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Identification of Technical Characteristics of Ergonomic Baby Dining Chair Products

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Abstract—This research aims to design an ergonomic toddler dining chair that enhances safety, comfort, and usability for families, restaurants, and daycare centers in Padang City. Existing toddler chairs often lack adjustable features, proper back support, and easy maintenance, leading to discomfort and potential safety risks. This study addresses these gaps by integrating user preferences with ergonomic design principles. A mixed-method approach was employed, utilizing the Kano Model to classify user needs into "Must-Be," "One-Dimensional," and "Attractive" categories. The identified user requirements were then translated into technical specifications using the Quality Function Deployment (QFD) methodology. Data collection involved distributing questionnaires to families and toddler chair providers, followed by validity and reliability tests using SPSS. The House of Quality (HoQ) matrix was constructed to align customer needs with design attributes, incorporating anthropometric data to ensure ergonomic suitability. This research contributes to the theory of ergonomic product development by demonstrating the integrated use of the Kano model and QFD models to prioritize and address user needs effectively. This research offers a solid foundation for developing an ergonomic toddler feeding chair that improves safety and comfort for toddlers, reduces the risk of musculoskeletal disorders, and improves usability for parents and service providers. The findings also emphasize the importance of anthropometric data in creating products tailored to specific user groups. The study identified key design attributes, including adjustable height and backrest, durable and easy-to-clean materials, and a foldable structure for portability. The results revealed that most user needs fall into the "One-Dimensional" and "Must-Be" categories, indicating that improvements in adjustability and material quality significantly enhance user satisfaction. The integration of ergonomic standards ensures that the proposed design supports proper sitting posture and minimizes the risk of musculoskeletal disorders. Unlike existing products, this study introduces an ergonomically optimized toddler chair that aligns with user preferences and safety standards. The research framework can serve as a reference for future studies in ergonomic furniture design.

Keywords: *Toddler dining chair, Ergonomics, Kano Model, Quality Function Deployment, Product Development*
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1. Introduction

Toddler feeding chairs are an essential product designed to support children's feeding processes during their early developmental stages, typically between the ages of 6 months and 3 years. At this age,

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toddlers begin to develop motor skills such as sitting upright, grasping objects, and chewing food, which are essential for their physical and cognitive growth [1]. A well-designed dining chair provides a safe and comfortable seating arrangement, so parents or caregivers can supervise toddlers without the need for constant physical support.

The development of ergonomic products plays an important role in ensuring user comfort, safety, and efficiency, especially in the context of furniture for toddlers. Integrating ergonomic principles in product design improves usability and reduces the health risks associated with improper posture [2]. The importance of ergonomics in product development has been widely recognized across various industries, from consumer electronics [3] to wearable technology [4]. Despite advances in product design, many toddler feeding chairs still fail to meet basic ergonomic standards. Problems such as inadequate adjustment, lack of back support, and difficulty in cleaning persist. These shortcomings not only jeopardize the comfort and safety of toddlers but also create additional challenges for caregivers [5], such as increased effort in maintenance and increased risk of injury due to instability [6]. Ergonomic interventions in furniture design have been shown to improve user satisfaction and reduce musculoskeletal tension [7]. Additionally, ergonomic considerations contribute to sustainable product design by minimizing material waste and optimizing user well-being [8].

A user-centric approach is essential in designing an ergonomic toddler dining chair that aligns with safety regulations and meets consumer needs. Evaluating ergonomic risks during the manual assembly process can improve product reliability and durability [9]. Furthermore, integrating the Quality Function Deployment (QFD) methodology ensures that customer expectations are effectively translated into technical specifications [10]. This study uses the Kano Model to categorize and prioritize user needs and preferences, a method widely applied to understand customer requirements [11]. These insights are then translated into technical specifications using QFD to ensure that the final product aligns with user expectations and ergonomic standards. Anthropometric data specific to toddlers are included to optimize dimensions, ensuring the chair accommodates the physical proportions of its target users [12]. Incorporating ergonomic data into a computer-aided design system can optimize the dimensions and functionality of the product, thereby reducing the risk of postural discomfort [13]. Advances in virtual reality and ergonomic assessment tools have also changed the way designers evaluate and refine their products [14].

