INTEGRATION BETWEEN THE KANO MODEL AND TIME-DRIVEN ACTIVITY-BASED COSTING (TD-ABC) AND ITS ROLE IN ENHANCING PRODUCT VALUE

,Rabab Ali Hafidh
Haider Atta Zabin
,Department of accounting, College of Administration and Economics
,University of Wasit
Wasit, Iraq

Abstract. The research aims to enhance product value and meet customer requirements by integrating the Kano Model with Time-Driven Feature-Based Costing (TD-FBC). The Kano Model identifies customer requirements by surveying their opinions and incorporating them into the product. Meanwhile, TD-FBC contributes to allocating costs to products in a manner that aligns with the features and functions customers desire in the product. To test the research hypothesis, Ur State Company / Extrusion Factory, one of the Ministry of Industry companies in Dhi Qar Governorate, was selected. The deductive approach was adopted in the theoretical framework to test the hypothesis and address the research problem, while the experimental approach was applied to implement the integration between the Kano Model and TD-FBC and demonstrate its role in enhancing product value. The research reached several conclusions, most notably that the integration between the Kano Model and TD-FBC leads to a deeper understanding of customer desires versus the costs incurred by the economic unit to achieve them. It also guides the economic unit’s resources and time toward high-value requirements from the customer's perspective, thereby enhancing product value.

ИНТЕГРАЦИЯ МОДЕЛИ КАНО И СИСТЕМЫ УЧЕТА ЗАТРАТ ПО ВИДАМ ДЕЯТЕЛЬНОСТИ, ОСНОВАННОЙ НА ВРЕМЕНИ (TD-ABC), И ЕЁ РОЛЬ В ПОВЫШЕНИИ ЦЕННОСТИ ПРОДУКЦИИ

Рабаб Али Хафид
Хайдер Атта Забин

Кафедра бухгалтерского учета,
Колледж управления и экономики,
Университет Васит,
Васит, Ирак

Аннотация. Настоящее исследование направлено на повышение ценности продукции и удовлетворение требований клиентов посредством интеграции модели Кано с системой учета затрат по характеристикам продукции, основанной на времени (TD-FBC). Модель Кано позволяет выявлять требования потребителей путем изучения их мнений и учитывать их при разработке продукции. В свою очередь, система TD-FBC способствует распределению затрат на продукцию в соответствии с характеристиками и функциями, которые являются наиболее значимыми для потребителей. Для проверки гипотезы исследования была выбрана Государственная компания «Ур» (Ur State Company), Экструзионный завод, являющийся одним из предприятий Министерства промышленности Ирака в провинции Ди-Кар. В теоретической части исследования был использован дедуктивный подход для проверки гипотезы и решения исследовательской проблемы, тогда как в практической части применялся экспериментальный подход для реализации интеграции модели Кано и системы TD-FBC и демонстрации её роли в повышении ценности продукции. По результатам исследования был сделан ряд выводов, наиболее важным из которых является то, что интеграция модели Кано и системы TD-FBC обеспечивает более глубокое понимание потребностей клиентов и соотношения между этими потребностями и затратами, которые несёт экономическая единица для их удовлетворения. Кроме того, данный подход позволяет направлять ресурсы и время предприятия на реализацию требований, обладающих наибольшей ценностью с точки зрения потребителя, что способствует повышению общей ценности продукции.

Introduction

Amidst the fierce competitive market and shorter life cycles of products owing to constant changes in the taste and preference of customers, caused by openness of the country to the global marketplace, market share retention or customer satisfaction cannot be achieved through product quality or cost alone anymore. It is therefore essential to utilize integrated management systems and methods that will increase product value by eliminating wastage of costs and identifying the needs of the customers. This research attempts to increase product value by combining the Kano Model method which emphasizes the analysis of voice of the customer and classifies their needs into different categories with the Time Driven Function-Based Costing (TD-FBC).

The Kano Model was invented by Dr. Noriaki Kano in the 1980s; this approach emphasizes the classification of the attributes of the products or services according to the effect that they have on customers' satisfaction. There are five main requirements for these attributes, including Must-be/Must-have, One-dimensional, Attractive, Indifferent, and Reverse. Using this classification, economic entities will be able to comprehend better what customers require from them, focusing on those aspects that really affect their satisfaction. Thus, applying the Kano Model is an intelligent move towards improvement of products.

The Time Driven Activity Based Costing (TD-ABC) method is believed to be one of the most significant contemporary approaches used in accounting that strive to give a more accurate representation of costs of activities and operations in enterprises. The TD-ABC approach is based on measuring the amount of time taken by resources to complete activities. This method is distinguished by its relative simplicity in comparison with traditional ones. Additionally, TD-ABC helps to identify inefficiencies and increases effectiveness through removing those activities that do not add value for customers. Therefore, using this method is crucial in optimizing costs and focusing on value-added activities.

The improvement of product value is among the objectives that have been identified to be critical for economic units. The process can therefore be described as an effort that seeks to improve the utility value of the product to the customer compared to its price. Value improvement is done through improvements in design quality, product performance, manufacturing efficiency, and customer services which meet the customers' needs beyond their expectations. The process of value improvement is highly associated with innovation and development since it helps the economic unit to gain competitive advantage.

Section One: Research Methodology

First: Research Problem

The Iraqi industrial economic entities confront many difficulties in attempting to integrate between client satisfaction and cost distribution. This could lead to the creation of designs that might have the emphasis on certain needs that would not add much to the satisfaction of the clients or cost saving done unilaterally. This means that there could be a waste of resources or the provision of products that may not provide value for money to the customers. The problem could be framed in the following questions:

1) Do the Kano Model and Time-Driven Function-Based Costing system contribute to enhancing product value?

2) What is the impact of this integration on supporting managerial decisions to balance customer satisfaction with cost reduction?

Second: Research Objectives

The research aims to achieve the following:

1. Examining the feasibility of constructing an integrated framework between the customer-satisfaction-oriented Kano Model and the time-driven TD-FBC system to determine the technological cost of activities.
2. Providing a guide for industrial managements on how to direct resources and time toward high-value functions.
3. Raising the awareness level of economic units regarding mechanisms to confront global competition by linking design quality with actual cost.

