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Research on Strategy Selection of Charging Pile Operators and Third-Party Platforms Considering Data Empowerment

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Abstract: *With the global energy depletion, environmental deterioration of the increasingly serious problems, the social awareness of energy conservation and emission reduction. By virtue of its advantages in the field of digital intelligence, third-party charging pile platform enterprises can accelerate the process of charging pile industry interconnection and promote the deep integration and coordinated development of transportation and energy fields. This paper studies the system composed of a third-party charging pile platform enterprise and a charging pile operator. When the third-party platform data enables the operator and the operator makes data operation input at the same time, the operator chooses to accept the conditions of data enabling, so as to achieve a win-win situation for both enterprises. In this paper, a data empowerment model is established for discussion. The research shows that charging pile operators will choose to accept data empowerment from the platform only when the cost increased by the cooperation between the two parties in data utilization is low. After receiving data empowerment from the third-party operation platform, the charging pile operator's own data application investment level is reduced, but the charging demand of users will be higher than that of the scenario without data empowerment.*

Keywords: *Charging pile, Platform, Operators, Data empowerment*

1. Introduction

As the world is facing increasingly serious problems of energy depletion and environmental deterioration, the awareness of energy conservation and emission reduction has been deeply rooted in people's minds. In order to further implement the central committee and state council on major strategic decisions of carbon peak, carbon neutral, vigorously develop new energy vehicles is the inevitable choice of sustainable transformation, auto industry as a new energy automobile charging pile supporting facilities, one of new infrastructure industries listed by the state, but the overall use efficiency of the charging network is low. Third-party platform helps to break the present situation of the current, between charging pile operators can assign operators can break through the platform data charging pile industry development, operating efficiently promote charging pile, optimize charging user experience, to accelerate the process of charging pile industrial connectivity, promote transportation and energy sector deeply integrated and coordinated development.

Due to the large number and complexity of charging pile brands, reasonable optimization of charging pile resource allocation plays a crucial role in promoting the development of charging pile industry. Interconnection is the development trend of charging pile industry, and the platform serves as a new structure for enterprise value creation [1], Break through the traditional linear trading logic, through the platform to achieve the purpose of value co-creation [2]. Third party operating platform to take advantage of big data access platform charging pile of information integration, assignment operator, optimization of the location planning of charging pile construction and operational planning, resource utilization in improving individual charging pile of charging at the same time can also guide users scientific planning route, provide more convenient one-stop charging experience.

The behavior of third-party platform charging pile operators is on the rise, and there are still some problems that need to be considered. Not all charging pile operators will choose to accept data empowerment from the platform, so it is necessary to discuss the conditions under which operators choose to accept data empowerment from the third-party platform. Third party platform is a bridge connecting members of the charging pile in the industrial chain, the third party cooperation platform with charging pile operators is stable affected both the interests of the operating decision-making and risk, it

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is necessary to talk about in data can assign a decision whether to promote cooperation between the platform and operators more beneficial, so as to realize the win-win of charging pile between members of the industry chain.

2. Literature References

With the advent of the era of big data, the use of data empowerment can reduce the uncertain factors brought by the huge data flow, which has become a non-negligible part of the sustainable development of enterprises. Different from foreign scholars who take data and data technology as an embedded technology context, rooted in psychological empowerment, organizational empowerment and other empowerment extension studies, domestic scholars are more inclined to the in depth study of BARNEY et al. 's enterprise resource-based theory [3]. In addition, data resources and data technology are preferred as business resources and social innovation resources for enterprises, providing important theoretical support for enterprises to explore the commercial and social value of data resources [4, 5].

The "empowerment" of digital platform is embodied in the enabling role of digital technology [6]. At present, there are some companies based on machine learning, using data mining technology to manage inventory and supply products; Others optimize their operations and business models by analyzing data information related to the market, competition, customers and products [7]. More and more scholars are beginning to pay attention to the issues of big data empowerment, digital economy and enterprise management [8]. Data empowerment is generally a process mechanism of data resources and data technology in the process of enterprise operation. Existing studies pay more attention to the effects of data and data empowerment on enterprise capabilities, production side, technical means or production efficiency, such as the benefits brought by data empowerment to manufacturing enterprises in terms of capability, response, flexibility, rapid market response and effective control of production costs. Liu et al. [9] took big data such as consumer click stream and competitor information as shared information for retail platform decision-making, and studied whether and how retail platform should share information with merchants.