This study aims to develop an ergonomic toddler feeding chair by integrating the Kano Model and QFD methodology, aligning with recent trends in ergonomic product development. These findings will contribute to the development of knowledge about ergonomics in furniture design, offering solutions that improve user experience, safety, and product longevity. This research integrates a user-centered approach with robust analytical methods to produce a dining chair design that addresses market limitations, including adjustability, safety, and ease of maintenance. These findings will benefit families, restaurants, and daycare centers in Padang City, as well as serve as a benchmark for ergonomic furniture design in the future. A holistic approach that blends user feedback, ergonomic principles, and technical innovation is needed to address these challenges and improve the user experience for toddlers and their caregivers.

2. Method

2.1 Product development

Product development is an iterative process that includes various stages, from planning and concept development to product testing and launch [15]. This study uses Ulrich's stages to define design specifications and evaluate concepts. The results of the toddler feeding chair design will be evaluated based on ergonomics, functionality, and safety before being determined as the final design. Ergonomics is the science that studies how to design tools and work environments to fit human capabilities and limitations to improve comfort, safety, and efficiency [1]. In the context of toddler dining chair design, ergonomics includes considerations of safety, comfort, and ease of use for toddlers and parents. As a branch of ergonomics, anthropometry provides numerical data related to the dimensions of the human body used in product design [6]. In this study, toddler anthropometric data were used to determine the

size of the chair, such as the seat height, the angle of the backrest, and the chair's overall dimensions. This ensures that the chair is designed according to the proportions of the toddler's body, thus supporting correct sitting posture and reducing the risk of musculoskeletal disorders.

This study used the Kano model to collect and analyze the needs of toddler dining chair users, including families with toddlers and chair providers in restaurants and daycare. Using functional and dysfunctional questions, attributes such as safety, comfort, and ease of use are identified and prioritized based on their effect on user satisfaction [16]. Noriaki Kano developed the Kano model to identify and categorize customer needs into five categories: must-be, one-dimensional, attractive, indifferent, and reverse requirements [11]. This model helps in understanding the product attributes that have the most significant impact on customer satisfaction. QFD is a structured method for translating customer requirements into product technical specifications [10]. The QFD process begins with collecting the Voice of Customer (VoC) through surveys and interviews, then processed in a House of Quality (HoQ) matrix**.** This study applied QFD to ensure that user needs, such as adjustable backrest features, folding mechanisms for storage, and easy-to-clean materials, translated into technical designs that meet ergonomic standards. This approach ensures that every critical attribute is considered in the design of an ergonomic toddler feeding chair [17]. Product design that considers the emotional aspect of the user, can increase customer attraction and satisfaction with a product. This technique has been applied in a variety of products, in order to adapt the design to customer preferences more effectively [18].

2.2 Research Methods

The data obtained through the questionnaire was processed using the Kano model and Quality Function Deployment (QFD) to determine the importance of customer needs in developing ergonomic toddler highchair products. The selection of the Kano Model in this study is based on its ability to classify user needs based on the level of satisfaction provided by a product feature. In the context of toddler dining chair design, the Kano Model allows the identification of product attributes that have the most impact on user satisfaction, such as safety features, comfort, ease of use, and durability. In this study, QFD is used to ensure that the attributes identified through the Kano Model can be implemented in the form of technical features of the toddler dining chair, such as seat height adjustment, folding mechanism, strong and easy-to-clean materials, and ergonomic design that is in accordance with toddler anthropometric data. The combination of the Kano Model and QFD allows this study to not only identify user needs but also develop measurable, structured, and data-driven solutions, resulting in a toddler dining chair design that is safer, more comfortable, and in accordance with user expectations. By understanding customer preferences more deeply, this approach ensures that product designs not only meet ergonomic standards but also improve the overall user experience.

The population for this research includes two primary groups: families with toddlers aged 6 months to 3 years residing in Padang City and organizations that provide toddler dining chairs, such as restaurants and daycare centers. A purposive sampling technique is employed to select respondents directly involved in using and providing toddler dining chairs. A total of 33 respondents participated, comprising parents and service providers. the study refers to previous research on ergonomic product design, which suggests that 30–50 respondents are adequate for Kano Model-based analysis (Wu et al., 2020). Additionally, the relatively homogeneous nature of the target population (families with toddlers and service providers) allows for meaningful conclusions despite the sample size. This sample size is considered adequate for the analysis, aligning with the requirements for validity testing using SPSS software.