Third: Research Hypothesis

The research stems from a main hypothesis stating that: "The integration between the Kano Model and the time-driven TD-FBC leads to enhancing product value by maximizing customer satisfaction and rationalizing activity costs."

Fourth Research Importance: The importance of the research stems from enriching accounting and managerial thought with a modern integrated tool. This tool helps uncover the flaws inherent in traditional accounting systems and works on enhancing product value in a way that aligns with meeting customer requirements, as well as achieving a competitive advantage for the economic unit.

Fifth Research Population and Sample (Field of Application): The research population is represented by the industrial sector in Iraq, while the specific field of application is represented by Ur State Company / Extrusion Factory – Unanodized Aluminum Profiles.

Section Two: Conceptual Framework

First: The Kano Model

1. The Origin, Concept, and Definition of the Kano Model:

The Kano Model was first introduced to distinguish among three primary requirements: must-be, one-dimensional, and attractive requirements. Each of these requirements influences customer satisfaction in distinct ways when fulfilled (Radfar et al., 2014: 441). Must-be requirements represent indispensable, "taken-for-granted" customer demands that are essential in a product or service. Their presence does not positively increase customer satisfaction; however, their absence leads to extreme dissatisfaction (Rui, 2013: 38). Conversely, for one-dimensional requirements, the level of customer satisfaction is directly proportional to the fulfillment level of the requirement within the product or service. This means that higher quality in meeting the requirement leads to increased customer satisfaction, and vice versa (Hao & Li, 2010: 10). Finally, attractive requirements are characterized by their ability to generate high levels of customer satisfaction when present in products or services. Nevertheless, their absence does not cause customer dissatisfaction, as these requirements are unexpected from the economic unit. Furthermore, Rust & Oliver categorized customer delight factors into the following categories based on human memory function (Goswami & Sarma, 2019: 407):

A. Imagined Delight: This involves customers remembering "delightful consumption experiences," which means accepting them as normal due to "heightened expectations." In short, this type of delight raises customer expectations and can foster customer loyalty through attraction.

B. Re-enacted Delight: This involves the customer joy experienced when a person plays a favorite movie or song. In the case of re-enacted delight, marketers can secure loyalty by re-enacting memories of delight.
C. Transient Delight: This type of delight can be attributed to fate, randomness, or mere coincidence.

Additionally, Mikulić defined the Kano Model as a customer requirements model, a customer needs model, or simply the theory of attractive quality; however, it has become popularly recognized as the Kano Model (Mikulić, 2007: 2).

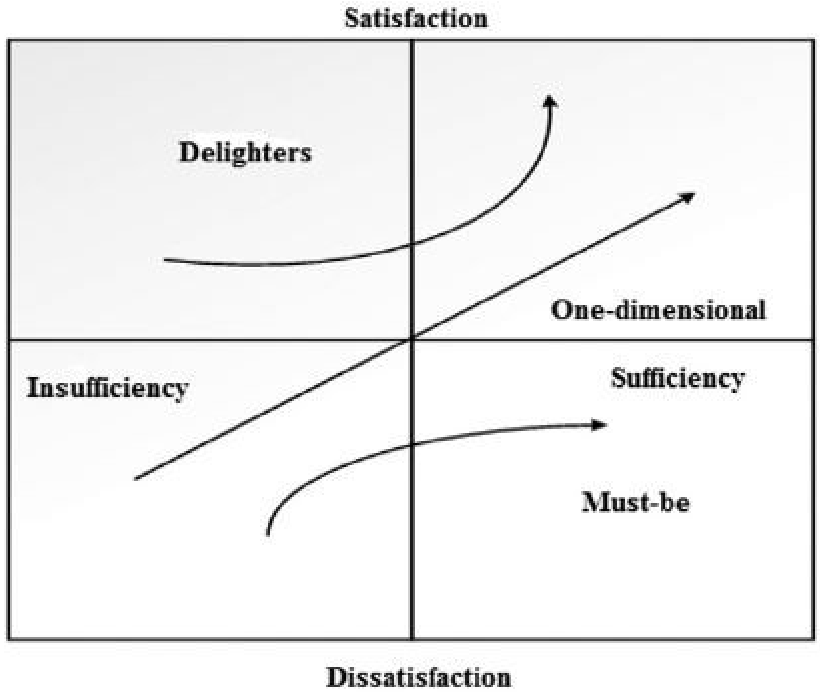
2. Customer Requirements According to the Kano Model: Kano classified customer requirements into three primary categories:

A. Must-Be Requirements (Must-Have): These are requirements that lead to dissatisfaction when they are not fulfilled (or when they are provided at an unsatisfactory level), because the customer takes them for granted. However, when they are fulfilled (provided at a satisfactory level or higher), they do not lead to positive satisfaction (creating an asymmetric effect). The attributes of these requirements are implicit, intuitive, and not particularly distinctive or explicit. Evidently, when an economic unit fulfills must-be requirements, it merely secures its entry into the market, whereas a decline in fulfilling them leads to an excessive increase in dissatisfaction (or a drop in satisfaction).

B. Performance Requirements (One-Dimensional): These are requirements that result in satisfaction when fulfilled and dissatisfaction when left unfulfilled (Mikulić, 2007: 2). It is clear that fulfilling performance requirements ensures that the economic unit can compete in the market. An increase in fulfillment leads to a proportional increase in satisfaction, while a decrease in fulfillment leads to a proportional decrease in satisfaction (or an increase in dissatisfaction), causing the economic unit to fall short.

C. Attractive Requirements: When these requirements are fulfilled, they provide delight and satisfaction; however, when they are not met, they do not cause dissatisfaction because they are unexpected by the customer. Meeting these requirements can be described as "expressive" or "articulate"; meaning that when the economic unit satisfies these unexpected requirements, the customer cannot deny their feeling of delight (Zwein, 2009:13). Fulfilling attractive requirements ensures that the economic unit distinguishes itself from competing firms in the market, as an increase in fulfillment triggers an exponential increase in satisfaction. For instance, on the Gmail website, it is pleasantly surprising that the platform provides an intelligent system to prioritize emails based on monitoring user behavior. It identifies which messages the user cares to open promptly, granting them priority over messages that are consistently ignored. The following Figure (1) illustrates these types of requirements:

Figure 1 - Types of Kano Model Requirements



Sources: ROTAR & KOZAR, The Use of the Kano Model to Enhance Customer Satisfaction, no: 4, november2017:344.