Other scholars have carried out relevant studies on the operation of data-enabled enterprises through empirical methods. Analyzing the enabling mechanism is helpful to optimize the resource allocation and structural adjustment of equipment manufacturing enterprises, and promotes the linkage enabling effect [10]. Service-oriented digital platforms enable multi-dimensional data and application sharing across industry boundaries and organizational boundaries [11], in this way, the limitation of single dimension empowerment (such as the promotion of transaction efficiency, the acceleration of innovation speed, etc.) is broken. Xie et al.[12] proposed a theoretical framework of cooperative assets under big data based on multiple case studies, which described how to transform big data resources into cooperative assets in the process of value co-creation between enterprises and customers. At the same time, the author also called for research on the value of big data. Xiao et al. [13] built a supply chain game model between e-commerce platform and multiple retailers based on the fact that data empowerment of e-commerce platform can help retailers to induce demand, analyzed the conditions under which retailers accept data empowerment of platform, and discussed the optimal decision of data empowerment level of platform. Lenka et al. [14] took four industrial manufacturers as research objects to identify and explain how digital capabilities achieve value co-creation with customers. Sun et al.[15] took C2B platform "Ai Recycling" and B2B platform "Easy recycling" as cases to introduce platform data empowerment into WEEE recycling business ecosystem, believing that the digital-intelligent recycling platform can empower suppliers, customers and other participants, and further expand the application field of data empowerment.

In the context of platform data empowerment, it is necessary to study the cooperation mechanism between the third-party platform of charging pile and the operator, which involves the collaborative operation of supply chain members. At present, most relevant studies focus on the cooperation strategy research at the operation or product level. Jha et al. [16] discussed the cost sharing of product development and technology development in collaborative product development. Dai et al.[17] used game theory to analyze the cooperative behavior of cost-sharing contracts and concluded that cost-sharing contracts can bring more profits to supply chain members compared with non-cooperative contracts. Lee and Cho[18] studied how to design the supplier management inventory contract between suppliers and retailers, and pointed out that the inventory management contract that includes the sharing of consignment inventory and backorder cost is conducive to the inventory cooperation between suppliers and retailers.

In summary, the research on data empowerment has been in-depth, but few scholars have studied the data empowerment between the third-party platform of charging pile and the operator. The existing

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literature provides an important theoretical basis for exploring the participation of third-party platforms and charging pile operators in data empowerment. Therefore, this paper will establish the strategy selection model of both sides in different situations to provide a reference for the optimization decision-making behavior of charging pile industry members. The innovations of this paper are as follows :(1) from the perspective of data empowerment, it discusses the operation decisions of third-party platforms and charging pile operators, and expands the research content of platform theory; (2) The profit of platform and operator is enriched by comparing the strategy selection in different situations, which enriches the research content of charging pile industry.

3. Model construction and analysis

3.1. Basic Assumptions

This chapter constructs a system consisting of a charging pile third-party platform enterprise and a charging pile operator. In the data empowerment contract coordination model, the third-party platform of charging pile and the operator cooperate with each other[19]. The third-party platform of charging pile provides data empowerment to the operator, and the operator, as the partner, can choose to accept or reject the platform's data empowerment. If the operator chooses to accept, it will cooperate with the third-party operation platform of charging pile by investing in the application of data. After the charging pile operator accepts the data empowerment, the third-party operation platform and the operator decide the data empowerment level is l_P and the input level of data utilization is l_O. The unit electricity price cost given to the State Grid by the charging pile operator is c, and the price per KWH of electricity used by users is p. In this model, the electricity unit price and charging unit price are fixed and determined by the state grid and charging pile charging market demand respectively.

Refer to the description of demand function by scholars[20], In this paper, the charging demand of new energy vehicle users in the context of platform data empowerment is D, which can be expressed as:

