cultural type and an urgent need for social and economic development today.

3.2.2. Co-competition of Organizational Culture

Based on the co-opetition model, Hofstede [17] proposed cross-cultural enterprise development. According to Zhao and Pan [18], the essence of cross-culture is to find enterprise goals that transcend cultural conflicts in the management process, so as to maintain the common code of conduct of employees with different cultural backgrounds, and thus

control and utilize the potential and value of the organization to the maximum extent. Since the 21st century, with the further acceleration of green innovation, the coexistence of competition and cooperation has become the new normal of green innovation. Based on the strong competitive relationship, to some extent, organizational culture is no longer suitable for innovation and development, and a new organizational culture model needs to be sought. Through the innovation of organizational culture mode, a new cultural format is formed. At the same time, in order to obtain green resources for development, organizations can blend and innovate in this cultural format. In cultural innovation, the new format culture has a clear strategic intention and competition mode, and the greater the difference, the more conducive to the green innovation of organizational culture. Therefore, as a new thrust, the competition and cooperation of organizational culture has brought kinetic energy to the evolution of green innovation culture.

3.2.3. Ecological Chain

In the process of industrialization for a period of time, the destruction of the environment made the organization obtain rare performance output, which led to the contradiction between the added value of each link in the industrial chain and the green benefits. In order to keep the environment sustainable, organizations need to focus on some specific "strategic links" and then play the core role of "green". Under this situation, the integrated ecological chain economy has risen rapidly. Ecological chain brings together interdependent or complementary subsystems of organizational operation in space, and creates a dynamic process of ecological value through cooperation and coordination [19]. Recently, the wave of green innovation swept across the world, leading to organizations being forced to change and survive in the cracks [20]. Instead, they need to consider existing innovation processes, identify unique challenges and develop solutions to problems [21]. As a result, the innovative forms of ecological chain have developed rapidly, such as the third district of Italy and the Silicon Valley of the United States.

According to the research of Roper et al [22], the innovative form of ecological chain can obtain the feedback loop needed for green innovation through recursive process, and transform it into new green products and processes, and then use its green to create added value. Therefore, the competitive advantage of green ecological chain needs to change from ecological chain economy to green economy, and through the rapid development of ecological chain, green innovation culture will be born. In the green practice, the "Rainforest Law" of the Silicon Valley Ecosystem in the United States confirms the sustainable prosperity of green innovation culture [23]. The value-added advantages brought by green innovation culture come from the joint efforts of organizational culture and green efficiency in the ecological chain system. This advantage is difficult to replicate, and it can also help organizations gain sustainable advantages. Therefore, based on the evolutionary perspective of ecological chain, in a sense, the rise of green innovation culture is inseparable from the evolution of ecological chain.

4. Research Status

The right part of Figure 3 focuses on its research status. This study makes an in-depth discussion on green innovation culture from three aspects: case, antecedent and influence.

Finally, the influence of green innovation situation is added at the bottom of the frame diagram, including industry, market, policy system, cultural differences and so on.

4.1. Cases

Hwang and Horowitz [23] studied the "rainforest law" in the high-tech ecosystem of Silicon Valley, and pointed out that green innovation culture can help organizations to effectively create, cultivate and activate innovation, and help reduce carbon footprint and maintain environmental sustainability. Finkle [24] analyzes the reasons for the formation of green innovation culture in Silicon Valley, and thinks that building innovation culture with green as the core is of great significance to the development of high-tech industries. After learning the typical foreign cases of green innovation culture, some cultural cases with certain characteristics have emerged in China. For example, Wang Fengbin et al [25] made a case analysis of Haier's innovative culture of "one person and one person", and found that the green process of organization is a closed spiral dynamic evolution system composed of five elements: situation, concept, mode, system and humanity, and summarized the law of green process as the circular effect of culture and control formed by the interweaving and combining of life and gram. This study promoted the application of the philosophy of "Five Elements Theory" in modern green, and indirectly promoted the further evolution of green innovation culture. Obviously, different national conditions, religious backgrounds, industrial and policy differences lead to different evolution modes of green innovation culture. Based on the research of different typical cases, it is the focus of this kind of research to refine commonness and differences and put forward valuable suggestions.