It can be observed from Figure (1) that it represents the foundational framework of the Kano Model requirements. It illustrates that the starting point of one-dimensional requirements moves from the dissatisfaction/shortage quadrant toward satisfaction/fulfillment. This is because the more the economic unit fulfills these requirements for the customer, the higher the degree of satisfaction, and vice versa. On the other hand, must-be requirements initiate from the shortage/dissatisfaction phase and progress toward fulfillment; this is because these requirements are mandatory for the economic unit to fulfill. Meeting them does not make the customer feel satisfied, but the economic unit's failure to provide them will result in customer dissatisfaction. Finally, regarding attractive requirements, the customer experiences delight whether the economic unit works to fulfill these requirements or not. This explains why their starting point lies above the shortage axis, meaning the customer inherently feels satisfied even if the economic unit does not actively fulfill them.

3. Steps for Implementing the Kano Model: The Kano Model is implemented through four consecutive steps, as follows:

A. Classifying Customer Requirements into Six Categories: Kano classified customer requirements into six distinct categories, which are detailed as follows (Al-Tamimi, 2023: 25).

i. Must-Be Requirements: These are requirements expected to be fulfilled by the product (taken for granted when achieved), but their non-fulfillment leads to dissatisfaction.
ii. One-Dimensional Requirements: Fulfilling these requirements leads to satisfaction, while failing to meet them results in dissatisfaction.
iii. Attractive Requirements: These are requirements completely unexpected by the consumer; fulfilling them leads to satisfaction, whereas not fulfilling them does not cause dissatisfaction.

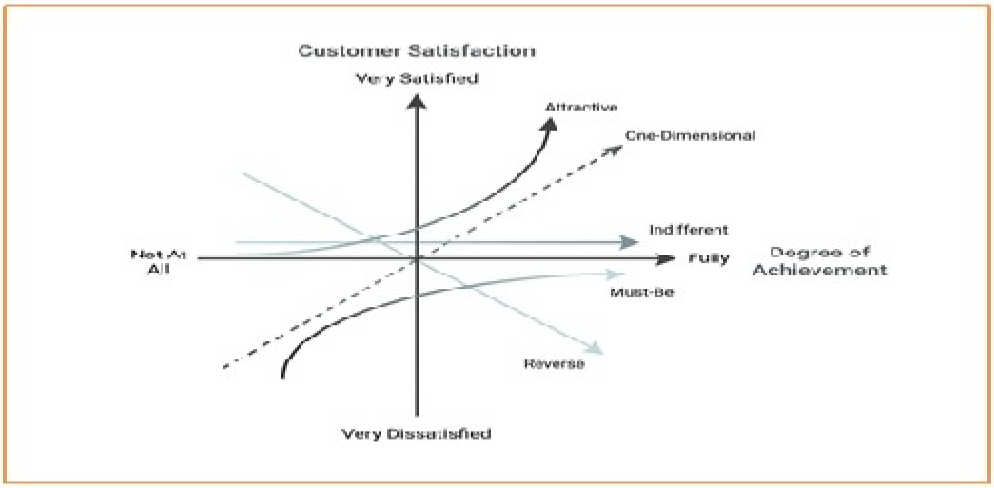
iv. Indifferent Requirements: These are requirements that do not lead to either satisfaction or dissatisfaction, regardless of whether they are achieved or not.

v. Reverse Requirements: These are requirements that lead to satisfaction when they are not implemented, and dissatisfaction when they are implemented.

vi. Questionable Requirements: These attributes emerge due to ambiguities and contradictions in customer responses, leading to a misunderstanding of the answers to customer-related questions in the Kano Model questionnaire. It is worth noting that these questionable requirements do not typically appear within the final analysis of the questionnaire, as they constitute a negligible percentage compared to the other requirements.

Figure (2) illustrates the classification of customer requirements:

Figure 2 - Types of Kano Model Requirements



sources: rui (2013) «a patient-oriented approach to facilities management in singapore's hospitals» a thesis submitted for the degree of master of science (building) department of building national university of singapore p (39).

B. Preparing the Questionnaire: The specialized Kano Model questionnaire is designed to determine customer requirements, utilizing analytical techniques featuring pairs of functional (positive) and dysfunctional (negative) questions (Gupta & Shri, 2017: 6). Table (1) illustrates the structure of the Kano Model questionnaire (Hao & Li, 2010: 11).

C. Analyzing the Questionnaire into Quality Requirements (Attributes): The Kano Model provides a rigorous methodology for mapping consumer responses.

After extracting information from the survey, the Kano evaluation matrix is utilized to tabulate and categorize the data (Bennur & Jin, 2012: 176). Table (1) provides an illustrative example for classifying survey responses and distinguishing requirements into the six categories previously detailed in step (A) (Al-Tamimi, 2023: 28):

Table 1 - Kano Evaluation Questionnaire

SOURCES: Pheng & Rui(2016) Service Quality for Facilities Management in Hospitals.

		Response to dysfunctional question				
		1. Like	2. Must be	3. Neutral	4. Live with	5. Dislike
Response to functional question	1. Like	Q	A	A	A	O
	2. Must be	R	I	I	I	M
	3. Neutral	R	I	I	I	M
	4. Live with	R	I	I	I	M
	5. Dislike	R	R	R	R	Q

The symbols presented in the table refer to:

1. **O: One-dimensional requirements**
2. **A: Attractive requirements**
3. **Q: Questionable requirements**
4. **R: Reverse requirements**
5. **M: Must-be requirements**
6. **I: Indifferent requirements**

D. Calculating Customer Satisfaction and Dissatisfaction Indices:

The Customer Satisfaction Index (CSI) is calculated using the following equation (Al-Tamimi, 2023: 32–33):

Satisfaction Index= {A+O}{A+O+M+I)

Similarly, the Customer Dissatisfaction Index (CDI) is measured using the following equation: Dissatisfaction=- (O+M}{A+O+M+I)

Second: Time-Driven Feature-Based Costing System (TD-FBC)

The Concept of Time-Driven Feature-Based Costing (TD-FBC):

The Time-Driven Feature-Based Costing system is fundamentally derived from the Time-Driven Activity-Based Costing (TD-ABC) system. Both systems apply the time equation that captures the time required to perform an activity necessary to complete one unit of a product. However, the TD-FBC system does not stop merely at the activity level; it goes further to address the primary features (functions) of the product for which it was created, as well as secondary features that enhance or contribute to achieving the primary ones, thereby reflecting customer desires. It is crucial to distinguish between an activity and a feature; an activity is essential for task completion but is not necessarily meaningful or beneficial to the end-consumer.