$$D = D_0 + \alpha l_P + \beta l_O$$

Where, $D_0 (D_0 \geq 0)$ represents the distribution function and probability density function of random market demand D_0 under the scenario of no data enabling are $F(x)$ and $f(x)$ respectively, where $F(x)$ is a strictly increasing and differentiable function. α is the sensitivity coefficient of the charging market demand of new energy vehicles to the data empowerment of the third-party platform, $\alpha \in [0, +\infty)$. The larger the value of α is, the better the data empowerment effect of the third-party platform of charging pile on the operator, that is, the stronger the promotion effect of platform data empowerment on the charging market demand of new energy vehicles. β represents the sensitivity coefficient of charging market demand to the data application input level of charging pile operators, $\beta \in [0, +\infty)$. The larger of β is, the better the data application ability effect of charging pile operators, that is, the higher the data application input level of charging pile operators, the more the charging market demand of new energy vehicles can be improved. When the data energy of the third-party platform is l_P, the cost is $c(l_P) = k_P l_P^2 / 2$; When the input level of data utilization of charging pile operators is $c(l_O) = k_O l_O^2 / 2$, the cost of data utilization input under the scenario of platform data empowerment is l_O, k_P, k_O is respectively represented as the platform data empowerment cost coefficient and the charging pile operator's data application input cost coefficient under the scenario of no data empowerment, and k_P, $k_O > 0$.

If charging pile operators can choose to accept the third party platform of data fu, the need to invest more in the middle of the cooperation between the two sides management costs, such as operators and the third party platform enterprise data team in cooperative communication cost, cost of organizational change and so on, led to the charging pile operator can assign a situation of data in data input costs increase, will increase the multiple of set to η, Therefore, in the data empowerment scenario, the cost incurred by the operator for the input level l_O of data utilization is $(1+\eta)\ k_O l_O^2 / 2$.

This chapter takes the scenario of no data empowerment as the baseline model (NS), and studies on the basis of which the third-party operation platform of charging pile enables operators' data and the scenario (DES) of charging pile operators' data input and application, and analyzes and compares them.

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3.2. Unempowered Situation (NS)

Firstly, the revenue balance between the third-party platform of charging pile and the operator in the scenario of no data empowerment (NS) is considered. In this scenario, the third party platform does not provide data enabling services for the operator, namely $l_P = 0$. The third-party platform of charging pile charges the operator a service fee with a proportion of S as the condition for allowing the operator to connect the charging pile to the platform. The service fee ratio is determined in the contract when the recharging pile operator settles in the third-party platform, which is consistent with the actual situation of charging pile operator accessing the third-party platform. For example, Didi's third-party platform Xiaoju Charging charges operators 20 percent of the charging service fee. In order to ensure the normal operation of charging pile operators, assume that $p(1-S) \geq c$. In this case, the charging pile operator only needs to decide its own data application input level l_O, and the demand function is expressed as: $D = D_0 + \beta l_O$. Therefore, in the case of no data empowerment, the profit function of the charging pile operator is:

$$\Pi_O^{NS} = \left[p(1-S) - c\right]D - c(l_O) = \left[p(1-S) - c\right](D_0 + \beta l_O) - k_O l_O^2 / 2 \tag{1}$$

According to Equation (1), the first-order condition is, $\frac{\partial \Pi_O^{NS}}{\partial l_O} = \left[p(1-S) - c\right]\beta - k_O l_O = 0$, and solving the second-order derivative leads to, $\frac{\partial^2 \Pi_O^{NS}}{\partial l_O^2} = -l_O$. It can be found that there is an optimal charging pile operator's data input and operation cost to maximize the profit. Therefore, in the case of no data empowerment, the optimal l_O^{NS} is:

$$l_O^{NS} = \frac{\left[p(1-S) - c\right]\beta}{k_O}$$

3.3. Data Empowerment Situation (DES)

In the case of decentralized decision-making, the charging pile operator chooses to accept data empowerment from the third-party service platform. It is assumed that both subjects are bounded rational, and the decision-making behaviors of both operators and platforms are aimed at maximizing profits. The third-party platform determines the data empowerment level l_P, and the charging pile operator determines the data input and operation cost l_O. In this case, the demand function is expressed as: $D = D_0 + \alpha l_P + \beta l_O$.