4.2. Antecedents

The existing research on green innovation culture can be divided into two channels: internal demand and environmental pressure. Internal demand mainly includes structural factors such as strategic vision, human resources, attitude and behavior of organization members, hierarchical resource allocation, knowledge transfer, willingness to share, and degree of exchange [26], while environmental pressure covers pressure factors such as policy wind direction, economic operation situation, market information accessibility, industry cycle, technological progress, network heterogeneity and knowledge attributes [27]. In the construction of green innovation culture, cooperation, communication and information sharing among organizations are the basis of cultural construction, accompanied by the creation, sharing and exchange of knowledge and the co-creation of green capital. According to Pekka [28], different organizations involved participate in the process of green innovation, and the creation of knowledge capital is more conducive to the development of green innovation culture. In addition, hierarchical elements such as human resource allocation can also play a key role in the direction of green innovation culture, thus highlighting the incentive effect of green values orientation. However, with the sustainability of the external environment, environmental factors are putting more and more pressure on the green innovation culture. The process of cultural competition, collision and game interaction among multi-agents in green innovation will bring great impact on the cultural evolution model of green innovation of organizations.

4.3. Influences

The research on the influence of green innovation culture can be divided into two layers: overall mechanism and individual mechanism. The overall mechanism is the ultimate ownership of the evolution of green innovation culture, while the individual mechanism is the gestation of organizational cooperation and interaction in green innovation culture. However, different scholars focus on the different scenarios of green innovation culture, mainly covering the following three aspects. First, the role of green performance emphasizes that green performance is the ultimate destination of organizations in the evolution of green innovation culture. Green innovation culture mainly affects the process and path of performance. When green innovation culture is integrated into the organization, green values and green standards will have a significant impact on green innovation management [29]. Second, based on the perspective of technological innovation, it is emphasized that a stronger green innovation culture can replace and promote green technological innovation, and even reveal the internal complexity of technological innovation through knowledge assets and green innovation capabilities [30]. In addition, changes in the external environment of the organization, such as eco-technology and green digitalization, make the organization's ability and performance in green innovation very limited, and the sustainability of the environment makes the organization rely more on the characteristics of green innovation culture [31], thus solving the factors affecting green innovation and performance. Third, the study of employees' green behavior. Green innovation behavior is understood as a multi-faceted phenomenon, and it is the micro-foundation of green. It is embedded and influenced by environmental factors such as green management, organization and innovation culture [32], and the importance of green innovation culture is more and more prominent for the green behavior of organizational employees [33].

5. Look to the Future

Focusing on the research status of green innovation culture, considering green innovation and related research directions, this paper makes the following prospects.

(1) Deepening the research of green innovation culture.

Based on the ecological chain, this paper explores the new connotation, new model and new research status of green innovation culture. The systematicness, interconnection and subversion of ecological chain will have a great impact on green innovation culture, mainly in the following aspects: First, cultural concepts. Based on the ecological chain, the concept of green innovation culture is constantly enriched, and the introduction of ecological chain into innovation breaks the traditional definition of organizational culture and presents a trend of continuous extension; The second is the cultural dimension. The ecological chain situation further highlights the most essential green state of the organization, the cultural boundary is more blurred, the cultural dimensions and measurement indicators are more numerous, and the organization with green innovation culture is more conducive to maintaining its competitive advantage; The third is the new green innovation culture. A variety of new green forms of innovative culture have emerged, and the cultural characteristics and evolution methods are quite different from those of traditional innovative culture. At the same time, the integration of innovation management and ecological chain

innovation has significantly changed the core connotation and operation mechanism of traditional innovation culture. Among them, the most remarkable change of green innovation culture is that "green values" have become its core. Thinking about the connotation of innovative culture from the perspective of ecological chain transcends the previous thinking mode of simply starting from innovative culture and contributes more huge and subversive green elements. In-depth research on new concepts and operating mechanisms emerging in green innovation has injected new elements of the times into green innovation culture.

(2) Pay attention to the changes in the evolution of new culture in green practice.

Re-examine the structure of green innovation culture and emphasize the integration with interdisciplinary subjects at the micro level. With the continuous expansion of cultural boundaries, it seems that the previous dimensions of innovative culture can no longer properly measure green innovative culture. On the contrary, based on the microscopic perspective, exploring the essence of green innovation culture will become the key direction of future research [34]: First, re-examine the dimensional structure of green innovation culture, and further explore the dimensional construction and evolution model of green innovation culture in the ecological chain. Secondly, considering the wave of green innovation, can the green innovation culture be integrated with interdisciplinary subjects at the micro level? Explore the impact of this effective integration mechanism on green innovation culture. Third, the traditional manufacturing industry and many traditional industries are impacted by green innovation, and many of them are facing the innovation transformation of narrow escape. At this stage, it is necessary to further explore whether the changes brought about by green innovation will have an impact on the evolution of green innovation culture. What is the impact? And whether there will be new cultural patterns? These problems are worthy of in-depth study.

(3) Extending the theoretical horizon of green innovation culture research.