Conversely, a feature is what the customer ultimately pays for. For instance, if an individual reviews a document, this constitutes an "activity," whereas if this review leads to improving security within the economic unit, this represents a «feature» (Bartolomei & Miller, 2001: 4).

Nhaili et al. defined time-driven feature-based costing as an advanced costing system designed on the basis of time-driven activities. This system has been introduced as a revolutionary approach in the field of costing, taking into account the allocation of resources to activities. The TD-FBC system is anchored on transforming cost drivers into a time equation that reflects the time required to perform activities as a function of certain cost drivers (Nhaili et al., 2016: 152). It is worth noting that time-driven feature-based costing is classified as a system rather than just a method—similar to the activity-based costing system—because it possesses inputs, processing, and outputs. The inputs consist of financial data related to cost accounts, alongside non-financial data represented by time-based cost drivers. The processing involves mathematical operations to determine the cost rate per time unit to calculate individual activity costs, determine the feature cost, and compute the ratio of the feature cost relative to total product costs, among other treatments. Finally, the outputs are represented by the actual cost of the product manufactured by the economic unit (Al-Khalil, 2012: 13).

2 . The Concept and Definition of Value:

Boztepe defined value as the monetary sacrifice a consumer is willing to make in exchange for a product. Money is viewed as a primary indicator of value, under the assumption that at the exact moment of purchase, the consumer performs a rational assessment of what is being received versus the amount of money being given (Boztepe, 2007: 56(.

The modern concept of value directly focuses on the interaction between the customer and the economic unit, where they simultaneously cooperate and compete. They cooperate in co-creating joint value, while competing in extracting economic value (Prahalad & Ramaswamy, 2004: 11).

Kotler outlines three levels illustrating the types of value a product can deliver to the customer. These levels presented by Kotler are closely analogous to the customer requirements introduced by Kano in his 1984 foundational model. These levels are as follows (Elg & Gustaffson, 2008: 10–39):

- **The First Level:** This level provides the core service, or in other words, fulfills the primary purpose that the product is fundamentally required to achieve.
- **The Second Level:** This level includes additional or secondary features that accompany the product—for instance, making a screen display colors instead of black and white, or integrating a flash into a camera. These features enhance product value and make it more advanced. Crucial factors at this level include the capability of on-time delivery, alongside the critical importance of product quality.
- **The Third Level:** A product containing features from this third level is referred to as an "augmented product." It incorporates intangible features that transcend ordinary standards, enabling the product to exceed customer expectations. This level necessitates the availability of technology that simulates all product processes, spanning from raw material procurement to product sales and post-sale services. Notably, economic units occasionally confront constraints regarding the limited time available for product development.

This economic unit achieves a unique competitive advantage when it manages to reach the third level in Kotler's hierarchy. In turn, the uniqueness of that particular product distinguishes it from other economic units on the market, resulting in an outstanding transformation of the value of the product and customer satisfaction. For those units that only reach the first two levels, however, the fast growth of technology and decreasing product life cycle make time insufficiency incapable of ensuring their survival in such a competitive environment.

Third: The Usefulness of the Kano Model in Increasing Product Value

Given all the above, the Kano Model is a necessary instrument in quality management and product development, as it allows one to get acquainted with customers' requirements and expectations. At the same time, the Kano Model contributes to understanding how different product features affect customer satisfaction. Thus, the use of the Kano Model may contribute to increasing product value through focusing on the requirements maximizing customer satisfaction.

Specifically, the role of the Kano Model in enhancing product value is manifested through:

1. Classifying Product Requirements:

The Kano Model helps classify product requirements into five primary categories (Gupta & Shri, 2018: 5):

- **A. Must-Be Requirements (Must-Have):** These requirements are essential and must be present in the product. Their absence leads to customer dissatisfaction, but improving them beyond the minimum threshold does not add to customer satisfaction. For example, in a smartphone, the ability to make calls is a must-be requirement.
- **B. Performance Requirements (One-Dimensional):** These requirements directly elevate the level of customer satisfaction. The higher the quality or performance of these requirements, the greater the customer satisfaction. A long battery life in a smartphone serves as an example.
- **C. Attractive Requirements:** These requirements are unexpected and bring sudden delight to customers. Their presence significantly enhances customer satisfaction, but their absence does not cause dissatisfaction. An example is the facial recognition feature in a smartphone.
- **D. Indifferent Requirements:** These are requirements that do not lead to either satisfaction or dissatisfaction, regardless of whether they are implemented or not.

- **E. Reverse Requirements:** These are requirements that lead to satisfaction when they are not implemented, and cause dissatisfaction when they are achieved.

Consequently, the Kano Model assists in identifying the areas where development teams should focus to guarantee improved customer satisfaction, by understanding what customers expect versus what surprises them, thereby achieving greater customer delight.

2. Prioritization:

By classifying requirements, the product development team can prioritize which requirements to focus on to achieve the greatest added value for the product and maximize customer satisfaction (Shahin et al., 2012: 344).

3. Increasing Competitive Differentiation:

Meeting attractive requirements can give the product an edge, since it gives the customer a special and unique experience.

4. Effective Resource Allocation:

Through this model, resource allocation will be more efficient and will help us meet the requirements that really matter to the customer and increase the value of the product. To increase the value of the product features, we need to verify the following points:

- **A.** Optimizing Must-Be Requirements: Making sure that must-be requirements are present and functioning efficiently, as their absence leads to customer dissatisfaction.
- **B. Enhancing One-Dimensional Requirements:** Increasing the effectiveness of the requirements expected by customers and improving their performance can lead to enhanced customer satisfaction and a higher perceived product value.
- **C. Adding Attractive Requirements:** Developing new and innovative features that surprise and delight customers can significantly elevate product value and make it stand out in the market.

