

CONCEPT OF A MODEL TO PREDICT THE QUALITATIVE-COST LEVEL CONSIDERING CUSTOMERS' EXPECTATIONS**Siwiec D., Pacana A., Ulewicz R.***

Abstract: The main problem of modern entrepreneurs is the adequate recognition of customer expectations based on current products. The purpose of the study is to propose the concept of a model to predict the qualitative-cost level of this modified product. The idea of the concept depends on determining the product that will be satisfactory for the customer, i.e., satisfied simultaneously in turn of quality and cost of purchase. A questionnaire is used to obtain customer expectations. Then, according to the DEMATEL method, the relations between these criteria are determined. Next, the weights (importance) of the criteria are estimated by arithmetic average. Additionally, according to the Likert scale, these criteria' initial quality (customer satisfaction) is assessed. Based on these, the quality of the product is estimated by using the WSM method. The calculated product quality is combined with the real cost of its purchase in the qualitative-cost analysis (AKJ). According to the results of the qualitative-cost analysis, the expected product of the customer is predicted. This process is supported by the Relative States Scale. The proposed conception can be used to verify any product. Therefore, it can be useful for different entities offering products to the customer and striving to meet their expectations (satisfaction). The originality is the simultaneous prediction of the expected level of product quality and the cost of its purchase and the ability to determine customer satisfaction at this qualitative-cost level.

Key words: predict, product quality, customer expectations, DEMATEL method, Weighted Sum Model

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Introduction

The dynamic changes in the market area and intense competition happened during the evolution of customer expectations (Gurau et al., 2001, Ingaldi, 2021). Therefore, the area of product quality improvement is aimed at achieving customer satisfaction (Pacana and Siwicz, 2021). It is possible by improving the internal features of the product, so the product attributes to determine its quality. Moreover, the external features of product quality, e.g., price of purchase (cost), is one of the main factors that condition the choice of product (Hocquett et al., 2012; Tomov and Velkoska,

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2022). Their proper selection can contribute to the acquisition of loyal customers who will always choose the same product. It is possible only through adequate recognition of customer needs. Then, fulfilment and adjustment of these needs for change over time (Keiningham et al., 2007). This is realized as part of the satisfactory assurance product. Therefore, it is necessary to develop adequate conceptions. These conceptions should be used in a consistent and well-targeted manner. Then, these conceptions should be useful in predicting products expected by customers (Chan et al., 2011). Despite that, predicting the expected quality of products and their simultaneous purchase cost is still an open problem (Czerwinska and Piwowarczyk, 2022; Streimikiene et al., 2022).

The literature review shows that Chan et al. (2011) predicted the purchase behaviours and estimated the product's net value according to those behaviours. In turn, in work (Gurau et al., 2001), a model was proposed to predict the profitability of customers according to a measure of customer satisfaction for market conditions. Despite the authors' work (Morgan et al., 2006) verified relations between customer satisfaction and their loyalty to products in the context of the predicted expected product. The analysis in a similar context was carried out by previous researchers (Keiningham et al., 2007; Xu et al., 2006; Marasová et al., 2021). The next example is the work (Pratibha, 1995), which anticipated various product service events. For this purpose, the customer satisfaction and quality of these services were verified in the context of causes and effects. Another approach was shown in this work (Gupta, 2018), where machine learning and linear regression were used to predict the quality of the product. That relied on adequately selected product attributes. Similar techniques were used by (Benardos and Vosniakos, 2003) in the context of predicting the quality of product surface (roughness). Material processing theories, experimental research, and the possibilities of using artificial intelligence (AI) were verified. However, Derkanosova et al. (2018) predicted customer satisfaction from the purchase of a product in categories in terms of choice: good (will definitely buy) and bad (will definitely not buy). For this purpose, the selection index verification algorithm was used, supported by the k-means method and multiple grouping. The software model was developed in another study (Maxfield et al., 2020). This model has presented the complexity of the product and its graphical scheme. The operation and deformation of the product were analyzed in this way. Additionally, the customer interactions in this model were verified.