Pay attention to the value creation of internal and external multi-subjects, and highlight the importance of green innovation culture. The situation of green innovation further highlights the central position of green innovation culture. The rapid development of green innovation and the explosion of green resources make organizations have to cooperate with more and different subjects to obtain more diverse green resources. Therefore, the original innovation culture has evolved in the intensity and depth of cooperation between different subjects, and it has become more grounded. In this scenario, the interaction between subjects should highlight the co-creation of green values, highlight the importance of green innovative culture, and empower the evolution of innovative culture with green values. Secondly, the key to the influence of green innovation scenarios on green innovation culture lies in environmental sustainability. Therefore, the green efficiency and green innovation of the organization have become the key elements to deal with this complex situation, and the organization needs to continuously grasp the green innovation culture.

(4) Enrich the research topics of green innovation culture.

Promote the integration of green culture with open innovation, innovation network and ecosystem. On the one hand, it focuses on the evolutionary perspective and the

organic integration of open innovation and green innovation culture. With the rapid development and evolution of green innovation, openness has become inevitable, and open innovation has a positive effect on helping organizations acquire more green resources and improve their competitiveness [35]. Green innovation culture has also evolved into an open green innovation culture; In addition, based on the ecological theory, the innovation network and ecosystem research are further considered. First, promote the integration of green innovation culture and innovation network research. The rapid development of network practice under green digitalization promotes the emergence and development of innovative networks, and core organizations carry out innovative practices and strategic alliances in the form of network cooperation, giving full play to the advantages of network links [36]. Based on the green innovation culture, it is of great theoretical and practical significance to discuss the issues of green co-creation and green innovation in the innovation network. Secondly, promote the integration of green innovation culture and ecosystem research. With the rapid development of green technology, the number and categories of partners have been expanding, and then a more complex green ecosystem has been derived. Compared with the green innovation culture, the links between organizations in the innovation ecosystem are closer and more frequent, even technical cooperation alliances. Under the background of the new era, it is worth considering to explore the construction and development of innovation ecosystem and network ecosystem, green activities and green models in ecosystem from the perspective of green innovation culture [37].

6. Main Research Conclusions

It is an inevitable product of the green era that organizations participate in the competition in a green cultural mode. The rapid rise of ecological chain after 2010 forces organizations to re-explore the nature of green. Therefore, based on the classic literature of green innovation culture at home and abroad, this paper systematically combs the traceability path, research status and prospect of green innovation culture, which provides rich theoretical value and practical significance for its follow-up research.

As far as theory is concerned:

Firstly, the traceability path of green innovation culture is deeply analyzed. This study starts with the cause of green innovation culture, and finally focuses on its traceability path. The research holds that the green innovation culture is driven by the theory and practice of green innovation, the competition and cooperation of organizational culture and the ecological chain.

Secondly, the research status of green innovation culture is excavated. This study makes an in-depth discussion on green innovation culture from case dimension, antecedent dimension and influence dimension, and at the same time adds the influence of situational factors such as industry, market, system and cultural differences. The research puts forward the evolution diagram of the research status of green innovation culture and the traceability path.

Thirdly, it predicts where the green innovation culture will develop. The research focuses on the current situation of green innovation culture, taking into account green innovation and related research directions, and makes a deep prospect of green innovation culture research from the aspects of deepening problem exploration, paying attention to

practical changes, extending theoretical horizons and enriching research topics.

From a practical point of view:

First, it is found that the study of green innovation culture has its good embeddedness. Research topics are constantly intertwined with emerging open green innovation, innovation ecology, performance, strategy, behavior and other research directions, which expands the research boundary. The research from the perspective of green innovation culture also brings new ideas to many traditional researches. Therefore, it is very necessary to explore the emerging fields of innovation and entrepreneurship based on the study of green innovation culture and study new problems with reference to the theory of innovation culture.

Secondly, it reveals that the study of green innovation culture has a distinct era. With the continuous progress of the times, human society has stepped into informationization from industrialization and then gradually developed into green, and the green innovation culture needs further evolution, or some changes will inevitably occur. Therefore, it is necessary to grasp the evolution of green innovation culture caused by the background of the times, and the research based on practice orientation is the future development direction of green innovation culture.

Thirdly, the limitations of the current research on green innovation culture are put forward. The research results of micro-mechanism such as the process, mechanism and operation mechanism of green innovation culture is not rich enough, and there are not many quantitative and empirical analysis results, which is not conducive to guiding the practice of green innovation. Therefore, it is particularly important to make a systematic and in-depth study on the evolution, mechanism and operation mechanism of green innovation culture from a micro perspective by using typical cases and quantitative analysis.

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