All things considered, using the Kano Model in the product development process will improve product value by having a good knowledge of what customers want in their products, categorizing product features according to how they affect customer satisfaction, and focusing on those that have the most positive effect on them.

Fourth: The Role of the TD-FBC System in Enhancing Product Value

The TD-FBC system plays an active role in enhancing product value through:

1. Greater Accuracy in Cost Allocation:

The TD-FBC system helps allocate costs with higher precision by directly linking costs to the time consumed in performing product features. This allows for a better understanding of the actual costs associated with each feature, which contributes to identifying areas that can be optimized to enhance resource utilization efficiency (Al-Kawaz, 2016: 63).

2. Improving Decision-Making:

Through a deep understanding of time-related costs, companies can make more informed decisions regarding production and design processes. For instance, non-essential or high-cost features can be identified and subsequently optimized or eliminated, leading to cost reductions without negatively impacting product quality (Majid, 2020: 175).

3. Enhancing Operational Efficiency:

Based on the time consumed to produce specific features, operational processes can be optimized to mitigate time and resource waste. This gained efficiency directly reflects on enhancing product value by lowering total costs and increasing the capability to deliver high-quality products at competitive prices (Al-Kishwan, 2018: 48).

4.Focusing on Value-Added Features:

The TD-FBC system helps shift focus toward features that add actual value to the product and matter most to customers. Consequently, efforts and resources are directed toward improving product aspects that elevate its market value (Majid, 2020: 172).

Therefore, a direct correlation exists between time-driven feature-based costing and product value enhancement. This system achieves greater efficiency in resource utilization, eliminates unnecessary costs, and boosts product quality, which ultimately enhances its value in the eyes of customers and consumers.

Fifth: The Role of Integration Between the Kano Model and TD-FBC in Enhancing Product Value

When merging the Kano Model with Time-Driven Feature-Based Costing (TD-FBC), significant improvements in product value can be realized through the following processes:

1. Optimizing Resource Allocation:

By leveraging the Kano Model, requirements that add the highest value to customers can be identified. Concurrently, using TD-FBC allows resources to be allocated more efficiently toward these requirements. Focus is placed on activities that support developing must-be, one-dimensional, and attractive requirements, which enhances the final product's value while keeping costs under control.

2. Cost-Benefit Analysis:

Combining both tools will allow conducting a cost-benefit analysis of each requirement of the product. The analysis will help identify whether or not it is worth investing more money, or there are possibilities to save on costs without losing customer satisfaction.

3. **Optimizing the Design and Development Processes:**

The clearer understanding of customer desires and willingness to pay for the required services/products will allow optimizing the design and development processes. TD-FBC will be able to determine the activities that require too many resources and calculate the costs of certain features. In addition, it will allow operation under the used capacity.

4. Increasing Customer Satisfaction and Saving Costs:

Identifying customer desires and using cost analysis in order to maximize the value of the final products.

In summary, it is clear that the application of Kano Model with TD-FBC contributes greatly towards increasing the value of the products because they help in assessing the requirements of customers and evaluating their cost from the perspective of TD-FBC systems. This approach helps economic units meet the needs of customers in terms of cost minimization and maximization of customer satisfaction. To the researchers, adopting the Kano Model along with TD-FBC at the State Company for Engineering Industries at Ur is an important aspect in increasing the value of the product and maximizing customer satisfaction. In this regard, Kano Model would first be used in analyzing and classifying customer needs and thereafter the use of TD-FBC.

Section Three: The Practical Framework (A Case Study at Ur State Company) Research Population, Sample, and Core Product Components:

As part of the testing process of the research hypothesis, and for the application of the above-integrated framework, the Ur State Company / Extrusion Factory, situated in Dhi Qar Province, was chosen. This is an aluminum factory specializing in the manufacturing of unanodized aluminum profiles (used in the production of doors, windows, and counters). One metric ton was adopted as the standardized measurement in regard to the production of such products, since there can be no alternative due to varying weight and millimeters among others. The following are the direct and indirect physical factors needed in order to manufacture one ton of unanodized aluminum profiles as identified by the engineers:

1. Aluminum Billets (AL 6063): Primary component in the product structure.

2. Graphite Material: Auxiliary materials used in coating dies to avoid sticking.

3. Protective Tape (Sticker): Protective layer preventing profiles from any scratches.

4. Timber: Wood used in placing below and above the profiles for easy lifting.

5. Strapping Bands (Clips): Metal or plastic bands to package profiles together.

First: Practical Application of the Kano Model and Classification of Customer Requirements:

A dual-response Kano questionnaire was designed and constructed in consultation with the factory's experts, comprising 12 core requirements concerning the quality and packaging of aluminum profiles. A total of (60) survey questionnaires were distributed to aluminum workshop owners, counter manufacturers, and door fabricators, from which (50) complete and valid questionnaires were recovered for statistical analysis. Following data processing and the cross-referencing of functional and dysfunctional responses based on the standard Kano evaluation matrix, the final results and classifications emerged as illustrated in Table (2) below:

Table 2 - Results and Classification of Customer Requirements According to the Kano Model

Customer Requirements	A	O	M	I	R	Q	Total	Kano Classification
1-Dimensional accuracy.	17	23	7	2	0	1	50	O
2-Producing profiles with customized shapes and dimensions upon customer request.	25	18	6	1	0	0	50	A
3-Profile straightness.	14	27	9	0	0	0	50	O
4-Profile hardness and resistance to bending without fracturing.	13	15	17	4	0	1	50	M
5-Retention of the designed shape after heat treatment.	8	20	14	5	2	1	50	O
6-Homogeneity of the metal micro-structure.	7	21	10	11	0	1	50	O
7-Secure packaging to protect profiles from scratches and damage.	9	18	23	0	0	0	50	M
8-Placing a clear identification label on each package.	9	11	12	18	0	0	50	I

9-Eco-friendly packaging.	8	12	11	17	2	0	50	I
10-Corrosion resistance.	11	22	15	2	0	0	50	O
11-Resistance to weather conditions.	12	15	12	8	3	0	50	O
12-Availability of modern production machinery	19	10	12	5	1	3	50	A

Second: Analyzing and classifying customer requirements according to the results of the Kano: survey model Based on the response frequencies presented in Table (2), both the satisfaction and dissatisfaction indices were measured for each requirement. To illustrate the mathematical equation applied, we provide a practical example demonstrating the calculation for the «Dimensional Accuracy» requirement (where frequencies are: A = 17, O = 23, I = 2, M = 7).