After the literature review, it was concluded that different concepts were used to predict product quality levels or cost of its purchase. Despite that, there is still a lack of coherent concepts to predict the qualitative-cost level expected by the customer. This means a lack of a single concept, which would enable verification of qualitative-cost relations considering the needs of the customer. Therefore, the purpose was to propose the concept of a model to predict the qualitative-cost level of the product considering customer expectations. The idea of concept relies on determining the necessary (key) criteria in assessing the quality of the product. Additionally, the concept refers to the prediction of customer satisfaction from the quality level

combined with the cost of purchase. It was assumed that the proposed conception could be used to verify any product. Therefore, it can be useful for different entities offering products to customers and striving to meet their expectations.

Concept of model

The model concept includes predicting the product's qualitative-cost level considering customer expectations. It refers to the determination of the expected product criteria and the relations between them. On this basis, the quality product is estimated, which is integrated with the purchase cost. According to the qualitative-cost level, the product expected by the customer is predicted. The concept of model relies on integrated techniques, i.e., the SMART(-ER) method (S – specific, M – measurable, A – achievable, R – relevant or realistic or reward, T – based on timeline or timebound, E – exciting or evaluated, R – recorded or reward (Lawlor and Hornyak, 2012), brainstorming method (BM) (Putman and Pauls, 2011), questionnaire, the DEMATEL method (Decision making trial and evaluation laboratory) (Kijewska et al., 2018; Kobry, 2018; Nusenu et al., 2019; Si et al., 2018; Siwiec and Pacana, 2021), the WSM method (Weighted Sum Model) (Gupta et al., 2021; Kolios et al., 2016; Siwiec and Pacana, 2021; Tscheikner et al., 2017; Androniceanu & Tvaronavičienė, 2019), the qualitative-cost analysis (AKJ) (Makiela et al., 2022; Ulewicz et al., 2021; Pacana et al. 2020), and Relative States Scale (Siwiec and Pacana, 2021). The choice of the proposed techniques was conditioned by the benefits and conditions of these methods, as is shown in the literature on the subject (Lawlor and Hornyak, 2012; Putman and Pauls, 2011; Si et al., 2018; Ulewicz et al., 2021). The concept of the model and the selected techniques were developed as part of eight main stages (Figure 1). The characteristic of the concept is shown in the next part of the study.

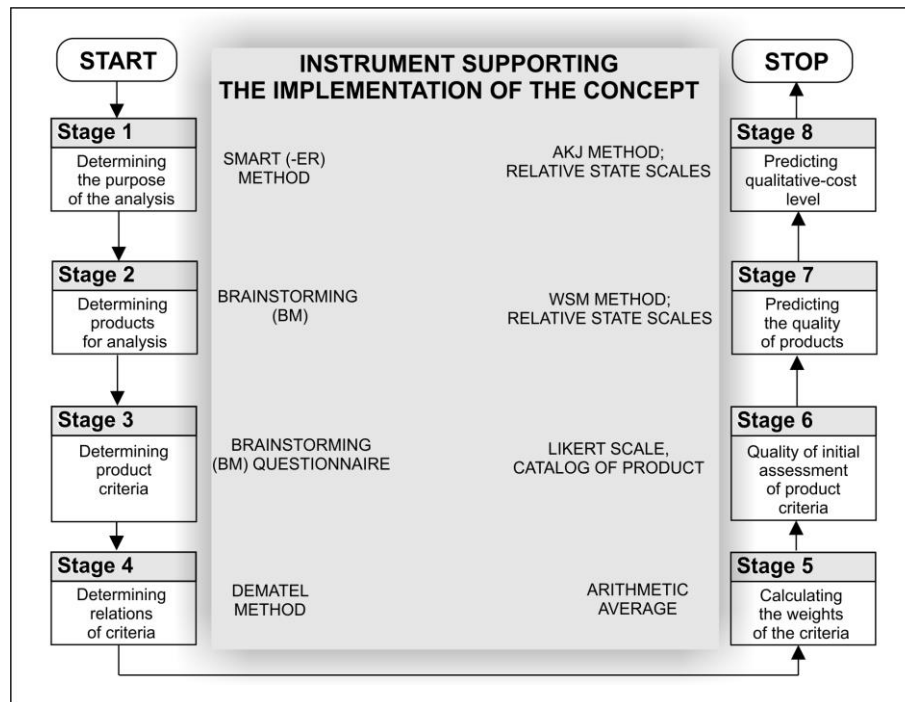


Figure 1: Scheme of stages and instruments of the proposed model to predict the quality of products.

