Comprehensive Evaluation of Product Design Quality for Stakeholder Needs

An Empirical Study on the Example of Company S

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Abstract. In view of the importance of quality in the design and development stage, we introduce the classification of stakeholders and their specific needs for product design quality, and construct a comprehensive evaluation index system for product design quality to meet the needs of stakeholders. A representative manufacturing company is selected as an empirical case, and the indicators are assigned with the CRITIC method and solved with the TOPSIS method. Finally, the evaluation results of the product design quality of the representative company are obtained, and the validity of the system in this paper is verified at the same time.

Keywords: Stakeholders · Product design quality · Indicator system · CRITIC weighting · TOPSIS method

1 Introduction

Involving stakeholders in the product design and development process and observing the mechanism of their role between the performance of new product development in high technology firms [1]. It is shown that in the process of developing new products, companies should have sufficient knowledge of stakeholders' needs and information [3], and need to pay attention not only to the value demands of internal stakeholders such as shareholders, new product development teams, and corporate alliances [2], but also to the demand information of important external stakeholders such as consumers, suppliers, and government, so as to lay the foundation for the improvement of new product development quality [5].

Based on this background, this study introduces stakeholder needs into the product design and development process, and analyzes in detail how stakeholder needs will affect each stage of the product design process and how to improve the design quality to meet such needs [4]. The evaluation index elements are then selected on this basis. The CRITIC method is used to calculate the weights of the indicators, and TOPSIS is applied to make a comprehensive evaluation of the research object.

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2 Comprehensive Evaluation Model of Product Design Quality

2.1 Evaluation Method Selection

Because of the differences and correlations among the evaluation indicators in this study, the CIRTIC weighting method, which can describe the different relationships among the indicators in a relatively comprehensive way, was chosen as the objective weighting method. The indicators selected in the index system are all quantitative indicators, which are available, practical and objective data, and are in line with the scope of application of TOPSIS method.

2.2 Evaluation Model Building

After summarizing and outlining the previous studies, combined with the actual product development and the current situation of social development, this paper is divided into seven categories based on the importance of the relationship between stakeholders and enterprises, whether they have social nature and whether the relationship with enterprises is directly established by real people, covering more comprehensively the groups or individuals who directly or indirectly exchange interests or influence interests with enterprises. The indicator system is shown in Fig. 1.

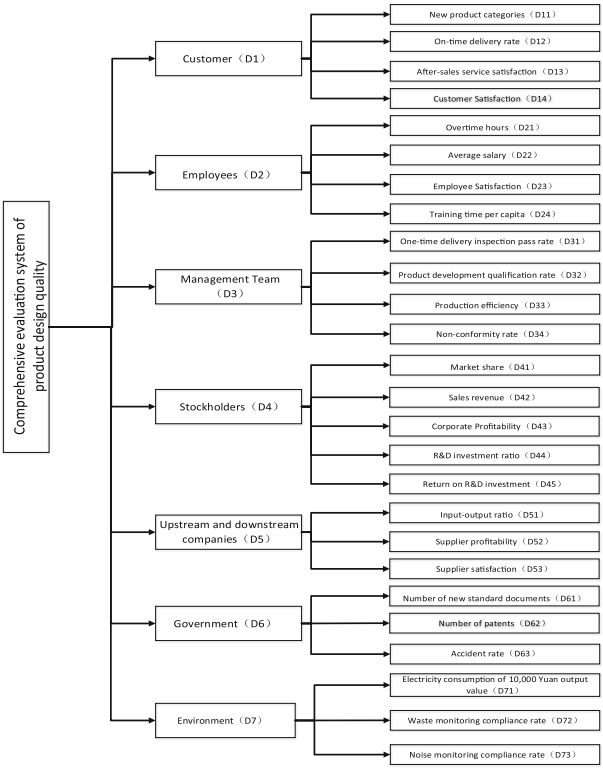

Fig. 1. Comprehensive evaluation system of product design quality

3 Empirical Analysis

This subsection will analyze and optimize the content and process of the development and design of a new product of this type by presenting the current status of the development and design process of a new aerial sensor project of Company S, taking into account the characteristics of the needs of corporate stakeholders. The calculation formula refers to the standard formula of CRITIC method and TOPSIS method. The final results of the calculations are shown in Tables 1, 2, 3 and 4.

