Research on Innovation Model of Manufacturing Materials from the Perspective of Green Development

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Abstract. From the perspective of green development, this paper constructs the innovation system of manufacturing materials on the basis of relevant literature at home and abroad. After that, this paper analyzes the dimensions of manufacturing material innovation and on this basis, puts forward the innovation models of manufacturing materials, and finally explores the upgrading paths of manufacturing material innovation models.

1. Introduction
Innovation is the motive force of economic development. At present, the manufacturing materials technology is gradually seeking to reduce pollution, reduce consumption and improve the ecology. Therefore, the innovation of manufacturing materials based on green development has attracted much attention. For manufacturing materials research, innovation is not a linear or mechanical process, but a dynamic and multi-factor system, that is, manufacturing material innovation system. The innovation system contains a variety of innovative models, through interaction and transformation, to generate innovation power, and ultimately achieve sustainable economic development.

2. Literature review
This article mainly summarizes the domestic and foreign scholars' research from two aspects of green manufacturing and technological innovation.

2.1. Green manufacturing
Since 1980s, scholars have begun to study green manufacturing. With regard to the concept and connotation of green manufacturing, some scholars believe that in the manufacturing process, green product production management, pollution prevention and innovative investment in clean technology are three dimensions of green manufacturing connotation (Hart, 1997). About the composition of green manufacturing, some scholars believe that from the system and integrated idea studying, construction of green supply chain model is to resolve the conflict between manufacturing industry and the environment, to achieve optimization of environment and sustainable development of the manufacturing industry (Wang Yingluo, 2003). With regard to the system structure of green manufacturing, some scholars believe that green manufacturing is a comprehensive manufacturing system including product life cycle, resource optimization and environmental impact (Liu Fei, 1997,2004).

2.2. Technological innovation
Schumpeter believed that the fundamental force to promote economic development lies in innovation. On the technical innovation, some scholars believe that the innovation of ecological technology, can
promote the strong innovation ability of enterprises to develop new markets, and to have the weak innovation ability of enterprises to further reduce costs (Grubb, Uiiph, 2002). On the path of green innovation, some scholars believe that the product development, supply chain evaluation, new product and market portfolio, emission rights and emission reduction internal transformation, process optimization is the realization path of green innovations (Kolk, Pinkse, 2005). On the path of innovation, some scholars believe that the technology innovation and development, mature industrial organization structure reform and innovation, is the innovation path of industrial transformation and upgrading (Li Zhaoyou, 2015).

2.3. Review of related research
According to the existing research, we find that there are more achievements in the field of natural science, and less research results in the field of social sciences. Much research has been done on materials, manufacturing, machinery and environment, and the study of management and economics has just started. The existing research focuses on green manufacturing, with more connotation and technology, and little research on innovation and path of green manufacturing.

3. Innovation system of manufacturing materials from the perspective of green development
Under the background of green economy, manufacturing industry needs "green" material with high technology content, low resource consumption and less environmental pollution.

![Figure 1. Innovation system of manufacturing materials](image)
As shown in Figure 1, the research and development of new materials mainly refers to the development of new green manufacturing materials. The improvement of traditional materials mainly refers to the green transformation of traditional manufacturing materials.

4. Innovation model of manufacturing materials from the perspective of green development
According to the influence degree of factors, the innovation of manufacturing materials is divided into Technological innovation dimension (T) and Institutional change dimension (I). The two dimensions can form a two-dimensional space. Due to different circumstances, the dimensions of technological innovation and institutional change are different from each other, so different types of innovation models will be formed.

![Figure 2. Innovation model of manufacturing materials](image)
As shown in Figure 2, the dimensions of technological innovation and institutional change constitute four innovative models of A1, A2, A3 and A4.

Basic type (A1): The characteristics of this model are lack of technological innovation and lack of
institutional change.

Technical type (A2): the characteristics of this model are strong technological innovation and weak system transformation.

Market type (A3): the prominent feature of this model is weak technological innovation and strong institutional change.

Strategic type (A4): the prominent feature of this model is strong technological innovation and strong institutional change.

5. Promotion of manufacturing material innovation model from the perspective of green development

According to the dimension of technological innovation and the dimension of institutional change, the upgrading paths of A1, A2, A3 and A4 are as follows.

Basic type (A1): eliminate non green materials. Upgrading technological innovation ability and transforming to technological type (A2). Or enhance the ability of institutional change, transforming to market type (A3). As shown in figure 3.

Figure 3. The improving path of Basic type

Technology type (A2): green manufacturing materials research and development. Upgrading the capability of institutional change and transforming to strategic type (A4). As shown in figure 4.

Figure 4. The improving path of Technical type

Market type (A3): Green improvement of traditional manufacturing materials. Upgrading technological innovation ability and transforming to strategic type (A4). As shown in figure 5.
Figure 5. The improving path of Market type

Strategic type (A4): green manufacturing, materials research and development, green improvement of traditional manufacturing materials. Promoted from A4 to A4’. As shown in figure 6.

Figure 6. The improving path of Strategic type

6. Conclusion

This paper constructed the innovation system of manufacturing materials, which could be divided into research and development of new materials and improvement of traditional materials. According to the influence degree of factors, the innovation of manufacturing materials was divided into technological innovation dimension and institutional change dimension. These two dimensions constituted four innovative models, such as: Basic type (A1), Technical type (A2), Market type (A3) and Strategic type (A4). These four innovation models could be effectively promoted by upgrading the specific capabilities contained in technological innovation dimension and institutional change dimension.

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