Satisfaction Index (SI) for Dimensional Accuracy= 23+17 / 17+23+7+2= 40/49 = 0.82

Dissatisfaction Index (DI) for Dimensional Accuracy= 23+7 / 17+23+7+2= 30/49 = 0.61

Using the same computational methodology, the indices for the remaining 12 requirements were calculated and are summarized in Table (3) below. This presentation ensures a clear overview of the satisfaction and dissatisfaction metrics.

Table 3 - Satisfaction and Dissatisfaction Indices for Customer Requirements

Customer Requirements	SI	DI
1-Dimensional accuracy.	0.82	0.61-
2-Producing profiles with customized shapes and dimensions upon customer request.	0.86	0.48-
3-Profile straightness.	0.82	0.72-
4-Profile hardness and resistance to bending without fracturing.	0.57	0.65-
5-Retention of the designed shape after heat treatment.	0.6	0.72-
6-Homogeneity of the metal micro-structure.	0.57	0.63-
7-Secure packaging to protect profiles from scratches and damage.	0.54	0.82-
8-Placing a clear identification label on each package.	0.4	0.46-
9-Eco-friendly packaging.	0.42	-0.48
10-Corrosion resistance.	0.66	0.74-
11-Resistance to weather conditions.	0.57	-0.57
12-Availability of modern production machinery	0.62	0.47-

An efficiency rate of 80% of the theoretical capacity was adopted as the practical available capacity to exclude naturally lost time (such as rest breaks and machine maintenance). The available time for a single production department was calculated based on the following equation:

(60 minutes × 7 daily working hours × 20 monthly working days, excluding official holidays) × 80% = 6,720 available minutes per month per worker.

The cost per minute (for both direct labor and indirect costs) was derived by dividing the total monthly cost by the practical capacity of the resources. The outputs for three main production departments for the month of February are summarized in Table (4):

Table 4 – Cost per Unit of Time (Minute) for Production Departments (IQD)

Production Unit / Department	Monthly Direct Cost of the Department Supervisor (IQD)	Cost Rate Per Minute (IQD/Min)	Monthly Direct Cost Per Worker (IQD)	Cost Rate Per Minute (IQD/Min)	Monthly Indirect Cost (IQD)	Cost Rate Per Minute (IQD/Min)
Extrusion and Cutting	**1,000,000**	**148.81**	**700,000**	**104.167**	**5,500,000**	**54.563**
Heat Treatment (Thermal Processing)	**750,000**	**111.607**	**600,000**	**89.286**	**4,500,000**	**334.821**
Packing and Packaging	**650,000**	**96.726**	**550,000**	**81.845**	**1,217,291**	**22.643**

Using the same mechanism, the cost rate per minute for the service and administrative support cost centers was calculated as follows: (Information and Follow-up = 1,520.886 IQD), (Maintenance = 1,292.766 IQD), (Transportation = 1,247.472 IQD), (Warehouses = 1,318.833 IQD), and (Quality Control = 11,193.491 IQD/Min), with the latter exhibiting a higher rate due to the elevated costs of laboratory equipment.

Third: The Technological Path and Production Activity Pools:

The detailed technological path for producing one metric ton of unanodized aluminum profiles within the factory was tracked, and the actual time duration required to execute each activity was measured in minutes alongside its place of occurrence:

1. Extrusion and Cutting Department: This department comprises 12 sequential activities, beginning with preparing and signing the work order (Information Section), receiving and weighing materials (Crane), preheating dies and aluminum billets (60 minutes for the press), lifting billets (120 minutes for the assistant), extrusion and profile forming (110 minutes), coating the disc with graphite (10 minutes), straightening and tension stretching (120 minutes), and cutting to requested lengths (120 minutes), followed by inspection and transport. The total technological path in this department amounts to 557 minutes.

2. Heat Treatment Department: This department involves 10 activities, most notably pushing containers, operating the aging furnace for (90 minutes) until the profiles acquire the required hardness, fan cooling (5 minutes), hardness testing, and transport. The total duration amounts to 110 minutes.

3. Packing and Packaging Department: This department includes 8 activities, encompassing laboratory inspection, wrapping the profile with the company's protective tape (40 minutes), packing and bundling profiles into large packages (30 minutes), and delivery to warehouses (30 minutes). The total duration amounts to 114 minutes.

Consequently, the total actual technological time required to produce one metric ton is 781 minutes. Conversion costs were calculated by multiplying the cost rate per minute (from Table 9) by the duration of each activity, yielding the following aggregated costs: (Extrusion Department = 185,812.726 IQD), (Heat Treatment = 63,203.907 IQD), and (Packing and Packaging = 105,910.242 IQD.

Fourth: Allocating Product Component Costs Using the TD-FBC System: Based on the factory management's assessment, the total actual time (781 minutes) was allocated across the five product components according to their actual consumption within the production departments). Table (5) presents the final summary of direct material costs combined with the technologically derived conversion costs for each component per metric ton:

Table 5 – Cost of Aluminum Profile Components per Ton According to the TD-FBC System IQD

Components	Material Cost	Conversion Costs	Total
AL 6063	**2,875,000**	**223,255.089**	**3,098,255.089**
Graphite	**2,294.506**	**25,761.544**	**28,056.05**
Sticker	**5,000**	**65,032.605**	**70,032.605**
Timber	**6,000**	**18,580.744**	**24,580.744**
Strapping Bands	**4,000**	**22,296.893**	**26,296.893**
Total	**2,892,294.506**	**354,926.875**	**3,247,221.381**

The accounting results demonstrate that the actual cost of producing one metric ton of unanodized profiles amounts to 3,247,221.381 IQD when implementing the TD-FBC system.

Final strategic cost allocation indicates a significant mismatch, where the packing department consumes substantial conversion costs (105,910.242 IQD) yet fails to resolve high customer dissatisfaction (-0.82) regarding protection, requiring immediate optimization. Reallocating savings from waste reduction toward improved packaging, identified as an 'Attractive' Kano requirement, will maximize value and rationalize activity costs.