Data collection in this research was carried out by collecting primary data. Primary data collection is customer needs data obtained by distributing questionnaires to existing users and providers of toddler highchairs. Questionnaires designed based on the Kano model include functional and dysfunctional questions to capture user preferences. Respondents rate their satisfaction and importance of attributes on a Likert scale.

Outer Model Test aims to test whether the questionnaire used in this research is feasible (valid and reliable). The outer model test is carried out in two stages, namely validity testing and reliability testing.

a) Validity test

Validity testing is to ensure that the data collected through questionnaires is valid. A validity test determines whether the questions measure what they are intended to measure, ensuring that the collected responses accurately represent user needs and preferences.

b) Reliability Test

Reliability testing ensures that the data collected through questionnaires is reliable. Reliability testing assesses the consistency of the responses, ensuring that the results are stable and reproducible over time.

3. Result and Discussion

3.1 Result

The customer needs to be related to ergonomic Highchairs for toddlers was obtained through a questionnaire distributed to users and providers of toddler Highchairs in Padang City. Based on the results of the questionnaire distribution, 14 customer needs were identified. Before processing the data using the Kano model, validity and reliability tests of the obtained data must be conducted. The validity test was performed to determine whether the measuring instrument was legitimate or valid. This test was conducted using IBM SPSS 26 with 33 respondents. The validity assessment was determined by comparing the correlation coefficient of each question with the table r-value. A confidence level of 95% was used in this validity test, with df=31 and a table r-value of 0.344. Some attributes, such as D2 and E3 showed higher correlation values. This indicates that respondents had a strong and consistent preference for features related to structural strength and adjustability, which are critical for toddler safety and comfort. Conversely, PQ1 and PQ2 had lower correlation values, suggesting that while price is an important factor, it is not as strongly correlated with ergonomic features as durability and adjustability. The results indicate that all attributes have correlation coefficients higher than the critical r-value, confirming that the questionnaire is valid. The results of the validity test are presented in **Table 1**.

Table 1 Result of the Validity Test

Code	Customer Need	R-Value Calculate	R-Value Table	Information
PQ1	The price of the chair is according to the quality and features it has	0.353	0.344	Valid
PQ2	The chair has an affordable price	0.367		Valid
E1	Adjustable seat height	0.620		Valid
E2	Adjustable seat back	0.660		Valid
E3	Adjustable foot restraints	0.664		Valid
D1	The chair has a long service life	0.408		Valid
D2	Using sturdy and strong materials	0.686		Valid
F1	The chair is easy to clean	0.358		Valid
F2	The chair is easy to move	0.646		Valid
F3	Foldable chair	0.422		Valid
F4	The chair can be disassembled	0.677		Valid
P1	Has a 5-point seat belt	0.629		Valid
P2	Has padded seat cushions	0.678		Valid

A1	Attractive design	0.583	Valid

The next step is to conduct a reliability test to evaluate the consistency of the questionnaire instrument. The reliability reference value typically refers to Cronbach's Alpha coefficient, calculated using SPSS. Reliability indicates the extent to which the questionnaire instrument produces consistent data when used repeatedly. The reliability value obtained was 0.823, indicating high internal consistency among the questionnaire items. The results of the reliability test are shown in **Table 2**.

Table 2 Results of The Reliability Test

Reliability Statistics	
Cronbach's Alpha	N of Items
0.823	14

After conducting the validity and reliability tests, the customer needs, or attributes related to toddler Highchairs will be analyzed using the Kano model. This analysis aims to classify product attributes based on quality dimensions and determine the importance of each attribute. The product attributes will be classified based on the results of the Kano questionnaire distributed to toddler Highchairs users and providers. The Kano questionnaire is designed to identify the preferences of users and providers regarding the attributes of toddler Highchairs. Two types of respondents were involved, users and providers, to differentiate the preferences of users and buyers. The responses from the two questionnaire questions will be combined and interpreted using the Kano evaluation table to determine the category of each product attribute. The results of the evaluation of toddler Highchair attributes using the Kano model are presented in **Table 3**.