Research Results

The concept of the model to predict the qualitative-cost level of the product level considering customer expectations is presented. The concept is realized in eight main stages.

Stage 1. Determining the purpose of the analysis.

To determine the aim, the SMART(-ER) method were used (Lawlor and Hornyak, 2012). The purpose is determined by the entity (bidder, broker, expert). In this case, the purpose is to predict the qualitative-cost level of product expected by the customer. The prediction is realized according to correlated criteria, i.e. technical, utility, and aesthetic, and the cost of purchase.

Stage 2. Determining products for analysis.

The choice is made by an expert (entity). This relies on determining any number of products, which will be proposed to the customer. These can be products which are at his disposal. These products should be the same type (Siwiec and Pacana, 2021).

Stage 3. Determining product criteria.

It was assumed that verification of the product includes technical criteria and customer criteria (utility and aesthetic). The idea is to acquire customer expectations and process these expectations into technical requirements for the product.

Therefore, technical criteria are basic criteria for the product, which generate quality of the product. These criteria are determined by an expert (or group of experts) during the brainstorming (BM) method and by using the catalog (specification) of the product. According to (Huang, 1999; Roder et al., 2013), the number of technical criteria should be equal to 14 to 25 criteria. In turn, customer criteria (utility and aesthetics) are obtained during an interview or questionnaire. These criteria are technical criteria described in a subjective (qualitative) way. Whereas, the aesthetic criteria are determining the landscape values during utility product or after it is installed in a given place (Lucchi et al., 2020; Sánchez-Pantoja et al., 2021). It was assumed that in the questionnaire, it is necessary to propose possible utility and aesthetic criteria. This will be useful for the customer to determine his preferences. Moreover, the customer should be able to point his own criteria. Out of all criteria, the customer was selected from 5 to 9 criteria. It resulted from the rule of effectiveness to compare these criteria in pairs, i.e., (Siwiec and Pacana, 2021). The criteria selected by the customer are so-called expected criteria. Then, the customer determines the weights only for the expected criteria. In this aim, following two authors of works (Lescauskiene et al., 2020; Odu, 2019; Til., et al. 2019), it was assumed that customer distributes 100 points between these criteria. The more points, the more important the weight.

Stage 4. Determining relations of criteria.

The aim is to determine the technical criteria sufficient to estimate the quality level of the product. It is realized by determining the relations between technical criteria and customer criteria (utility and aesthetic). It was assumed to use the DEMATEL method, which is described in the literature on the subject, e.g. (Kijewska et al., 2018; Kobry, 2018; Nusenu et al., 2019; Si et al., 2018; Siwiec and Pacana, 2021). Technical criteria correlated with customer criteria are the key criteria to calculate the quality of the product. It was considered those based only on that criteria, the next stages of the model are realized.

Stage 5. Calculating the weights of the criteria.

The weights of the criteria are calculated based on the value of the weights from the questionnaire (from stage 3). It relies on the conversion of weight values to decimal values (1). Then, the arithmetic averages from these values are calculated (2). The average value is calculated from all customer criteria correlated with a given technical criterion. Then, the normalization of the criteria weights is done (3) (Manikandan, S. 2011; Siwiec and Pacana, 2021):

$$w_i = \frac{p_i}{100} \quad (1)$$

$$\bar{w}_i = \frac{\sum_{n=1}^n w_i}{n} \quad (2)$$

$$w_i^n = \frac{w_i}{\sum_{i=1}^n \bar{w}_i} \quad (3)$$

where: p – number of points in the questionnaire, w – weight of the criterion, i = 1, 2, ..., n.