Table 1. Product design quality comprehensive evaluation index weights

Dimensionality	Weights (%)	Indicators	Weights (%)
customer (D1)	14.424	New product categories	3.039
		On-time delivery rate (%)	5.228
		After-sales service satisfaction (%)	3.388
		Customer Satisfaction (%)	2.769
Employees (D2)	11.438	Overtime hours (hour)	2.775
		Average salary (yuan)	3.132
		Employee Satisfaction (%)	2.774
		Training time per capita (hour)	2.757
Management Team (D3)	12.603	One-time delivery inspection pass rate (%)	3.044
		Product development qualification rate (%)	3.055
		Production efficiency (%)	3.253
		Non-conformity rate (%)	3.251
Stockholders (D4)	24.124	Market share (%)	3.698
		Sales revenue (million yuan)	3.266
		Corporate Profitability (%)	3.099
		R&D investment ratio (%)	3.557
		Return on R&D investment (%)	13.603
Upstream and downstream companies (D5)	14.397	Input-output ratio (%)	8.119
		Supplier profitability (%)	3.479
		Supplier satisfaction (%)	2.799
Government (D6)	5.748	Number of new standard documents	0
		Number of patents	2.943
		Accident rate (%)	2.805
Environment (D7)	14.168	Electricity consumption of 10,000 Yuan output value (million kWh)	8.156
		Waste monitoring compliance rate (%)	3.199
		Noise monitoring compliance rate (%)	2.813

Table 2. Proximity of the seven major stakeholders

Seven dimensions	2019	2020	2021	Average
customer (D1)	0.4819	0.2327	0.8019	0.5055
employee (D2)	0.3614	0.6033	0.6386	0.5344
Management team (D3)	0.5699	0.3709	0.6291	0.5233
Stockholders (D4)	0.3411	0.5143	0.7103	0.5219
Upstream and downstream companies (D5)	0.3223	0.1737	1.0000	0.4987
government (D6)	0.4940	0.6738	0.5059	0.5579
environment (D7)	0.0000	0.4352	1.0000	0.4352

Table 3. Comprehensive closeness

Year	Positive ideal solution distance (D+)	Negative ideal solution distance (D-)	Comprehensive closeness	Sorting
2019	0.74903077	0.58273008	0.43756361	2
2020	0.79704477	0.44462066	0.35808411	3
2021	0.48095508	0.85977121	0.64127273	1

From the detailed analysis of the indicators such as closeness and weighting above, it can be concluded that the satisfaction of the needs of major stakeholders in the quality of product design of company S can be described as the strengths and weaknesses of company S in the product design stage, as shown in Table 4.

Table 4. Strengths and weaknesses of the product design phase of company S

Categories	Specific content
Advantages	A relatively even level of satisfaction for most stakeholders' needs
	The product design phase produces more patent results
	Ability to respond quickly to changes in customer needs
	Valuing employees in the product design phase
	Product design will take into account the actual supply and demand of raw materials
Disadvantages	Unstable return on investment from upstream companies
	Less consideration of the workload and power consumption in the production phase during the product design phase
	Changes in the external environment have a greater impact on the quality of product design
	Overall profitability of new products is low

4 Conclusion

In this study, a comprehensive evaluation of the quality of product design of Company S in terms of satisfying the needs of seven major stakeholders was conducted. Due to the characteristics of the analyzed dimensions and indicators, the CRITIC method was chosen to determine the weights of the indicators, and then a comprehensive evaluation was conducted using the distance between superior and inferior solutions (TOPSIS) method based on the weights derived from the CRITIC method.

The results of the comprehensive evaluation showed that the average of the proximity of the seven stakeholders was maintained at about 0.5, indicating that the degree of satisfaction of the needs of the seven stakeholders in the product design quality of company S was basically qualified, but the level was not high. The empirical analysis can show that the comprehensive evaluation system constructed in this study for product design quality is more scientific and reasonable.

References

1. Ma L, Xu G, Gao Y. Stakeholder integration and new product development performance of high-technology firms-a mediated model with moderation[J]. Science and Technology Management Research, 2021, 41(21):60-70.
2. Xie Xuemei, Wang Lijun. The mechanism of user involvement on the performance of new product development in companies: based on online community perspective[J]. Nankai Management Review, 2019, 22(03):91-102.
3. Zhao Unity. Exploration on the construction of internal control system for enterprise product quality management [J].
4. Finance and Accounting, 2020, No. 614(14):48-51. Freeman R E. Strategic management: a stakeholder approach[M] J. Boston: Pitman, 1984.
5. Mark E. Holder and Frederick W. Langrehr and J. Lawrence Hexter. Dividend Policy Determinants: An Investigation of the Influences of Stakeholder Theory[J]. Financial Management, 1998, 27(3):73-82.