Table 3 Results of Evaluation Attributes Using the Kano Model

Code	Customer Need	Grade
PQ1	The price of the chair is according to the quality and features it has	O
PQ2	The chair has an affordable price	O
E1	Adjustable seat height	O
E2	Adjustable seat back	O
E3	Adjustable foot restraints	I
D1	The chair has a long service life	O
D2	Using sturdy and strong materials	O
F1	The chair is easy to clean	M
F2	The chair is easy to move	I
F3	Foldable chair	O
F4	The chair can be disassembled	I
P1	Has a 5-point seat belt	I
P2	Has padded seat cushions	I
A1	Attractive design	I

After obtaining the Voice of Customer, the attributes representing customer needs are identified through importance-level calculations using the Kano model. The identified attributes are categorized into several grades: One-Dimensional (O) and Must-Be (M). However, customer needs classified under

the Indifferent (I) category are excluded, as these attributes do not impact customer satisfaction regardless of their presence. This suggests that users are less concerned with these attributes than with other, more essential features. E3 (Adjustable footrest) although this feature provides additional comfort, it is not a top priority for users. F2 (Easy to move chair) the ease of chair transfer may not be as crucial as stability and safety. P1 (Has a 5-point seat belt) some users may find that a 3-point seat belt is sufficient, so the 5-point feature is not a major consideration. P2 (Has a soft seat cushion) the added comfort of the cushion is not always a major factor in choosing a high chair for toddlers. A1 (Attractive chair design) aesthetic design is not a priority for many users, as functional factors are more important. Based on this analysis, it can be seen that most of the attributes in the One-Dimensional (O) and Must-Be (M) categories are related to safety, durability, and flexibility of use, which are top priorities for customers. Meanwhile, attributes in the Indifferent (I) category tend to be optional or less considered by users in purchasing decisions. By understanding this classification, the design of toddler dining chairs can be more focused on improving safety, durability, and flexibility of settings, while features in the Indifferent category can be additional options without being a top priority in product design.The customer needs utilized in the QFD method are presented in **Table 4**.

Table 4 Customer Needs to be Utilized In The QFD Method

Attribute Code	Customer Need	TKK	*Grade*
PQ1	The price of the chair is according to the quality and features it has	4.52	O
PQ2	The chair has an affordable price	4.55	O
E1	Adjustable seat height	4.30	O
E2	Adjustable seat back	4.27	O
D1	The chair has a long service life	4.67	O
D2	Using sturdy and strong materials	4.76	O
F1	The chair is easy to clean	4.30	M
F3	Foldable chair	4.27	O

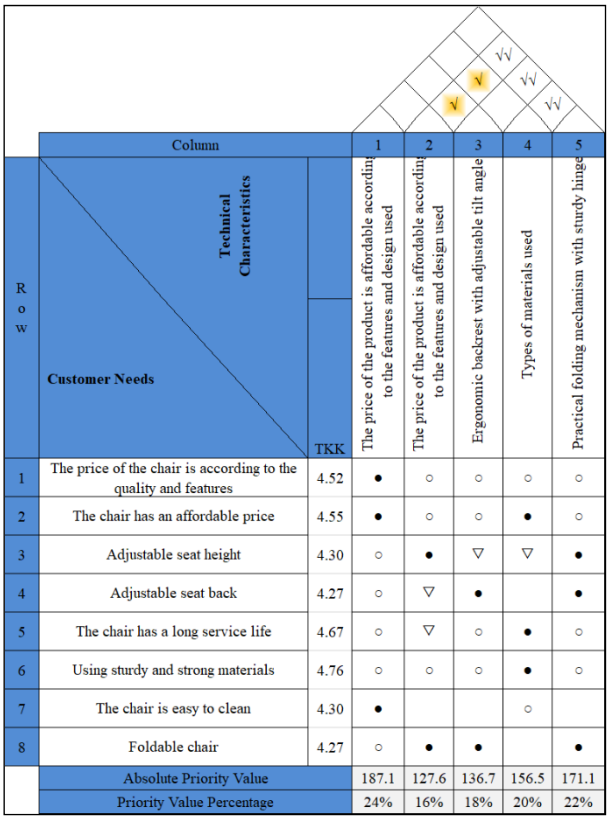
Determining the technical characteristics of a product is an essential step in the Quality Function Deployment (QFD) process, especially in creating a House of Quality (HoQ). Technical characteristics are set to translate customer needs into measurable specifications so that the resulting product can meet or even exceed customer expectations. The technical characteristics of toddler feeding chair products can be seen in **Table 5**.

