Structural characteristics of EV Li-ion batteries recycling supply chain network

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Introduction

With the rapid increase in the decommissioning of the EV Li-ion batteries (EV-LIBs),The EV-LIBs recycling industry is growing dramatically. Based on the realistic supply relationship data of major firms in the EV-LIBs recycling industry, this paper uses the complex network theory to construct a global firm-level EV-LIBs recycling supply chain (EV-LIBs-RSC) network and analyze the structural characteristics of the EV-LIBs-RSC network from the network level. Specifically, the degree distribution, average degree, overall density, average shortest path length, and community structure of EV-LIBs-RSC network are systematically analyzed. The relevant results can assist the government in proposing appropriate industrial policies.

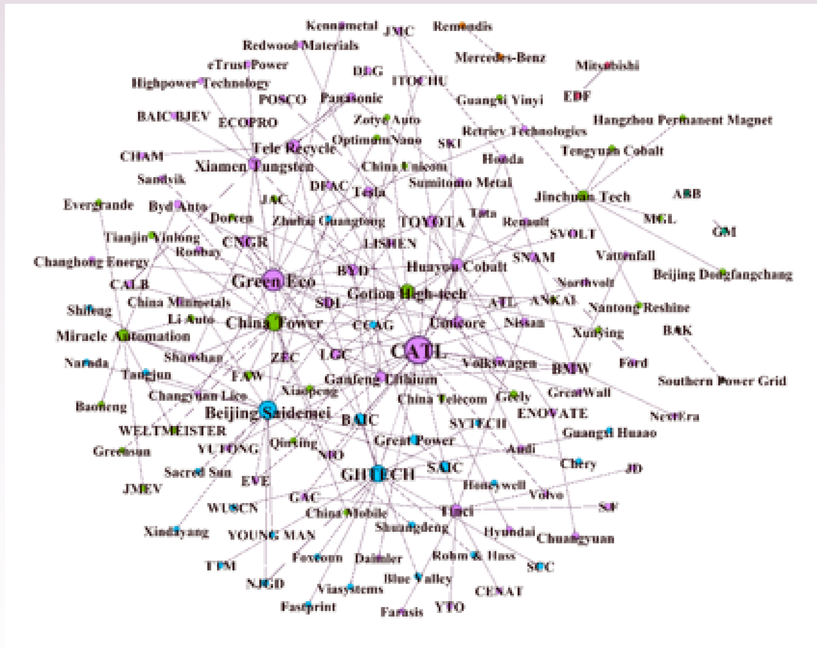
Data Collection

The data includes the EV-LIBs recycling firms and the supply relationship between these firms. And these data are mainly obtained from the annual reports of the corresponding firms and relevant industry research reports. Specifically, 134 firms and 199 supply relationships were identified to construct the global EV-LIBs-RSC network. Among the 134 firms, 47 firms are auto firms, 26 firms are battery firms, 21 firms are intermediate products firms, 12 firms are recycling firms, 8 firms are echelon utilization firms, and 20 firms are others.

Methods

This paper uses complex network theory to build the firm-level EV-LIBs-RSC network based on the realistic supply relationship data among major EV-LIBs recycling firms. The related firms are regarded as vertices and the supply relationship between them as the directed edges of suppliers and customers, and then, a directed network is constructed. Then a series of network-level metrics are used to explore the structural characteristics of the network. These metrics used in this paper mainly include the following.

- **Network degree distribution**
- **Network average degree and network density**
- **Network average path length**
- **Network community**

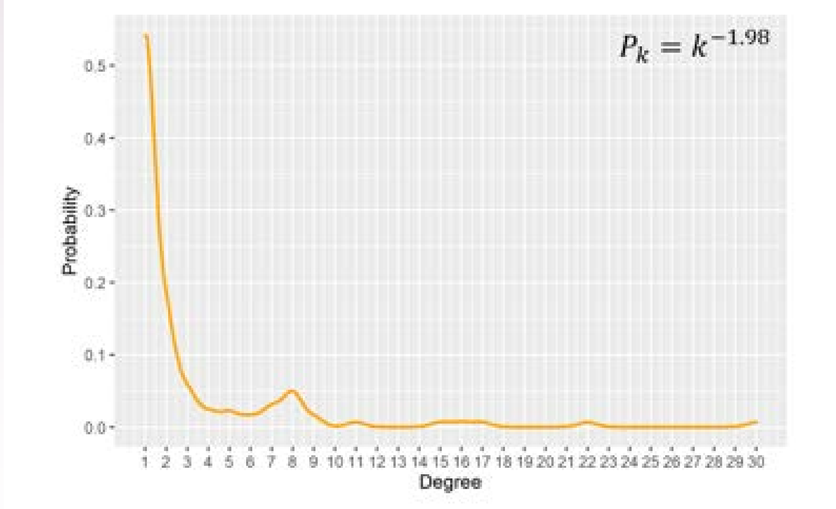


Visual representation of the EV-LIBs-RSC network community.

Conclusion

From the network level, the current EV-LIBs-RSC has the characteristics of a complex network with relatively decentralized and scale-free distribution, and presents the network characteristics of a small world phenomenon. In addition, the number of network communities is large, and the network presents a relatively obvious modular feature. Network communities vary in size, with large communities being very large and small communities consisting of only two firms.

The topology of the EV-LIBs-RSC network is only analyzed from a static perspective in this paper. In fact, in the context of the rapid development of the EV-LIBs recycling industry, the number of recycling firms is increasing, and new cooperative relationships are being established between firms. Therefore, future research can further explore the structural changes of the EV-LIBs-RSC network from a dynamic perspective and analyze the reasons for these changes.



The degree distribution of EV-LIBs recycling supply chain network.