Stage 6. Quality of initial assessment of product criteria.

It refers to determining the meeting of customer expectations by key product criteria. The assessment is done by an expert on the Likert scale (1-5), where 1 - the lower quality of criterion, and 5 is the highest quality of the criterion (Wang and Chin, 2011). It is necessary to assess the quality of all key criteria (from stage 4) for all verified products (from stage 2). It is useful to rely on characteristic catalogues of these products.

Stage 7. Predicting the quality of products.

This stage is based on the estimation of the quality of product. Then, based on quality levels, customer satisfaction is predicted. To this aim, the Weighted Sum Model (WSM) (Gupta et al., 2021; Kolios et al., 2016; Siwicz and Pacana, 2021; Tscheikner et al., 2017), and Relative States Scale were used. The WSM method is used to estimate the quality of products. In this method, the quality is estimated considering the weights (importance) of the criteria and initial assessment of the quality of these criteria. Formula (4) is used for this:

$$A_i^{WSM} = \sum_{i=2}^n w_i^n x_{ij} \quad (4)$$

where: w – weight of the criterion, x – initial assessment of quality of criterion $i, j=1, \dots, n$

After the estimated quality of all products, it is necessary to predict the satisfaction of quality. It refers to the prediction of meeting customer expectations, where the maximum value of quality is the most favorable product. In case of similar values of product quality, the choice is done according to the Relative States Scale, as is shown in, e.g., (Ulewicz et al., 2021).

Stage 8. Predicting qualitative-cost level.

The idea of this stage is based on the combined quality of the product with the cost of its purchase. The purpose is to determine the product which will be satisfied for the customer both in quality and cost of purchase. Qualitative-cost analysis (AKJ) is used for that (AKJ). The method is shown in the subject of literature (Ulewicz et al., 2021; Pacana et al., 2020; Siwicz and Pacana, 2021). The last choice is realized based on the Relative States Scale.

Discussion

The turbulent area causes the main problem of enterprises is achieving customers' expectations from products. Therefore, it is necessary to obtain customer information based on current products and financial aspects. It can be concluded that customer satisfaction is predicted according to the cost of purchasing the product or market conditions (Chan et al., 2011; Derkanosova et al., 2018; Gurau et al., 2001). Also, the relationship between customer satisfaction and their loyalty to products in the context of the predicted expected products was analyzed based on the studies (Keiningham et al., 2007; Morgan et al., 2006; Xu et al., 2006; Androniceanu et al., 2022). Hence, it was concluded those different concepts to predict product quality

levels or cost of its purchase were applied. However, there is still a lack of coherent concepts to predict the qualitative-cost level expected by the customer. It refers to the lack of a single concept that would enable verification of qualitative-cost relations considering the customer's needs. The purpose of the study is to propose the concept of a model to predict the qualitative-cost level of this modified product. The idea of the concept depends on determining the product that will be satisfactory for the customer, i.e., satisfied simultaneously in turn of quality and cost of purchase. The originality of the concept is the simultaneous prediction of the expected level of product quality and the cost of its purchase and the ability to determine customer satisfaction at this qualitative-cost level.

The predicted benefits of the proposed concept are

- possibilities to determine social-ecological interactions by combining customer criteria (utility and aesthetic) with technical criteria, and by which the product quality is determined
- increased precision in determining expectations by its verification according to its weights (importance for the customer)
- taking care of the surroundings (landscape) by including aesthetic criteria and focusing on achieving the expected level of quality

Limitations of the model are

- the possibility of having expectations only for a single customer
- a lack of included changes of expectations over time

The proposed conception can be used to verify any product. Hence, this approach can be useful for different entities offering products to the customer and striving to meet their expectations (satisfaction).