Table 5 Technical Characteristics Of Toddler Highchair Product

No.	Customer Need	Technical Characteristics
1	The price of the chair is according to the quality and features	The product's price is affordable according to the features and design used.
2	The chair has an affordable price.	
3	Adjustable seat height	Flexible height setting mechanism.
4	Adjustable seat back	An ergonomic backrest that can be adjusted at an angle of tilt.

5	The chair has a long service life	
6	Using sturdy and strong materials	Types of materials used
7	The seat is easy to clean.	
8	Foldable seat	Practical folding mechanism with sturdy hinges.

HoQ phase 1 is created using selected customer needs data and predetermined characteristics. Customer requirements are placed on the left of the HoQ (row), while the characteristics are at the top of the HoQ (column). The value of the importance level obtained from the calculation results using the Kano model is also used in the design of this HoQ. The phase 1 HoQ matrix can be seen in **Figure 2**.



Row	Customer Needs \ Technical Characteristics	TKK	1	2	3	4	5
	Column		The price of the product is affordable according to the features and design used	The price of the product is affordable according to the features and design used	Ergonomic backrest with adjustable tilt angle	Types of materials used	Practical folding mechanism with sturdy hinges
1	The price of the chair is according to the quality and features	4.52	●	○	○	○	○
2	The chair has an affordable price	4.55	●	○	○	●	○
3	Adjustable seat height	4.30	○	●	▽	▽	●
4	Adjustable seat back	4.27	○	▽	●		●
5	The chair has a long service life	4.67	○	▽	○	●	○
6	Using sturdy and strong materials	4.76	○	○	○	●	○
7	The chair is easy to clean	4.30	●			○	
8	Foldable chair	4.27	○	●	●		●
	Absolute Priority Value		187.1	127.6	136.7	156.5	171.1
	Priority Value Percentage		24%	16%	18%	20%	22%

Figure 1 Phase 1 HoQ Matrix

HoQ Phase II (technical or part *characteristics*) transforms technical characteristics into design characteristics that underlie the development of toddler feeding chair products. This matrix illustrates the relationship between the design characteristics of a product and its technical characteristics. The phase 2 HoQ matrix can be seen in **Figure 3**.

Row	Design Characteristics / Technical Characteristics	TKK	1 Lightweight and sturdy material	2 Has a 3-level seating height adjustment mechanism	3 Has a 3-angle backrest fixing mechanism	4 Has foam on the seat and backrest	5 Has a folding mechanism	6 Has a 3-Point seat belt	7 Has anti-slip padding on the legs of the seat	8 Removable seat tray	9 Has handles on the back of the seat
1	Affordable price according to the features and design used	187.1	●	●	●	●	●	●	●	●	●
2	Practical folding mechanism	171.1	○	○	●		●			●	●
3	Types of materials used	156.5	●			○		●	●	●	
4	Ergonomic backrest with adjustable tilt angle	136.7			●	○	○	○			
5	Flexible height setting mechanism	127.6		●			○		○		
	Absolute Priority Value		3605	3345	4454	2563	5425	3502	3475	4632	3224
	Priority Value Percentage		10.5%	9.8%	13.0%	7.5%	15.9%	10.2%	10.2%	13.5%	9.4%

Figure 2 Phase 2 HoQ Matrix

Based on the calculations, a priority value was obtained for the first design characteristic of the toddler dining chair, namely an affordable price according to the features and design used 3605. This priority value is also calculated in the form of a percentage, which is 10.5%. This means that the affordable price characteristics according to the features and design contribute 10.5% in meeting the technical characteristics of the toddler feeding chair. The calculation of the priority value for each design characteristic of the toddler feeding chair is carried out similarly**.**

3.2 Discussion

This study revealed differences in priorities between parents and facility providers (daycare/restaurants) in choosing toddler dining chairs. Parents place more emphasis on price, safety, comfort, and ease of use, with key features such as flexible seat height adjustment and backrest to support good sitting posture for toddlers. In addition, they also prioritize ease of cleaning the chair, considering that toddlers' eating activities often leave food residue. On the other hand, service providers such as restaurants and daycares prioritize price, product durability, ease of storage, and safety for various types of toddlers. Therefore, they need chairs that are sturdy, foldable, and easy to move to facilitate daily operations.