In the context of decentralized decision-making, the profit function of the third-party service platform can be expressed as:

$$\Pi_P^{DES} = Sp(D_0 + \alpha l_p + \beta l_O) - k_P l_P^2 / 2 \tag{2}$$

The profit function of charging pile operator is:

$$\Pi_O^{DES} = \left[p(1-S) - c\right](D_0 + \alpha l_p + \beta l_O) - (1+\eta)\, k_O l_O^2 / 2 \tag{3}$$

The derivatives of Equation (2) and Equation (3) with respect to l_P and l_O are solved respectively. From $\frac{\partial^2 \Pi_P^{DES}}{\partial l_P^2} = -k_P < 0$ and $\frac{\partial^2 \Pi_O^{DES}}{\partial l_O^2} = -\left(1+\eta\right)k_O < 0$, it can be concluded that there exists a unique optimal l_P and l_O that maximize the profits of the third-party platform and operator. According to the first-order condition: $\begin{cases} \frac{\partial \Pi_P^{DES}}{\partial l_P} = Sp\alpha - k_P l_P \\ \frac{\partial \Pi_O^{DES}}{\partial l_O} = \left[p(1-S) - c\right]\beta - (1+\eta)\, k_O l_O \end{cases}$, it can be concluded that in decentralized decision-making situation, the optimal data empowerment level of the third-party platform is:

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$l_P^{DES} = \frac{Sp\alpha}{k_P}$, and the optimal data input and application level of the charging pile operator is: $l_O^{ES} = \frac{\left[p(1\text{-}S)-c\right]\beta}{(1+\eta)k_O}$.

4. Conclusion

In this paper, the decision-making problem of third-party platform enterprises and operators of charging piles is investigated in the scenario of no data empowerment (NS) and the scenario of data empowerment (DES).

The premise for charging pile operators to accept data empowerment from third-party operating platforms is to obtain more benefits. Combining the profit function of the scenario with no data empowerment and the scenario with data empowerment, the research conclusions are mainly as follows:

Conclusion 1: When $\eta \le \frac{2\alpha^2 Spk_O}{\beta^2 k_P\left[p(1-S)-c\right]-2\alpha^2 Spk_O}$, charging pile operators choose to accept data empowerment from third-party platforms; On the contrary, operators will not accept platform empowerment.

Proof: $\Pi_O^{DES} - \Pi_O^{NS} = \frac{\alpha^2 Sp\left[p(1-S)-c\right]}{k_P} - \frac{\eta\beta^2\left[p(1-S)-c\right]^2}{2(1+\eta)k_O}$, when $\eta \le \frac{2\alpha^2 Spk_O}{\beta^2 k_P\left[p(1-S)-c\right]-2\alpha^2 Spk_O}$, $\Pi_O^{DDES} - \Pi_O^{NS} \ge 0$;Otherwise, $\Pi_O^{DES} - \Pi_O^{NS} < 0$, Proposition 1 is proven. It can be seen that when the incremental management cost coefficient of the charging pile operator does not increase much, the operator will accept the data empowerment of the third-party platform. Therefore, for charging pile operators, the development of platform data empowerment can be effectively promoted by summarizing the experience of cooperation with third-party platforms, generating mature data application cooperation methodology, and thereby reducing the additional data application input costs incurred when receiving data empowerment.

Conclusion 2: In the scenario without data empowerment and the scenario with data empowerment, the data utilization level relationship of charging pile operators and the charging demand of users meet the following requirements: (1) $l_O^{NS} \ge l_O^{DES}$ (2) $D^{NS} \le D^{DES}$.

Proof :(1) $l_O^{NS} - l_O^{DES} = \frac{\eta\left[p(1\text{-}S)-c\right]\beta}{(1+\eta)k_O} \ge 0$; (2) $D^{NS} - D^{DES} = -\alpha l_P \le 0$. According to Conclusion 2, after receiving data empowerment from the third-party operation platform, the charging pile operator's own data application investment level is reduced, but the charging demand of users will be higher than that of the scenario without data empowerment. The reason is that after the charging pile operator accepts the data empowerment from the third-party platform, it will help promote the interconnection of charging piles, integrate various data resources, and better provide users with one-stop charging service. Therefore, when the operator accepts the data empowerment from the platform, the charging demand of new energy vehicle users will increase. This will offset the negative impact on market charging demand caused by charging pile operators reducing the level of data input and use. The data empowerment of charging pile operators by third-party platforms can also reduce the input cost of data utilization of operators and improve the profits of charging pile operators while increasing the total market charging demand of users. Operator, but it is worth mentioning that the charging pile after fu can accept the third party platform data tend to decrease the cost of their own data using is essentially the "free rider" behavior of operators, operators and charging pile after fu can accept platform data, improve its own data using appropriate investment level can make the data after the fu can act more effective, therefore, The third-party platform of charging pile can make verified contracts to constrain operators' "free-riding" behavior and motivate them to improve the input level of data utilization.

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