Conclusion

Meeting customer expectations is the main purpose of organizations. It is looking for different methods that support this process. Mainly in terms of quality and cost, i.e., achieving a satisfactory product quality and its purchase cost. Therefore, the purpose was to propose the concept of a model to predict the qualitative-cost level of the product considering customer expectations. The proposed conception concerned the identification of key product criteria in groups: utility, aesthetic, and technical. Moreover, it relies on determining its weights (importance) for the customer. The concept of the model included integrated techniques, i.e., the SMART(-ER) method, brainstorming (BM), questionnaire, the DEMATEL method, the WSM method, qualitative-cost analysis (AKJ), and Relative States Scale. It was considered that calculation of product quality for expected criteria and important for customer allows growth customer satisfaction. The quality was estimated using the WSM method. Then, it was considered useful to combine this quality with the cost of purchasing the product. It was assumed that the AKJ method will be used for that. According to qualitative cost analysis, the satisfaction of the customer satisfaction with the product is determined.

Future research will be based on adjusting model to obtain expectations from a larger group of customers. Also, it is planned to develop a computer algorithm to dynamically determine qualitative-ecological interactions and assess product quality.

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KONCEPCJA MODELU PRZEWIDYWANIA POZIOMU JAKOŚCIOWO-KOSZTOWEGO Z UWZGLĘDNIENIEM OCZEKIWAŃ KLIENTÓW

Streszczenie: Głównym problemem współczesnych przedsiębiorców jest odpowiednie rozpoznanie oczekiwań klienta na podstawie aktualnych produktów. Celem opracowania jest zaproponowanie koncepcji modelu do przewidywania poziomu jakościowo-kosztowego produktu według modyfikacji produktu. Idea koncepcji polega na określeniu satysfakcjonującego dla klienta produktu, który będzie jednocześnie zadawalający pod względem jakości i kosztu jego zakupu. Kwestionariusz wykorzystuje się do pozyskania oczekiwań klienta. Kolejno, według metody DAMATEL określane są relacje pomiędzy

kryteriami. Następnie stosując średnią arytmetyczną szacowane są wagi (ważność) kryteriów. Dodatkowo, według skali Likerta oceniana jest wstępna jakość (satisfakcja klienta) z tych kryteriów. Na ich podstawie szacowana jest jakość produktu zgodnie z metodą WSM. Obliczona jakość produktu łączona jest z rzeczywistym kosztem ich zakupu w analizie kosztowo-jakościowej (AKJ). Według poziomu kosztowo-jakościowego przewidywany jest produkt oczekiwany przez klienta. Wybór wspierany jest skalą stanów względnych. Proponowana koncepcja może być stosowana do weryfikacji dowolnych produktów. Dlatego może być użyteczną dla różnych podmiotów oferujących produkty klientowi i dążących do spełnienia ich oczekiwań (satisfakcji). Oryginalnością jest jednocześnie przewidzenie oczekiwanego poziomu jakości produktu i kosztu jego zakupu oraz możliwość określenia satisfakcji klienta z tego poziomu jakościowo-kosztowego.

Słowa kluczowe: przewidywanie, jakość produktu, oczekiwania klienta, metoda DEMATEL, model sumy ważonej

考虑客户期望的定性成本水平预测模型概念

摘要: 现代企业家的主要问题是基于当前产品对客户期望的充分认识。该研究的目的是提出一个模型的概念来预测这种改性产品的定性成本水平。该概念的想法取决于确定令客户满意的产品，即同时满足质量和购买成本。使用问卷调查来获得客户的期望。然后，根据 DEMATEL 方法，确定这些标准之间的关系。接下来，通过算术平均，估计标准的权重（重要性）。此外，根据李克特量表，评估这些标准的初始质量（客户满意度）。在此基础上，使用 WSM 方法对产品质量进行评估。在定性成本分析（AKJ）中，将计算出的产品质量与其购买的实际成本相结合。根据定性成本分析的结果，预测客户的预期产品。这个过程得到了相对状态量表的支持。所提出的概念可用于验证任何产品。因此，它对于向客户提供产品并努力满足他们的期望（满意度）的不同实体很有用。独创性是同时预测产品质量的预期水平和购买成本，以及在此定性成本水平上确定客户满意度的能力

关键词: 预测, 产品质量, 客户期望, DEMATEL方法, 加权和模型