Fifth: Comparative Analysis: The Company's Traditional System Versus the TD-FBC System:

The results of the TD-FBC system were compared with the current traditional costing system applied at Ur State Company. The traditional system calculates the cost per ton by adding imported direct materials (2,875,000 IQD) and dividing the total monthly wages by the actual production volume of (77.472 tons), which yields a highly inflated labor cost share per ton amounting to (1,285,490.9 IQD). Furthermore, it allocates monthly manufacturing overhead based on theoretical available capacity and the technological quantity that includes abnormal spoilage (1.3 tons per single ton of production), reaching (175,223.809 IQD).

Table 6 – Cost Variance Between the Company's Traditional System and the TD-FBC System

Cost Element	**The Company's Traditional System**	**TD-FBC System (IQD)**	**Variance (IQD)**

	(IQD)		
Material Cost	2,892,294.506	2,892,294.506	0
Conversion Costs	1,460,714.709	354,926.875	1,105,787.834
Cost Variance			1,105,787.834

The accounting analysis demonstrates a massive reduction in the cost per single metric ton, amounting to 1,105,787.834 IQD, when implementing the TD-FBC system. The scientific rationale behind this reduction is attributed to the success of the TD-FBC system in excluding the costs of idle and unused capacity. Furthermore, it avoids charging the product with labor wages that are unrelated to actual production time, thereby eliminating the unjustified inflation of operational costs inherent in the traditional system.

Sixth: Functional Analysis of Product Components (Primary / Secondary(: In compliance with the second step of the practical framework, the five components were dismantled and analyzed to determine their engineering and marketing functions. In consultation with the factory's engineers, they were classified into "primary" functions (essential for the product) and "secondary" functions:

1. AL 6063 Billets: Perform the function of producing precise and complex shapes for structural profiles (Primary(.
2. Graphite Material: Performs four distinct functions: reducing thermal retention to prevent profile deformation (Primary), lubricating die walls to prevent aluminum from adhering to the steel (Primary), filling micro-scratches to mitigate die wear (Secondary), and preventing the appearance of external black scratches on the surface (Secondary). Based on joint brainstorming sessions, the utility proportions of these functions from the component were determined at (35%, 35%, 15%, and 15%) respectively, to allocate its total cost of (28,056.05 IQD).
3. Protective Tape (Sticker): Its function is to protect surface profiles from external scratches and damages during handling (Secondary).

4. Timber and Strapping Bands (Clips): Perform a joint function, which is facilitating terrestrial transport and handling operations by binding and strapping the profiles securely (Secondary).

The cost of each function was determined based on its utility percentage relative to the total component cost derived from Table (5). For single-function components, the function cost was equal to the entire component cost (e.g., Protective Tape = 70,032.605 IQD, Timber = 24,580.744 IQD, and Strapping Bands = 26,296.893 IQD.

Seventh: Practical Integration and the Composite Weighting Matrix for Prioritizing Optimization: To scientifically prioritize development and optimization in a manner that balances customer desires with the company's financial burden, the Composite Weighting Method was applied. This method balances the customer satisfaction index with the net requirement cost technologically extracted via the TD-FBC system (where shared activity costs were distributed among requirements based on the relative importance of Kano satisfaction indices). A weighting coefficient was assigned to each Kano classification as follows:

Must-be= 3, One-dimensional = 2,Attractive= 1.5, Indifferent = 0.

The following weighted mathematical equation was applied:

Composite Weight= Kano Coefficient*Satisfaction Index / Net Requirement Cost* 10,000

Competitive optimization priorities were arranged in ascending order based on the final composite weight value in the table:

Table 7 - Optimization Priorities Matrix According to the Integrated Composite Weighting

Requirements	Kano Classification	SI	Kano Coefficient	Net Requirement Cost (IQD)	Composite Weight
Secure packaging	**M**	**0.54**	**3**	**3,554.682**	**4.56**
Resistance to weather conditions such as heat and humidity	**O**	**0.57**	**2**	**3,759.478**	**3.03**

Homogeneity of the metal micro-structure	**O**	**0.57**	**2**	**9,459.707**	**1.21**
Profile hardness	**M**	**0.57**	**3**	**14,642.294**	**1.17**
Corrosion resistance.	**O**	**0.66**	**2**	**18,529.563**	**0.71**
Retention of the designed shape after heat treatment	**O**	**0.6**	**2**	**20,146.342**	**0.6**
Profile straightness	**O**	**0.82**	**2**	**32,840.904**	**0.5**
Producing customized shapes and dimensions upon customer request	**A**	**0.86**	**1.5**	**33,862.315**	**0.38**
Dimensional accuracy.	**O**	**0.82**	**2**	**83,563.608**	**0.2**

The matrix demonstrates that "secure packaging" occupies the first rank for development and optimization; this is because it represents a must-be requirement that is critical to preventing customer dissatisfaction, and it can be enhanced at a very low cost by utilizing anti-scratch adhesive tape. On the other hand, both "identification labeling" and "eco-friendly packaging" yielded a composite weight of zero, as they are classified as indifferent requirements (I) that do not influence customer satisfaction. Consequently, from a managerial accounting perspective, it is recommended to avoid allocating any financial resources to them, to dispense with eco-friendly packaging, and to replace printed labels with low-cost barcode or QR code stickers to optimize company funds.

Eighth: Strategic Analysis of the Capital Investment Decision (Fulfilling the Attractive Requirement:The results revealed an eager desire among customers for the availability of modern machinery as an attractive feature (A), with a satisfaction index of (0.62). Accordingly, the equations of the TD-FBC system were applied to evaluate a proposal submitted by a leading Chinese company to procure a semi-automatic aluminum extrusion press machine (1000T) valued at ($115,000), which is equivalent to (151,800,000 IQD) inclusive of transportation and installation costs.

- **Planned monthly production capacity of the machine** = 300 tons.

- **Total production over the operational lifespan (20 years)** =300* 12 * 20 = 72,000 \tons.
- **Capital cost share per single ton of the machine** = 151,800,000 / 72,000} = 2,108.33 IQD/Ton.