In terms of ergonomics, this study uses local toddler anthropometric data as the basis for designing chair dimensions. However, to ensure compliance with international standards, these results can be compared with standards such as EN 14988 (European standard) and ASTM F404 (United States standard). If there are significant differences in the dimensions of chairs designed with global standards, it is important to evaluate whether these differences have an impact on the comfort and safety of toddlers in Indonesia. In addition, the research findings show that features that support toddlers' posture, such as height adjustment and flexible backrest, are key factors in ergonomic design. Integration of these features can help reduce the risk of fatigue during mealtimes and improve toddlers' comfort in long-term use.

The results of the Kano Model show that the majority of toddler dining chair attributes fall into the One-Dimensional (O), Must-Be (M), and Indifferent (I) categories. One-Dimensional (O) attributes, such as seat height adjustment, adjustable backrest, and strong material, directly affect user satisfaction. If these features are available, users will be satisfied; if not, they will be disappointed. Meanwhile, Must-Be (M) attributes, such as ease of cleaning

the chair, are mandatory features expected by users. If these features are not available, the user experience will be disrupted even if other features are available. On the other hand, Indifferent (I) attributes, such as attractive design and soft seat cushions, do not have much influence on user satisfaction. This shows that aesthetic aspects are not a top priority for parents or facility providers compared to functional aspects. Understanding the distribution of attributes in the Kano Model provides important insights into toddler dining chair design strategies. Since most of the features are in the One-Dimensional (O) category, improving product quality will have a direct impact on user satisfaction. Meanwhile, features in the Indifferent (I) category can still be considered as added value that increases the chair's appeal in the market, although not the main determining factor. By understanding these needs, the design of toddler dining chairs can accommodate both user segments without sacrificing ergonomic and safety aspects.

Based on the research results, there are several innovation opportunities that can be applied to increase product competitiveness. One of them is the development of a more flexible chair adjustment mechanism, for example with a multi-level setting so that the chair can be used longer as the toddler grows. In addition, the application of modular components, such as removable backrests and chair legs, can make the chair more functional by changing it into a regular chair when the child is older. In terms of materials, the selection of anti-stain and anti-bacterial materials is also an important consideration, considering that cleanliness is one of the main aspects that parents pay attention to. With these innovations, the developed toddler dining chair can meet user needs more optimally. Ergonomic, easy-to-use, and highly durable designs will provide significant added value for both parents and facility providers. Therefore, the results of this study can be the basis for the development of toddler dining chairs that are not only functional but also highly competitive in the market.

4. Conclusion

This study successfully identified and determined the design characteristics of ergonomic toddler dining chairs that combine safety, comfort, and usability, addressing the critical needs of families, restaurants, and daycare centers in Padang City. By integrating the Kano model and QFD methodology, the research effectively translates user needs into technical specifications, providing a solid foundation for further product development. The study identified 14 critical customer needs through comprehensive data collection and analysis. Development of technical specifications to suit user needs, including adjustable seat height and backrest, long service life, sturdy materials, and ease of cleaning. Using anthropometric data to ensure the chair's dimensions are optimized for toddlers supports correct sitting posture and reduces the risk of musculoskeletal disorders. Creation of a House of Quality (HoQ) matrix to prioritize design characteristics and ensure the final product meets ergonomic standards.

This research provides a solid foundation for developing an ergonomic toddler dining chair with several practical benefits, including improved safety and comfort for toddlers, reduced risk of musculoskeletal disorders, and improved usability for parents and service providers. This design overcomes the limitations in the market, providing a safer and more convenient product compared to current options. The research framework used in this study can be a reference for future studies in developing ergonomic products. Further research can explore additional features and materials to improve the functionality and sustainability of toddler feeding chairs. Additionally, expanding the study's sample size and geographic scope can provide a more comprehensive insight into user needs and preferences.

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