Upon substituting these values into the composite weight equation:

Composite Weight = 1.5 * 0.62 / 21,084 * 10,000 = 0.44

This analysis demonstrates that investing in the procurement of the modern machine represents a sound strategic decision. Technological automation effectively integrates extrusion, cutting, and cooling functions simultaneously, leading to a substantial reduction in labor costs within those units. Furthermore, it minimizes time and resource waste while eliminating non-value-added activities, which directly reflects on lowering the total cost and enhancing the overall product value.

Section Four: Conclusions and Strategic Recommendations

The research validated its main hypothesis by demonstrating that integrating the Kano Model with the Time-Driven Feature-Based Costing (TD-FBC) system achieves a sustainable strategic advantage by aligning customers' engineering desires with actual technological costs based on elapsed time. Specifically, the TD-FBC system exposed critical flaws in the company’s current traditional system, successfully reducing the calculated cost per single metric ton by 1,105,787.834 IQD by excluding idle capacity costs and indirect operational labor overheads that do not consume actual time.

Furthermore, the composite weighting matrix proved that the highest satisfaction index does not inherently dictate optimization priority; instead, it must be balanced against cost, which positioned secure packaging as the absolute first priority since it represents a mandatory requirement to eliminate customer dissatisfaction at the lowest financial burden, while integrating modern PLC-controlled technology shortens the technological path to minimize waste. Consequently, the research strongly recommends that Ur State Company immediately abandon its traditional costing methods and adopt this integrated framework as a periodic managerial and accounting tool for product pricing and development.

Additionally, the company should urgently upgrade its aluminum profile packaging using anti-scratch adhesive wrapping to resolve consumer dissatisfaction, eliminate resource-wasting indifferent features—such as costly eco-friendly packaging—by replacing traditional labels with low-cost QR codes, and expedite the capital investment to procure the modern 1000T Aluminum Extrusion Press Machine to maximize time savings, halve operational labor, and enhance dimensional accuracy.

References:

1. Al-Kawaz, S. M., & Al-Baldawi, S. A. K. (2016). Using time-driven activity-based costing and target costing techniques to improve product value: An applied study for the State Company for Textile Industries in Hilla – Najaf Factory for Menswear. *Iraqi Journal of Administrative Sciences, 12*(48).
2. Al-Khalil, Muhar Abdullah, (2012). "Application of Modern Management Accounting Methods in Jordanian Public Shareholding Industrial Companies", Master's Thesis, Department of Accounting, College of Business, Middle East University.
3. Al-Kishwan, Ali Muhammad Hassan Muhammad, (2018). "Employing the Time-Driven Activity-Based Costing (TD-ABC) Approach to Improve Product Value: A Comparative Study Between the ABC Approach and the TD-ABC Approach Applied at Al-Sadiq Factory for Dishdasha Tailoring in Najaf Al-Ashraf", Master's Thesis, Council of the College of Administration and Economics, University of Karbala.
4. Al-Tamimi, Fuad Muhammad Abid, (2023). "Integration of KANO Model and Sustainable Balanced Scorecard and Its Role in Improving Sustainable Strategic Performance", Master's Thesis, Council of the College of Administration and Economics, Wasit University.

5. Bartolomei, J. E., & Miller, T. (2001). *Functional Analysis Systems Technique (FAST) as a Group Knowledge Elicitation Method for Model Building*. Wright-Patterson Air Force Base, OH: United States Air Force.
6. Bennur, S., & Jin, B. (2012). A conceptual process of implementing quality apparel retail store attributes: An application of Kano's model and the quality function deployment approach. *International Journal of Business, Humanities and Technology, 2*(1), 174–183.
7. Boztepe, S. (2007). User value: Competing theories and models. International Journal of Design, 1(2), 55–63.
8. Elg, D., & Gustafsson, M. (2008). *Creating Customer Value: A Case Study at Stilexo*. Bachelor Thesis, School of Engineering, Jönköping University, Sweden.
9. Goswami, S., & Sarma, M. K. (2019). Modelling Customer Delight in Hotel Industry. *Global Business Review*, *20*(2), 405-419.
10. Gupta, M., & Shri, C. (2018). Understanding customer requirements of corrugated industry using Kano model. *International Journal of Quality & Reliability Management, 35*(1), 16–35. https://doi.org/10.1108/IJQRM-08-2016-0128
11. Hao, S., & Li, M. (2010). *Building attractive quality of career service in Library & Learning Resources of University of Borås based on Kano theory* (Master's thesis). University of Borås, Sweden.
12. Majeed, N. (2020). *Using the Time-Driven Activity-Based Costing (TD-ABC) System to Monitor Management in Economic Enterprise: An applied study* (Doctoral dissertation, Ahmed Draia University, Adrar, Algeria, Faculty of Economic, Commercial, and Management Sciences).
13. Mikulić, J. (2007). *The Kano model: A review of its application in marketing research from 1984–2006*. Zagreb University. Retrieved from https://www.researchgate.net/publication/228434290_The_Kano_model-A_review_of_its_application_in_marketing_research_from_1984-2006

14. Nhaili, A., Meddaoui, A., & Bouami, D. (2016). Effectiveness improvement approach basing on OEE and lean maintenance tools. *International Journal of Process Management and Benchmarking, 6*(2), 150–169.
15. Prahalad, C. K., & Ramaswamy, V. (2004). Co-creation experiences: The next practice in value creation. *Journal of Interactive Marketing, 18*(3), 5–14. https://doi.org/10.1002/dir.20015
16. Radfar, F., Omidvari, M., & Haleh, H. (2014). Understanding customer requirements through quantitative analysis of services attributes based on Kano's model: A case study of Tabriz's municipalities. *International Journal of Scientific Management and Development, 2*(9), 441–448.
17. Rotar, L. J., & Kozar, M. (2017). The use of the Kano model to enhance customer satisfaction. *Organizacija, 50*(4), 339–350. https://doi.org/10.1515/orga-2017-0025
18. Zhu, R. (2013). *A patient-oriented approach to facilities management in Singapore's hospitals* (Master's thesis). National University of Singapore.
19. Shahin, A., Pourhamidi, M., Antony, J., & Park, S. H. (2013). Typology of Kano models: A critical review of literature and proposition of a revised model. *International Journal of Quality & Reliability Management, 30*(3), 341–358. https://doi.org/10.1108/02656711311299863
20. Chan, L. K., & Wu, M. L. (2002). Quality function deployment: A literature review. European Journal of Operational Research, 143(3), 463–497.